

## Our “21st Annual” Livestock & Forages Field Day

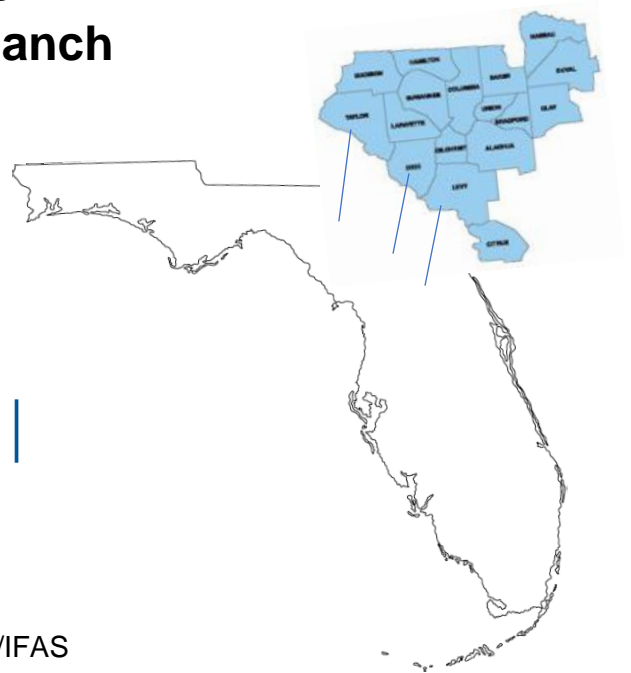
July 25, 2019  
Santa Fe River Ranch

Presented by:



**NORTH FLORIDA  
LIVESTOCK AGENTS GROUP**

Representing 13 north Florida counties



- |                   |  |
|-------------------|--|
| 8:00-8:30         | Registration and Welcome   |
| 8:30-9:30         | Weed ID & Control, Dr. Brent Sellers, UF/IFAS  |
| <b>9:30-10:00</b> | <b>Break – Education/ Industry Displays</b>  |
| 10:00-11:30       | Concurrent Sessions (Pick only 3) <ul style="list-style-type: none"><li>• Herbicides &amp; Nozzle Selection</li><li>• Soil Sampling &amp; Fertility</li><li>• Haylage</li><li>• Pest Management</li><li>• Beef Cow Pregnancy Simulator</li></ul> |
| 11:30 – 12:15     | Equipment Demos  |
| <b>12:15</b>      | <b>Lunch, Farm Credit</b>  |
| 12:45             | Forage Economic Outlook, Chris Prevatt, UF/IFAS  |

July 25, 2019

Dear Producer:

**Welcome to our Annual Livestock & Forages Field Day**, hosted by UF/IFAS Extension Agents representing 13 north Florida Counties! We hope you will enjoy the educational activities planned for you today and that you take away new ideas or maybe a slight twist on an old one. Either way our goal is to help you to be more informed and better able to remain sustainable and profitable in all of your agricultural endeavors!

I want to take a moment and ask you to help us thank all of our industry supporters. Please visit their displays and when the time comes for a new purchase, perhaps one of them may be able to help. I want to also again thank you for supporting our efforts, not just today but throughout the year! Whether you attend this event or any of our local programs we appreciate your support and look forward to hearing from you about how we can better meet your educational needs.

Two of our biggest supporters that also need to be thanked are:

**Alan Hitchcock & his Family** for providing us with this beautiful ranch as a venue each year – Thank you Alan and crew!

And for always being there to provide us a great meal at this event –

**Farm Credit of Florida!**

Thank you all for your generosity and support!

Again on behalf of all of us in the North Florida Livestock Agents Group (NFLAG), we appreciate you coming, please let us know if we can help! There are plenty of us.

Sincerely,

Luke Harlow

NFLAG - Chair



**NORTH FLORIDA  
LIVESTOCK AGENTS GROUP**

An Equal Opportunity Institution

# Thank You Sponsors



**FARM CREDIT**  
OF FLORIDA

12300 NW U.S. Hwy. 441  
Alachua, FL 32615-8500  
Phone: (386) 462-4201

<https://farmcreditfl.com>

Santa Fe River Ranch

29220 NW 122nd Street  
Alachua, FL 32615  
Email: [santaferiverranch@gmail.com](mailto:santaferiverranch@gmail.com)  
<http://santaferiverranch.com>

*Mike Scott*  
**PLUMBING**

**PROGRESSIVE**  
**CATTLEMAN**

Note: The mention of brand name, tradename, trademark, or business does not constitute an endorsement by UF/IFAS Extension – NFLAG. We appreciate their support in our educational endeavors.



HoBo Tractor  
462 SE State Road 238  
Lake City, FL 32025  
(386) 755-2450  
[howard@hobotractor.com](mailto:howard@hobotractor.com)  
  
<http://hobotractor.com/>



Gatorland Kubota  
4502 NW 13<sup>th</sup> ST  
Gainesville, FL 32609  
352-376-4506  
[gatorlandmark@gmail.com](mailto:gatorlandmark@gmail.com)  
<https://www.gatorlandkubota.com/>



Mayo Fertilizer Inc.  
P.O. Box 357  
Mayo, FL 32066  
386-294-2024  
<http://mayofertilizer.com/>



TIGERCO  
P.O. Box  
Braymer, MO 64624  
[www.tigercoinc.com](http://www.tigercoinc.com)



ADCO Global  
12558 Bass Road  
Live Oak, FL 32060  
386-209-2123  
[Cody@adcoglobalinc.com](mailto:Cody@adcoglobalinc.com)



# CHIEFLAND ACE FARM SUPPLY

Proud To Be Locally Owned and Operated

**352-493-4294**

Chiefland Farm Supply  
215 E. Rodgers Ave.  
Chiefland, FL 32626

<http://chieflandfarmsupply.net/>



# Boehringer Ingelheim

Boehringer Ingelheim Animal  
Health

Caroline Feagle  
352-895-0350

# zoetis

FOR ANIMALS. FOR HEALTH. FOR YOU.

Zoetis

Kurt Piepenbrink  
813-267-7601

[kurt.piepenbrink@zoetis.com](mailto:kurt.piepenbrink@zoetis.com)



Florida Department of Agriculture  
Office of Ag Water Policy

729 E. Wade Street  
Trenton, FL 32693  
850-688-0142



Suwannee River Water  
Management District

9225 CR 49  
Live Oak, FL 32060

[www.mysuwanneeriver.com](http://www.mysuwanneeriver.com)

Note: The mention of brand name, tradename, trademark, or business does not constitute an endorsement by UF/IFAS Extension – NFLAG. We appreciate their support in our educational endeavors.

# Weed Management in Pastures and Rangeland—2019<sup>1</sup>

B. A. Sellers<sup>2</sup>

Weeds in pastures and rangeland cost ranchers in excess of \$180 million annually in Florida by reducing forage yield, lowering forage quality, and causing animal injury through toxicity or specialized plant organs (thorns and spines). Effective weed management begins with a healthy pasture. Weeds are seldom a serious problem in a well-managed, vigorously growing pasture. Good pasture management involves the proper choice of the forage species and variety, an adequate fertility program, controlled grazing management, and pest management (weeds, insects, and diseases).

If pasture health declines, weeds will exploit the situation and become established. Bare ground is the perfect environment for establishment of weeds. Once established, weeds must be controlled with mechanical or chemical methods. However, unless the pasture-management problem that caused forage decline is corrected, the grass will not re-establish and weeds will re-infest the area.

Integrated weed management is both an economically and environmentally sound approach to weed management. An integrated approach involves scouting, prevention, and control (biological, cultural, mechanical, and chemical) in a coordinated plan.

## Scouting

Scouting pastures is the foundation of a sound weed management program but is often overlooked. Scouting involves routinely walking or driving through pastures and identifying weeds. This defines the scope of the problem and allows the best management practices to be implemented in a timely fashion. The number of weeds, the species present, and their locations are important. Note the dominant species as well as uncommon or perennial weeds. The management strategies adopted should focus on controlling the dominant species, while preventing the spread of less common species. If not managed proactively, the less common weeds in a pasture may become future dominant weed problems.

Proper identification of weeds is the first step toward weed control. A good example is knowing the difference between tropical soda apple (TSA) and red soda apple (cockroach berry). Of the two, only TSA is a troublesome invasive weed that must be controlled. However, some have occasionally confused the two species and allowed TSA to go uncontrolled. Unfortunately, this costly mistake results in TSA spreading throughout the ranch and potentially onto neighboring ranches. If there are questions concerning weed identification, contact your local UF/IFAS Extension office for assistance.

1. This document is SS-AGR-08, one of a series of the Agronomy Department, UF/IFAS Extension. Original publication date January 2000. Revised February 2009, February 2010, March 2011, January 2012, January 2013, January 2014, February 2015, December 2015, December 2016, February 2017, January 2018, and January 2019. Visit the EDIS website at <https://edis.ifas.ufl.edu> for the currently supported version of this publication.

2. B. A. Sellers, associate professor, Agronomy Department; UF/IFAS Range Cattle Research and Education Center, Ona, FL 33865.

The use of trade names in this publication is solely for the purpose of providing specific information. UF/IFAS does not guarantee or warranty the products named, and references to them in this publication do not signify our approval to the exclusion of other products of suitable composition. All chemicals should be used in accordance with directions on the manufacturer's label. Use herbicides safely. Read and follow directions on the manufacturer's label.

The Institute of Food and Agricultural Sciences (IFAS) is an Equal Opportunity Institution authorized to provide research, educational information and other services only to individuals and institutions that function with non-discrimination with respect to race, creed, color, religion, age, disability, sex, sexual orientation, marital status, national origin, political opinions or affiliations. For more information on obtaining other UF/IFAS Extension publications, contact your county's UF/IFAS Extension office.

U.S. Department of Agriculture, UF/IFAS Extension Service, University of Florida, IFAS, Florida A & M University Cooperative Extension Program, and Boards of County Commissioners Cooperating. Nick T. Place, dean for UF/IFAS Extension.

Some weeds grow best in wet sites (maidencane ponds, depressional areas, ditches, etc.), while others can be found on dry sites (ditch banks, upland areas, and fence rows). Scout pastures for weeds in conjunction with other activities, such as checking calves, working cattle, and feeding. When a weed is first discovered, remove it or spot treat with an appropriate herbicide. Do not allow that one plant to produce seed and give rise to hundreds of new plants. It is less expensive (in terms of both time and money) to control one plant than to wait and have to control hundreds of plants.

Poisonous plants (e.g., *Crotalaria*, black nightshade, spiny pigweed, lantana, etc.) are commonly found throughout Florida. Animals do not usually choose to graze most poisonous plants when forage is abundant; however, when quality forage is limited because of poor growing conditions or overstocking, they may graze these plants.

## Prevention

Prevention is any activity that keeps weeds from infesting a pasture. Most weeds spread by seed. Thus, preventing the movement of weed seeds onto the ranch reduces potential weed pressure. Weed seeds can be transported in hay, harvested grass seed, sod, cattle, mowing equipment, or dispersed by wind, water, and wildlife. Producers should avoid buying hay or grass seed that is contaminated with weed seeds. Refuse to purchase hay from someone who cannot provide a weed-free product. Using certified forage seed reduces weed seed contamination and is highly recommended.

Also, consider TSA. Cattle have been shown to excrete TSA seeds for at least 7 days after consumption. If cattle are grazing in a TSA-infested pasture, it is recommended that the cattle are held in a clean area for 10 days before moving them to a new pasture. This will reduce the likelihood of transporting TSA seeds. Remember, an ounce of prevention is worth a pound of cure.

## Control

### Cultural Control

Cultural practices improve weed control by increasing the competitiveness of the forage. This involves optimizing forage production through monitoring soil pH, fertility, and, potentially, water management. Generally speaking, a thick sward will prevent weed emergence, will outcompete emerged weeds, and will capture the majority of environmental resources (light, water, nutrients) necessary for growth. The aim of cultural practices is to modify your

management program so that the sward is as competitive as possible.

Soil pH is an important factor for forage growth as well as weed establishment. Forage agronomists and soil scientists at the University of Florida have determined the optimum soil pH for most forages grown in Florida. Acidic soils limit plant growth and can result in aluminum and manganese toxicity and magnesium, calcium, phosphorous, molybdenum, and potassium deficiency. Soil acidity may also result in poor root growth, which can reduce water and nutrient uptake. Weeds that grow under such conditions can be indicators of low soil pH. For example, crowfoot grass germination is optimum at soil pH levels between 4 and 5, which is too low for optimum forage growth. Thus, the presence of crowfoot grass in your pasture may warrant a soil test and corrective action.

### Mechanical Control

Mowing is one of the most often used weed control methods in pastures. Mowing improves the appearance of a pasture, temporarily increases forage production, and, if properly timed, prevents weeds from producing seed. Mowing is generally more effective on broadleaf weeds than grass weeds and is more effective on annual weeds than perennial weeds. Carefully consider the cost of mowing and the anticipated effectiveness. As fuel prices increase, it may be more cost-effective to avoid mowing and use other forms of weed control since other weed control methods may be more effective on a given species.

Mechanical weed control does have drawbacks. Large weeds with extensive root systems will not be controlled through mowing alone. Additionally, mowing misses prostrate-growing weeds like crabgrass, spurge, and matchweed. Mowing can also spread vegetative plant stems, allowing the plant (e.g., prickly pear) to root elsewhere. If mowing is performed after seed set, seeds can accumulate on the mowing equipment and worsen the weed problem by spreading seed to other pastures.

### Biological Control

Biological control involves the use of biotic agents (e.g., plants, herbivores, insects, nematodes, and phytopathogens) to suppress weeds. Overall, biological control is still in its infancy, but great strides are being made, especially against invasive plants. Two good examples are the tobacco mild green mosaic tobamovirus (TMGMV) and the newly released insect, *Gratiana boliviana*, both used for TSA control. The virus TMGMV can be sprayed to control

existing TSA plants, while the beetle is used primarily for suppression.

Most biological control agents rarely provide complete weed control, but they usually suppress the weed population to a manageable level. Additionally, biological control agents are rarely fast-acting, so time is needed for the agent to suppress a given weed population. For example, the effect of *Gratiana boliviana* is not often seen until the year following the release of the beetle.

## Chemical Control

Chemical weed control includes the use of herbicides. Herbicides kill weeds by inhibiting plant processes necessary for growth. Herbicides should be selected based on forage species being grown, weed species present, cost, and ease of application. Application method and environmental impact should also be considered.

Proper herbicide choice and application rate are extremely important. Lower-than-recommended application rates will not provide consistent weed control, while excessive application rates may cause injury to the forage or result in only killing the above ground portion of perennial weeds. Also, herbicides must be applied at the correct time to be cost-effective.

Preemergence applications are made before weeds germinate and emerge. Understanding the life cycle of the weed is important when using a preemergence herbicide. Some weed seeds germinate in the summer, while others germinate in the winter months. Always refer to the herbicide label for additional information about controlling specific weeds.

Postemergence applications are made after the weeds emerge. The most effective and cost-efficient applications are made when the weeds have recently emerged and are small. For perennial weeds (regrowing from root storage organs), it is advisable to allow them to bloom before spraying, which allows sufficient leaf surface for coverage and ensures that the perennial is transporting photosynthates back to the roots.

Postemergence herbicides may be broadcast over the entire pasture or may be applied as a spot treatment to sparse weed patches. Spot treatment is less costly compared to broadcast spraying. Other application methods include wipers and mowers that dispense herbicide while mowing the weed. In all cases, it is extremely important to carefully read the herbicide label before purchase to determine if that herbicide controls the weeds in your situation.

## PRECAUTIONS WHEN USING PHENOXY OR BENZOIC ACID HERBICIDES

1. For information about growth-regulating herbicides not covered below, see UF/IFAS Publication SS-AGR-12, *Florida's Organo-Auxin Herbicide Rule 2018* (<http://edis.ifas.ufl.edu/wg051>).
2. Application of other pesticides from sprayers previously used for 2,4-D, dicamba, or other phenoxy or benzoic acid herbicides to susceptible crops may result in injury.
3. Legumes in pastures or rangelands will be injured or killed by these herbicides.
4. Avoid drift to susceptible crops by applying at low pressures and when wind speeds are low and blowing away from susceptible crops. The use of a drift-control additive is advisable.
5. Clean sprayer thoroughly with household ammonia as follows:
  - a. Flush system with water. Drain.
  - b. Flush the system with ammonia (1 qt ammonia per 25 gallons water); let it circulate for at least 15 minutes, then flush the system again. Drain again.
  - c. Remove screens, strainers, and tips, and then clean in fresh water.
  - d. Repeat step 5b.
  - e. Thoroughly rinse the tank, hoses, booms, and nozzles.
  - f. Be sure to clean all other associated application equipment.

## Forage Tolerance

Not all cultivars of a particular forage species respond similarly to a given herbicide (Table 5). 'Argentine' bahia-grass tolerates most pasture herbicides except Roundup, while 'Pensacola' may be severely injured by metsulfuron-containing products, such as Cimarron and others. All herbicides may be used on stargrass and bermudagrass, with some level of injury from Velpar (hexazinone). *Hemarthria*, also known as limpograss, is the most sensitive to herbicide applications of all forage grasses grown in Florida.

It is important to realize that the response observed from an herbicide application can vary. For example, the chance for forage injury can increase or decrease as the rate of



herbicide applied either increases or decreases. Additionally, environmental conditions such as high temperature and high relative humidity may increase the potential for herbicide injury. For example, we have observed little or no injury to limpgrass from 8 pt./acre 2,4-D amine when applied under cooler conditions, while 4 pt./acre in warmer weather caused moderate to severe injury.

The response of forages in Table 5 is for established forage cultivars. However, 2,4-D + dicamba (2 pt./acre) can be applied to sprigged forage cultivars, except for limpgrass, seven days after planting/sprigging. A forage can be considered established when at least three tillers are present on bahiagrass or at least 6 in. of new stolon growth is present on sprigged forages.

## Summary

Maintaining healthy, productive pastures will minimize the risk associated with weedy plants. Good pasture management practices such as adequate fertilization, insect control, and controlled grazing will result in healthy pastures. Unfortunately, weeds are present in pastures and the associated loss in forage production can have serious economic implications. An integrated weed management strategy involving prevention, detection, and control is the most economical and environmentally friendly approach to pasture weed management.

Table 1. Weed control in pastures and rangeland.

Trade Name and Rate of Commercial Product Per Acre	Common Name	Remarks
<b>DURING ESTABLISHMENT</b>		
<b>Preemergence to Weeds</b>		
2,4-D Several Brands <sup>1</sup> 1.0–2.0 qt. of 4 lb./gal. formulation	2,4-D amine or LV ester 1.0–2.0 lb.	<b>Bermudagrass and stargrass only.</b> Apply after sprigging and before emergence of sprigged bermudagrass. Will not give complete weed control; however, short residual control of seedling broadleaves, sedges, and certain grasses may be noted for 2–3 weeks, if proper environmental conditions exist.
Diuron 4L 1.5–4.5 pt. or Diuron 80 1–3 lb.	Diuron 0.8–2.4 lb.	<b>Bermudagrass only.</b> Will provide fair to good control of crabgrass, crowfootgrass, and goosegrass. Plant sprigs 2 inches deep. If sprigs have emerged at time of application, bermudagrass injury will occur. Do not graze or cut hay within 70 days. Before application, ensure that your product has proper labeling, since not all Diuron products are labeled for use in pastures. Do not use this herbicide when planting tops.
2,4-D + dicamba <sup>1</sup> (Weedmaster, others) 2 pt.	dicamba + 2,4-D	<b>Bermudagrass and stargrass only.</b> Similar to 2,4-D, but often provides greater weed control. Short residual control of seedling broadleaves, sedges, and certain grasses may be noted for 2–3 weeks if proper environmental conditions exist. <b>Do not apply to limpograss (<i>Hemarthria</i>) during establishment.</b>
<b>Postemergence to Weeds</b>		
2,4-D Several Brands <sup>1</sup> (0.5–1.0 qt. of 4 lb./gal. formulation)	2,4-D amine	<b>Do not apply to bahiagrass until plants are 5”–6” tall. Do not apply to limpograss (<i>Hemarthria</i> sp.) during establishment.</b> Bermudagrass can tolerate 2,4-D at any growth stage. Controls most seedling broadleaf weeds. Repeat application may be needed.
2,4-D + dicamba <sup>1</sup> (Weedmaster, others) 2 pt.	dicamba + 2,4-D	Can be used during establishment of hybrid bermudagrass, stargrass, and pangolagrass. Annual sedges and some grasses will be suppressed if less than one inch at time of application. Best results are seen if applications are made 7–10 days after planting. <b>Do not apply to limpograss (<i>Hemarthria</i>) during establishment.</b>
Banvel, Clarity, Vanquish 1.5–2 pt.	dicamba	Primarily used for establishment of limpograss ( <i>Hemarthria</i> ). Annual sedges and some grasses will be suppressed if less than one inch at time of application. Best results are seen if applications are made 7–10 days after planting.
<b>ESTABLISHED STANDS</b>		
<b>Dormant Pastures</b>		
Gramoxone SL 1–2 pt.	paraquat	For <b>dormant</b> bermudagrass or bahiagrass. Apply in 20–30 gallons of water in late winter or early spring (probably in January or February) before grass begins spring green-up. Add one pt. surfactant (non-ionic) per 100 gal. spray mix. Do not mow for hay until 40 days after treatment. Can be mixed with 2,4-D or other herbicides for more broad-spectrum control.
Prowl H <sub>2</sub> O 1.1–4.2 qt.	pendimethalin	Applications of 3 qt/ac. have provided satisfactory weed control, but late-season escapes should be expected. Provides preemergence control of crabgrass, goosegrass, Texas panicum, sandbur, and other summer annual grasses. Must have activating rainfall or irrigation within two weeks or control will be minimal at best. Does not control plants that have already emerged.
Roundup Weathermax (or other 5.5 lb formulations) 11 fl. oz. or Roundup Ultra (or other 4 lb formulations 16 fl. oz.)	glyphosate	Apply in mid- to late-winter months to bermudagrass or bahiagrass pastures and hayfields for the control of weedy grasses. Apply before new growth appears in the spring. Bermudagrass that is not dormant at the time of application may show a 2–4 week delay in green-up. No restrictions exist between application and grazing or haying.
<b>Non-Dormant Pastures</b>		
2,4-D Several Brands <sup>1</sup> 2.0–4.0 pt. of 4 lb./gal. formulation	2,4-D amine <b>or</b> LV ester 1.0–2.0 lb.	<b>Broadleaf weeds.</b> Annual weeds should be treated soon after emergence for best control with lower rates. Perennial weeds should be allowed to obtain a leaf surface large enough to allow sufficient spray coverage (about 12”–18” tall). Use amine formulations during warm weather and LV esters during cool weather. Avoid drift. Applications of 2,4-D to limpograss ( <i>Hemarthria</i> sp.) will cause significant injury during periods of high temperatures and humidity; much less injury has been observed during cool and dry conditions.

Trade Name and Rate of Commercial Product Per Acre	Common Name	Remarks
Banvel <sup>1</sup> , Clarity, Vanquish 0.5–2.0 qt	dicamba	<b>Broadleaf weeds.</b> Rate depends on weed species and size. Refer to the label for grazing restrictions. Avoid drift. <i>Hemarthria</i> has generally exhibited more tolerance to dicamba than 2,4-D.
Chaparral 2.0–3.3 oz.	metsulfuron + aminopyralid	Use on bermudagrass, pangolagrass, stargrass, and limpograss. Do not use on bahiagrass. Controls tropical soda apple, pigweed, blackberry, and many other problematic weed species. Will not control dogfennel. Add a non-ionic surfactant at 1–2 pt./100 gal. of solution. Avoid applications during spring green-up.
Cimarron Plus 0.125–1.25 oz. or Cimarron Xtra 0.5–2.0 oz./ac.	metsulfuron + chlorsulfuron	Use on bermudagrass, pangolagrass, and stargrass. Controls several cool-season broadleaf weeds, pigweeds, and Pensacola bahiagrass. Bermudagrass should be established no less than 60 days prior to application. Add a non-ionic surfactant at 1–2 pt./100 gal. of solution. Avoid application during spring green-up.
Cimarron Max Part A (0.25–1.0 oz.) Part B (1.0–4.0 pt.)	Part A— metsulfuron Part B—2,4-D + dicamba	Cimarron Max is a two-part product that should be mixed at a ratio of 5 oz. <i>Part A</i> to 2.5 gallons <i>Part B</i> . Depending on the weeds present and the rate range that is selected, this mix will treat between 5 to 20 acres. For specific information on rate selection, consult the product label.
GrazonNext HL <sup>1</sup> 1.6–2.1 pt.	aminopyralid + 2,4-D	Excellent control of TSA, horsenettle, and other members of the nightshade family. Also controls pigweeds and other broadleaf weeds including less than 20" dogfennel. Do not apply more than 2.1 pt./ac./yr. Do not apply to desirable forage legumes or severe injury and stand loss will occur. Do not apply to limpograss. GrazonNext will pass through animals and remain in the waste. Do not mulch sensitive crops with manure if animals have been grazing on GrazonNext-treated pastures. Avoid applications of this product to limpograss pastures during hot and humid conditions.
MSM 60, others 0.3–1.0 oz.	metsulfuron	Use on bermudagrass, pangolagrass, and stargrass. Controls several cool-season broadleaf weeds, pigweeds, and Pensacola bahiagrass. Bermudagrass should be established no less than 60 days prior to application. Add a non-ionic surfactant at 1–2 pt./100 gal. of solution. Avoid application during spring green-up.
Impose or Panoramic 4–12 fl. oz.	imazapic	DO NOT apply to bahiagrass. DO NOT apply during spring transition or severe bermudagrass or stargrass injury will occur. In summer months, expect 3–4 weeks of bermudagrass stunting after application, followed by quick recovery and rapid growth. This will reduce harvest yields of that cutting by 30%–50%. If this yield reduction is not acceptable, do not use these herbicides. Yield reductions of subsequent cuttings have not been observed. For control of crabgrass, sandspur, nutsedges, and vaseygrass, use 4 oz./ac. For suppression of bahiagrass, use 12 oz./ac.
Milestone 3–7 oz.	aminopyralid	Excellent control of tropical soda apple, horsenettle, and other members of the nightshade family. Controls pigweeds and other broadleaf weeds, but does not control blackberry or dogfennel. Can be safely applied under trees. Do not apply more than 7 oz./ac./yr. Do not apply to desirable forage legumes or loss of stand will occur. The use of a non-ionic surfactant is recommended. Milestone will pass through animals and remain in the waste. Do not mulch sensitive crops with manure if animals have been feeding on Milestone-treated pastures. Safe on limpograss.
Outrider 1.0–1.33 oz.	sulfosulfuron	Safe to apply to established bermudagrass and bahiagrass. Provides excellent control of annual and perennial sedges.
Pastora 1–1.5 oz.	metsulfuron + nicosulfuron	<b>Established Bermudagrass Only.</b> Can be used to effectively control seedling crabgrass, sandbur, vaseygrass, and established johnsongrass. Established vaseygrass will require retreatment for long-term control. If sandbur or crabgrass is greater than 4" tall, only seedhead suppression should be expected. Do not apply more than 2.5 oz./ac./yr. Do not apply to limpograss or bahiagrass due to high injury potential.
PastureGard HL <sup>1</sup> 1–2 pt.	triclopyr + fluroxypyr	Provides excellent control of dogfennel, blackberry, teaweed, and other broadleaf weeds. Less effective on tropical soda apple than triclopyr-ester (Remedy Ultra, others) alone. Forage legumes will be severely injured or lost if present at time of application. Applications of 2 pt./A may result in less than desirable weed control. Do not apply more than 8 pt./A per season. Surfactant should be added to spray mixture at 0.25% v/v.

Trade Name and Rate of Commercial Product Per Acre	Common Name	Remarks
Prowl H <sub>2</sub> O 1.1–4.2 qt.	pendimethalin	Apply only to established perennial warm-season grasses including bahiagrass and bermudagrass grown for forage or hay production between cutting or grazing events. DO NOT apply to bermudagrass and other warm-season grasses after greenup in the spring before the first cutting. DO NOT apply when surface water is present. Maximum application per year is 4.2 qt/acre. Provides preemergence control of annual and some perennial grass weeds, but does not control existing plants.
Remedy Ultra, others 2 pt.	triclopyr ester	Provides excellent control of herbaceous and certain woody plants in pasture and rangeland. For best results, apply in 30 or 40 gallons of water per acre. The addition of a non-ionic surfactant at 0.25% v/v will increase control. Applications at air temperatures >85°F may cause moderate to severe bermudagrass injury for 2–3 weeks.
Roundup Weathermax 8–11 fl. oz./ac.	glyphosate	For control of annual grasses in bermudagrass and stargrass. Apply immediately after hay removal, but prior to regrowth. Applications made after regrowth has occurred will cause stunting. Application rates as low as 6 oz./ac. are often effective for crabgrass and other small annual grass weeds. Do not apply more than 2 qt./ac./year. If Roundup Weathermax is applied to a dormant pasture, it cannot be sprayed again that season. Be sure to read the label of the particular brand prior to purchase to ensure that the application site is labeled for use.
Sandea 0.67 – 1.33 oz	halosulfuron	Safe to apply to bahiagrass, bermudagrass, and stargrass for annual and perennial sedge control. Does not control Surinam sedge. Do not apply more than 1.33 oz per acre in a 12 month period.
Telar 0.1–1.0 oz.	chlorsulfuron	For use on established warm-season forage grass species. Telar will control blackberry, pigweeds, wild radish, and selected winter weeds. Not effective on ragweed, tropical soda apple, and other common weeds. Ryegrasses will be severely injured or killed by Telar. Do not apply more than 1.3 oz./ac./yr. There are no grazing restrictions for any animals.
2,4-D + dicamba <sup>1</sup> (Weedmaster, others) 0.5–4.0 pt.	dicamba + 2,4-D amine	See remarks for 2,4-D and dicamba above. This mixture is usually more effective than either herbicide used alone.
<b>Hard-To-Kill Perennial Grasses</b>		
glyphosate 1.3–4. oz per gal	glyphosate 1%–3% solution for hand sprayer	<b>Spot treatment.</b> Apply when perennial weeds are actively growing. Surrounding forage will be killed if sprayed.
glyphosate 4–8 qt. to 2 gal. water	glyphosate 33%–50% solution	<b>Wiper application.</b> Apply at speeds up to 5 mph. Two passes in opposite directions. No more than 10% of any acre should be treated at one time.
<b>Smutgrass</b>		
Velpar L/Tide Hexazinone 2.75–4.5 pt., Vellosa 2.29–3.75 pt. or Velpar DF 0.9–1.5 lb.	hexazinone	Apply hexazinone to established stands of bermudagrass or bahiagrass when soil conditions are warm and moist and weeds are actively growing. Best control of smutgrass is usually achieved in late spring to early summer when regular rainfall occurs at an application rate of 3 to 4 pints/acre (Velpar L/Tide Hexazinone). Some temporary yellowing of the bermudagrass or bahiagrass will be observed, but plants will soon outgrow this effect. Apply hexazinone by ground equipment only, and only one application is allowed per year. <b>KEEP SPRAYS WELL AWAY (AT LEAST 100 ft.) FROM THE BASE OF DESIRABLE TREES, ESPECIALLY OAKS.</b> Check label instructions for further precautions and safe use suggestions.
<b>Pensacola Bahiagrass</b>		
MSM 60, others 0.3 oz.	metsulfuron	Apply to bermudagrass hay fields early in the season, after bahiagrass green-up but prior to seedhead formation. Early applications are often most effective; fall applications rarely control bahiagrass. Do not apply with liquid fertilizer solutions, as poor control may occur. Prolonged periods of dry weather prior to application will greatly decrease herbicide effectiveness. Always include a non-ionic surfactant at a rate of 0.25% v/v. Common or 'Argentine' bahiagrass will not be effectively controlled. Pasture legumes will be severely injured or killed.
Cimarron Plus 0.5 oz. or Cimarron Xtra 1.0 oz.	metsulfuron + chlorsulfuron	Same as metsulfuron.

Trade Name and Rate of Commercial Product Per Acre	Common Name	Remarks
<b>Cogongrass</b>		
Roundup, others 4 to 6 fl oz/ga	glyphosate 3 to 5% solution for hand sprayer	For spot treatment of cogongrass. For best results apply in the fall prior to frost. Applications to the entire patch plus an additional 5 ft beyond the patch is beneficial. Late fall treatment is typically better than spring treatments.
Roundup, others 128 oz.	glyphosate	For broadcast treatment of cogongrass infestations. Burning followed by 6 weeks of regrowth tends to improve control over treating long-established cogongrass stands. Late fall treatment is typically better than spring treatments.
Arsenal, others 1.4 fl oz/gal	imazapyr 1% solution for hand sprayer	For spot treatment of cogongrass. Do not apply near areas with desirable hardwood trees. Provides longer-term control than glyphosate. Applications to the entire patch plus an additional 5 ft beyond the patch is beneficial. Late fall treatment is typically better than spring treatments. <b>DO NOT</b> treat more than 1/10 of the available area to be grazed or cut for hay.
Arsenal, others 48 oz/acre	imazapyr	For broadcast treatment of cogongrass. Do not apply near areas with desirable hardwood trees. Provides longer-term control than glyphosate, but plant-back restrictions may limit opportunities to plant forage crops in treated areas with this herbicide. <b>DO NOT</b> treat more than 1/10 of the available area to be grazed or cut for hay nor apply more than 0.75 lb of imazapyr (48 fl oz) per acre per year.
<b>Tropical Soda Apple</b>		
Chaparral 2–3 oz.	metsulfuron + aminopyralid	Excellent control of TSA plants. Provides preemergence control of TSA seedlings for approximately six months after application. There are no grazing or haying restrictions; however, delaying cutting for 14 days will enhance weed control. Not for use on 'Pensacola' bahiagrass.
GrazonNext HL <sup>1</sup> 1.6–2.1 pt.	aminopyralid + 2,4-D	Excellent control of tropical soda apple. Provides preemergence control of TSA seedlings for approximately six months after application. The 1.6 pt./ac. rate is highly effective on emerged TSA plants, but the 2.1 pt./ac. rate will provide the greatest length of residual control. Do not apply more than 2.1 pt./ac./yr. Will severely injure desirable forage legumes. Do not apply to limpograss. There are no grazing restrictions, but do not harvest for silage or hay for seven days.
Milestone 5–7 oz.	aminopyralid	Excellent control of tropical soda apple. Provides preemergence control of TSA seedlings for approximately six months after application. The 5 oz rate is highly effective on emerged plants, but the 7 oz. rate will provide the greatest length of residual control. Do not apply more than 7 oz./ac./yr. Do not apply to desirable forage legumes or loss of stand will occur. Volatility is low. The use of a non-ionic surfactant at 0.25% v./v. is recommended.
Remedy Ultra, others <sup>1</sup> 1.0 qt.	triclopyr ester	Apply in late spring through summer as a broadcast spray for control of this species. Best results will occur when plants are adequately covered with spray solutions. Application of 30–40 gal./ac. of herbicide solution will be more effective than 20 or lower. The addition of a non-ionic surfactant at 0.25% v./v. will increase control. Retreatment will be required as new seedlings emerge. Spot spray rate is 0.5%–1.0% v./v.
<b>Prickly Pear Cactus</b>		
Remedy Ultra, others <sup>1</sup> 20% + basal oil 80%	triclopyr ester 20% diesel fuel or basal oil 80% (Spot treatment)	Apply as a spot treatment directly to prickly pear pads during spring and summer. Grass will be burned in treated spots but will recover. The addition of diesel fuel drastically enhances herbicide uptake, which will lead to prickly pear control. Prickly pear will die slowly over a period of 6–8 months with a few plants requiring retreatment.
Trumpcard 3 pt.	fluroxypyr + 2,4-D	Apply Trump Card as a broadcast treatment in water. The use of a surfactant is required. A maximum of 3 pt./acre per growing season is allowed, but 6 pt./ac. is required for effective control. Two applications of 3 pt./ac. over two growing seasons has been shown to be effective.
Vista XRT 22 oz.	fluroxypyr	Apply Vista XRT at 22 oz./ac. as a broadcast treatment in water. The use of a surfactant is required. For spot treatment, use 0.5 fl. oz. (15 ml) per gallon of water. Control is very slow, and it often takes more than one year to see satisfactory results.

Trade Name and Rate of Commercial Product Per Acre	Common Name	Remarks
<b>Blackberry</b>		
Chaparral 2 oz.	metsulfuron + aminopyralid	Chaparral will provide good to excellent control of blackberry. For best results, apply when moisture conditions are sufficient and blackberry plants are not under drought stress. Late bloom and fall applications of Chaparral are the most effective. DO NOT apply in bahiagrass pastures. Do not mow within six months prior to application or control will be greatly reduced.
Cimarron Plus 0.75 oz. or Cimarron Xtra 2.0 oz./ac.	metsulfuron + chlorsulfuron	Cimarron will provide good to excellent control of blackberry. Results are best when applied at blooming or late in the fall. Do not mow within six months prior to application or control will be reduced. <b>DO NOT</b> apply to bahiagrass pastures.
Escort, MSM 60, others 0.3–0.5 oz	metsulfuron	Metsulfuron will provide good to excellent control of blackberry. Results are best when applied at blooming or late in the fall. Apply to bahiagrass pastures only as a last resort and expect 6–8 weeks of reduced growth and some stand thinning. Mixing with 1 pt./ac. 2,4-D amine will help reduce bahiagrass injury when applying in bahiagrass.
PastureGard HL <sup>1</sup> 2 pt.	triclopyr + fluroxypyr	Control similar to Remedy.
Remedy Ultra, others <sup>1</sup> 2 pt.	triclopyr	For best control of blackberry, apply 2 pt. when blooming and do not mow within one year prior to application. Remedy does not control dewberry. Applications made during prolonged periods of dry weather can greatly decrease control. Fall applications often provide more consistent blackberry control.
Telar 0.75 oz.	chlorsulfuron	Similar to control with Cimarron. Telar can safely be applied to bahiagrass or bermudagrass.
<b>Dogfennel</b>		
2,4-D + dicamba <sup>1</sup> (Weedmaster, others) 2–3 pt.	dicamba + 2,4-D	Apply when plants reach a height of 12"–18". Weedmaster is most effective approximately one month after dogfennel transition from winter dormancy. Refer to previous comments for dicamba and 2,4-D above.
GrazonNext HL <sup>1</sup> 24 oz.	aminopyralid + 2,4-D	Apply when plants are less than 30" tall. If plants are larger than 30", tank-mix GrazonNext with 3 pt./ac. 2,4-D, or 8 oz/A PastureGard HL.
PastureGard HL <sup>1</sup> 24 oz.	triclopyr + fluroxypyr	For control of larger dogfennel that has reached 40 inches or more in height.
Trump Card 3 pt.	fluroxypyr + 2,4-D	For control of dogfennel that are 18"–36".
<b>Mixed Stands: Grass - Clover/Lespedeza Pastures</b>		
2,4-D amine <sup>1</sup> 0.5–1.0 pt.	2,4-D (0.25 + 0.5 lb)	Apply only one treatment per year to established perennial clover. Slight to moderate injury may occur. See label for specific use information.
<b>Thistles</b>		
2,4-D 2 qt.	2,4-D	Highly effective if applied to thistles in the rosette stage. 2,4-D is not effective on thistles that have bolted or flowered. During cool temperatures, the ester formulation of 2,4-D will be most effective.
GrazonNext HL <sup>1</sup> 1.6–2.1 pt.	aminopyralid + 2,4-D	Excellent control of thistles at any stage of growth.
2,4-D + dicamba <sup>1</sup> (Weedmaster, others) 1.0–2.0 qt	dicamba + 2,4-D	Apply late fall to early spring when daytime temperatures are > 50°F. Applications are most effective if applied before flower stalks elongate. The addition of crop oil will increase herbicidal activity. Refer to previous comments for dicamba and 2,4-D above. For small rosettes, 1 qt./ac. rate is sufficient. For larger rosettes, 1.5–2 qt./ac. will be required.
<sup>1</sup> For state rules pertaining to application of organo-auxin herbicides in Florida, see EDIS Publication SS-AGR-12, <i>Florida Organo-Auxin Herbicide Rule 2015</i> ( <a href="http://edis.ifas.ufl.edu/wg051">http://edis.ifas.ufl.edu/wg051</a> ). Herbicide recommendations in this report are contingent upon their registration by the US Environmental Protection Agency. If an herbicide's EPA registration is canceled, the herbicide is no longer recommended.		

Table 2. Estimated effectiveness of herbicides on common broadleaf weeds in pastures and hayfields (2,4-D through Impose/Panoramic).<sup>1</sup>

Weed Name	2,4-D	Chaparral	Cimarron Plus or Xtra	Banvel or others	Vista XRT	Diuron	GrazonNext HL	Metsulfuron	Impose/Panoramic
bagpod	F-G	E	E	G	-	-	E	E	-
bitter sneezeweed	E	E	E	E	-	G	E	E	-
blackberry	P	G-E	G-E	F-G	F	P	P-F	G-E	P
bracken fern	P	E	E	P-F	P	P	P	E	-
Brazilian pepper-tree	P	P	P	P	P	-	P	P	P
bullrush	G	-	-	G	P	P	P	-	-
bushmint	P	-	-	F	F-G	-	F	-	-
butterweed	F-G	E	E	F-G	-	-	E	E	-
buttonbush	P	-	-	-	-	-	-	-	-
Caesarweed	G-E	G	G	-	G-E	-	G-E	G	-
camphor weed	F-G	-	-	F-G	-	-	G	-	-
Carolina geranium	P-F	G	G	F-G	G	-	F-G	G	-
castor bean	F-G	-	-	-	-	-	F-G	-	-
chickweed	F	E	E	E	-	P	F	E	-
coffee weed	G	E	E	E	G	-	E	E	-
coral ardisia	P	P	P	P	P	-	P	P	G
creeping indigo	G	E	E	G	-	-	E	E	-
crotalaria, showy	G	G	-	G	G	-	G	-	-
cudweed	F	G	G	E	-	-	E	G	-
curly dock	F	E	E	E	-	P	E	E	-
dayflower	G	F	F	F	-	-	F-G	F	-
dewberry	P	F-G	F-G	P	-	-	P	F-G	-
dodder	P	-	-	P	-	P	-	-	-
dogfennel	F-G	P	F	F-G	G	P	F-G	F	-
dollarweed	G	G	G	E	F	-	G	G	-
elderberry	F-G	-	-	F-G	-	-	F-G	-	-
evening primrose	E	G	G	E	-	G	E	G	-
Florida pusley	P	-	-	P-F	P	E	G-E	-	-
flat-top goldenrod	G	P	P	F-G	P	-	G	P	-
gallberry	G	-	-	E	-	P	-	-	-
goatweed	G	G	G	F-G	P-F	-	-	G	P
goldenrod	F	P	P	G	-	P	G	P	-
greenbrier	P	F	F	P	F-G	-	P	F	-
groundcherry	F-G	-	-	F-G	-	-	E	-	-
hairy indigo	F-G	E	E	F-G	F-G	-	E	E	-
hempvine	F-G	E	-	F-G	E	-	E	-	-
honeysuckle	-	-	-	E	-	P	-	-	-
horsenettle	P	E	P-F	G	F	P	E	P-F	-
horseweed	F	G	F	E	-	P	E	F	-
kudzu	P-F	G	P-F	G	P	P	G	P-F	P
lantana	P	P	P	P	F-G	-	P	P	-
matchweed	G	-	-	G	F-G	-	G-E	-	-

Weed Name	2,4-D	Chaparral	Cimarron Plus or Xtra	Banvel or others	Vista XRT	Diuron	GrazonNext HL	Metsulfuron	Impose/Panoramic
maypop	P	P	P	P	-	-	-	P	-
Mexican tea	G	E	E	G-E	-	-	E	E	-
milkweed	F-G	-	-	G	-	-	F-G	-	-
morning glory	G-E	E	G-E	E	E	-	E	G-E	-
palmetto	P	P	P	F	G	P	P	P	P
pawpaw	P	P	F	P	F-G	-	P	F	-
persimmon	P	-	-	F-G	-	P	P	-	P
pigweed	F	E	E	E	P	F	E	E	G
plantains	E	E	E	E	-	-	-	E	-
pokeberry	G	-	-	E	P	P	P	-	-
prickly pear	P	P	P	F	G	P	P	P	P
prickly poppy	G	E	G	G-E	G	-	E	G	-
ragweed	E	E	G	E	G	G	E	G	F
red sorrel	P	E	E	E	-	F	-	E	-
redroot, Carolina	-	P-F	P-F	-	P-F	-	-	P-F	F-G
rosary pea	F	E	G	G	F-G	-	E	G	-
sand vetch	F	E	G	G	G	-	E	G	-
saltbush	P	P	P	P	F	-	P	P	-
shepherd's purse	E	-	-	E	-	G	-	-	-
sicklepod	G	G	G	E	G	F	G	G	F-G
smartweed	G	E	G	G	-	-	E	G	-
softrush	G	P	P	F-G	P	-	F-G	P	-
Spanish needles	G-E	E	G	E	-	-	E	G	-
stinging nettle/fireweed	P	E	-	-	G-E	-	E	-	P
tall elephant's foot	F	-	-	F-G	-	-	F-G	-	-
teaweed	P	G	G	G	-	-	G	G	-
thistles	E	E	F	G	G	F	E	F	-
toadflax, oldfield	F-G	G-E	G-E	G	-	-	G-E	G-E	-
tropical soda apple	P	E	P	F-G	F	P	E	P	P
Virginia pepperweed	G	-	-	E	G	G	-	-	-
wax myrtle	P	P	-	P-F	-	P	P	-	-
whitehead broom	P	P-F	P-F	P	P	-	P	P-F	-
winged sumac	F-G	-	-	-	F-G	-	F-G	-	-
wild garlic	G-E	G	G	E	-	P	-	G	-
wild radish	G	G-E	G-E	E	-	P	G	G-E	-
yellow jessamine	-	G	G	-	-	-	-	G	-
yellow woodsorrell	P	F-G	F-G	G	F	-	F-G	F-G	-

<sup>1</sup> Weed control symbols: E = 90%–100% control; G = 80%–90% control; F = 60%–80% control; P < 60% control.



Table 3. Estimated effectiveness of herbicides on common broadleaf weeds in pastures and hayfields (Milestone through WeedMaster or others).<sup>1</sup>

Weed Name	Milestone	Outrider	PastureGard HL	Remedy	Velpar	WeedMaster, others
bagpod	E	-	G	F-G	-	F-G
bitter sneezeweed	E	-	E	E	-	E
blackberry	P	P	G-E	G-E	F	P-F
bracken fern	P	-	P-F	P-F	F	P
Brazilian pepper-tree	P	P	P-F	G-E	G-E	P
bullrush	P	-	P	F-G	-	-
bushmint	P	-	G	G	-	P
butterweed	G-E	-	G-E	-	-	F-G
buttonbush	-	-	F-G	G	-	-
Caesarweed	G-E	-	E	E	-	G-E
camphor weed	-	-	G	F-G	-	G
Carolina geranium	G-E	-	-	-	-	G
castor bean	-	-	G	G	-	F-G
chickweed	-	-	F	E	E	E
coffee weed	E	-	E	E	-	G
coral ardisia	P	-	F-G	G	-	P
creeping indigo	E	-	G	G	-	G
crotalaria, showy	-	-	E	E	-	G
cudweed	E	-	G	E	-	G
curly dock	E	-	F	E	P	E
dayflowers	-	-	G	G	-	G
dewberry	-	-	F-G	F-G	-	P
dodder	-	-	P	P	-	P-F
dogfennel	P-F	P	E	G-E	G	G
evening primrose	E	-	G	E	E	E
Florida pusley	-	-	G	-	-	F
flat-top goldenrod	P	-	P	P	-	G
gallberry	-	-	E	E	P	G
goatweed	-	-	F	F	F-G	G
goldenrod	G	-	G	G	-	G-E
hairy indigo	E	-	G-E	G	-	G
hempvine	E	-	E	E	-	F-G
honeysuckle	-	-	P	P	-	E
horsenettle	E	-	F	F-G	-	F
horseweed	E	-	G	G	-	E
kudzu	G	P	F	F	-	F
lantana	P	-	P-F	P-F	-	P
matchweed	G	-	G	G	-	G
maypop	-	P	G	F	-	P-F
Mexican tea	E	-	E	E	-	E
milkweed	F-G	-	F-G	F-G	-	F-G
morning glory	E	-	E	E	-	E
palmetto	P	P	G	F	P	P-F

Weed Name	Milestone	Outrider	PastureGard HL	Remedy	Velpar	WeedMaster, others
pawpaw	P	-	F-G	G	-	P
persimmon	P	P	F-G	F-G	F	P-F
pigweed	E	-	F	E	G	E
plantains	P	-	-	-	-	E
pokeberry	F	-	P	P	-	E
prickly pear	P	P	F	G <sup>2</sup>	P	P-F
prickly poppy	E	-	E	E	-	G-E
ragweed	E	-	E	E	F	E
red sorrel	-	-	F	E	-	G
redroot, Carolina	-	-	F-G	G	-	G
rosary pea	E	-	G-E	G-E	-	F-G
sand vetch	E	-	E	E	-	E
saltbush	P	-	G-E	E	-	F
shepherd's purse	-	-	G	E	E	E
sicklepod	-	-	G-E	E	-	E
smartweed	E	-	G	G	-	G-E
softrush	P	-	F	P-F	-	F-G
Spanish needles	E	-	E	E	-	E
stinging nettle/fireweed	E	P	E	E	-	F
tall elephant's foot	F	-	F-G	F-G	-	F
teaweed	-	-	G	G	-	F-G
thistles	E	-	G-E	E	E	E
tropical soda apple	E	P	G	G-E	F-G	F-G
Virginia pepperweed	-	-	G	P	E	E
wax myrtle	P	-	F-G	G	P	P-F
whitehead broom	P	-	P	P	F-G	P
winged sumac	-	-	G	G	-	F-G
wild garlic	P	-	P	-	-	E
wild radish	P	-	G-E	E	E	E
yellow jessamine	-	-	G	G	-	-
yellow woodsorrell	-	-	F	F	-	F

<sup>1</sup> Estimated effectiveness based on rates recommended in this report. Effectiveness may vary depending on factors such as herbicide rate, size of weeds, time of application, soil type, and weather conditions.

<sup>2</sup>When applied as spot-treatment in basal oil.

Weed control symbols: E = 90%–100% control; G = 80%–90% control; F = 60%–80% control; P < 60% control.

Table 4. Estimated effectiveness of herbicides on common grass and sedges in pastures and hayfields.

Herbicide	bahia-grass	bermuda-grass	broom-sedge	crab-grass	dallis-grass	guinea-grass	johnson-grass	rye-grass	sandbur	smut-grass	vasey-grass	nutsedge
<b>2,4-D</b>	P	P	P	P	P	P	P	P	P	P	P	P
<b>Banvel or others</b>	P	P	P	P	P	P	P	P	P	P	P	P
<b>Chaparral</b>	G	P	P	P	P	P	-	P	P	P	P	P
<b>Cimarron Plus or Xtra</b>	G	P	P	P	P	P	-	P	P	P	P	P
<b>Diuron</b>	P	P	P	F-G	P	P	P	P	G	P	P	P
<b>GrazonNext HL</b>	P	P	P	P	P	P	P	P	P	P	P	P
<b>Metsulfuron</b>	G	P	P	P	P	P	-	P	P	P	P	P
<b>Impose/Panoramic</b>	P-F	P	P	E	F	-	G	F	G-F	P	P-G	G-E
<b>Milestone</b>	P	P	P	P	P	P	P	P	P	P	P	P
<b>Outrider</b>	P	P	P	P	P	P	E	-	-	P	F-G	E
<b>Pastora</b>	F-G	P	P	F-G	F-G	F-G	G	G	G	P	F-G	P
<b>PastureGard HL</b>	P	P	P	P	P	P	P	P	P	P	P	P
<b>Remedy</b>	P	P	P	P	P	P	P	P	P	P	P	P
<b>Velpar</b>	P	P	P	P	-	-	-	G	-	E	-	P
<b>Vista XRT</b>	P	P	P	P	P	P	P	P	P	P	P	P
<b>Weedmaster or others</b>	P	P	P	P	P	P	P	P	P	P	P	P

<sup>1</sup> Estimated effectiveness based on rates recommended in this report. Effectiveness may vary depending on factors such as herbicide rate, size of weeds, time of application, soil type, and weather conditions.

Weed control symbols: E = 90%–100% control; G = 80%–90% control; F = 60%–80% control; P < 60% control.

Table 5. Tolerance of **established** (for at least 6 months) forage cultivars to commonly used herbicides.

Forage Species	Cultivar	2,4-D	Aim	Ban-vel	Chaparal	Cimmaron Plus	Cimmaron X-tra	Vista XRT	Grazon-Next HL	Impose/Panoramic	Met-sulfuron (MSM 60, others)	Milestone	Outrider	Pastora	Pasture-gard HL	Remedy Ultra, others	Round-up/others	Telar	Vis-ta	Ban-vel + 2,4-D (Weed-Master, etc.)	Vel-par
Bahiagrass	Argentine	T	T	T	I	I	I	T	T	S	I	T	T	NL	T	T	S	T	T	T	T
	Pensacola	T	T	T	S	S	S	T	T	S	S	T	T	NL	T	T	S	T	T	T	T
Bermudagrass	Coastal	T	T	T	T	T	T	T	T	I	T	T	T	T	T	T	I-S	T	T	T	T-I
	Florakirk	T	T	T	T	T	T	T	T	I	T	T	T	T	T	T	I-S	T	T	T	T-I
	Jiggs	T	T	T	T	T	T	T	T	I-S	T	T	T	T	T	T	I-S	T	T	T	T-I
	Tifton-85	T	T	T	T	T	T	T	T	I	T	T	T	T	T	T	I-S	T	T	T	T-I
Brachiaria	Mulato	T	I	T	N	N	N	T	T	N	N	T	T	NL	T	T	S	N	T	T	N
Stargrass	Florico	T	T	T	T	T	T	T	T	I	T	T	T	NL	T	T	I-S	T	T	T	NL
	Florona	T	T	T	T	T	T	T	T	I	T	T	T	NL	T	T	I-S	T	T	T	NL
	Okeechobee	T	T	T	T	T	T	T	T	I	T	T	T	NL	T	T	I-S	T	T	T	NL
	Ona	T	T	T	T	T	T	T	T	I	T	T	T	NL	T	T	I-S	T	T	T	NL
Hemarthria	Floralta	I-S	T	T	T	T	T	T-I	I-S	T-I	T	I	T	NL	I	I	S	T	I	I-S	NL
	Gibbuck	I-S	T	T	T	T	T	T-I	I-S	T-I	T	I	T	NL	I	I	S	T	I	I-S	NL
	Kenhy	I-S	T	T	T	T	T	T-I	I-S	T-I	T	I	T	NL	I	I	S	T	I	I-S	NL

T = tolerant; very little injury if any  
 I = Intermediate; slight injury, will regrow in approximately one month  
 S = Severe injury; more than two months to recover or complete death  
 N = No current information available  
 NL = Not labeled

Table 6. Days between herbicide application to forage or pasture and feeding, grazing, or animal slaughter.

Herbicide	Non-lactating Cattle			Lactating Dairy Cattle		Horses
	Grazing	Hay Cutting	Slaughter	Grazing	Hay Cutting	
Banvel (Up to 1 pt.)	0	7	30	7	37	0
Banvel (Up to 2 pt.)	0	7	30	21	51	0
Banvel (Up to 4 pt.)	0	7	30	40	70	0
Chaparral	0	0	0	0	0	0
Cimarron Plus and Cimarron Xtra	0	0	0	0	0	0
Vista XRT	0	7	0	0	7	0
2,4-D	0	7	3	7	7	0
GrazonNext HL	0	7	0	0	7	0
Metsulfuron	0	0	0	0	0	0
Impose or Panoramic	0	7	0	0	7	0
Milestone	0	0	0	0	0	0
Outrider	0	14	0	0	14	0
Pastora	0	0	0	0	0	0
PastureGard HL	0	14	3	0	14	0
Prowl H <sub>2</sub> O	0	0	0	0	0	0
Remedy Ultra, others	0	14	3	0	14	0
Roundup Powermax (Dormant application)	0	0	0	0	0	0
Roundup Powermax (Between cuttings)	0	0	0	0	0	0
Roundup Powermax (Pasture renovation)	56	56	56	56	56	56
Sandea	0	37	0	0	37	0
Telar	0	0	0	0	0	0
Trumpcard	7	14	2	7	14	7
Velpar	0	38	0	0	38	0
2,4-D + dicamba (Weedmaster, others)	0	7	30	7	7	0

# Calibration of Herbicide Applicators <sup>1</sup>

J. A. Ferrell, B. A. Sellers, and R. Leon<sup>2</sup>

Calibrate your pesticide applicators on a regular basis to ensure that output from each nozzle is consistent and the desired application rate is achieved. If a pesticide applicator is not properly calibrated, the pesticide will probably be applied below or above the desired application rate. Under-application of pesticides generally leads to a lack of pest control and poor pesticide performance, while over-application will cost more money than necessary and may also unintentionally result in harm to desirable species.

The two most common methods for sprayer calibration are discussed below.

## 5940 Method

The 5940 equation is a very accurate way to determine sprayer output (Equation 1). (Each term in this equation is discussed in order, from top and first to bottom and last.)

### Equation 1

$$GPA = (5940 * GPM) / (MPH * W)$$

GPM, Gallons Per Minute

GPA, Gallons Per Acre

MPH, Miles Per Hour

W, Spray Width of One Nozzle in Inches

5940, Constant

**GPM—Gallons Per Minute.** The amount of water discharged from a nozzle in 1 minute. This measurement is achieved by turning on the sprayer and holding a measuring cup underneath the nozzle for one minute. Next, transfer the water obtained into a measuring device that will accurately quantify the water in terms of either fluid ounces or milliliters. Next, convert that amount of water from ounces or milliliters to gallons (since gallons-per-minute is the desired unit).

One gallon consists of 128 fluid ounces or 3786 milliliters. To convert to gallons, divide the amount of water acquired in one minute by 128 or 3,786, depending on whether the container you are using measures the water volume in terms of ounces or milliliters. The result of this calculation is gallons per minute (GPM).

For the most accurate measurement, collect water from multiple nozzles to ensure that output is similar across the boom. (It is common for a nozzle to become plugged, and this practice will identify any malfunctioning nozzle). You can also pour the samples together to determine an average GPM.

1. This document is SS-AGR-102, one of a series of the Agronomy Department, UF/IFAS Extension. Original publication date April 1999. Revised April 2004, October 2009, and September 2012. Reviewed October 2015. Visit the EDIS website at <http://edis.ifas.ufl.edu>.
2. J. A. Ferrell, professor, Agronomy Department; B. A. Sellers, associate professor, Agronomy Department, Range Cattle Research and Education Center; and R. Leon, assistant professor, Agronomy Department, West Florida Research and Education Center; UF/IFAS Extension, Gainesville, FL 32611.

The use of trade names in this publication is solely for the purpose of providing specific information. UF/IFAS does not guarantee or warranty the products named, and references to them in this publication do not signify our approval to the exclusion of other products of suitable composition. Use herbicides safely. Read and follow directions on the manufacturer's label.

The Institute of Food and Agricultural Sciences (IFAS) is an Equal Opportunity Institution authorized to provide research, educational information and other services only to individuals and institutions that function with non-discrimination with respect to race, creed, color, religion, age, disability, sex, sexual orientation, marital status, national origin, political opinions or affiliations. For more information on obtaining other UF/IFAS Extension publications, contact your county's UF/IFAS Extension office.

U.S. Department of Agriculture, UF/IFAS Extension Service, University of Florida, IFAS, Florida A & M University Cooperative Extension Program, and Boards of County Commissioners Cooperating. Nick T. Place, dean for UF/IFAS Extension.

**W—Spray Swath (or Width).** A measurement in inches describing an area covered by one nozzle. If calibrating a boom sprayer, this measurement is the spacing between the nozzles (Figure 1). Common spacing for flat fan nozzles ranges between 15 and 24 inches (see manufacture specifications). If using a boomless nozzle (Figure 2), W will be the width of the pattern for that nozzle. One boomless nozzle will commonly spray a pattern of 12–15 feet. In that case, W for that nozzle will be between 144 and 180 inches.



Figure 1. Measuring nozzle spacing to determine “W”.  
Credits: J. Ferrell, UF/IFAS



Figure 2. A wide-swath, boomless nozzle.  
Credits: J. Boyd, U. of Arkansas

**MPH—Miles per hour.** Most equipment will have a somewhat reliable speedometer. Nonetheless, check the accuracy of the instrument periodically because speed is directly linked to sprayer output in gallons per acre (GPA). If speed is doubled, GPA decreases by half; therefore, small changes in ground speed cause large changes in the amount of pesticide being applied. To check speed, measure off an area (usually 100 feet) and time how long it takes to travel that distance. If using a tractor, make sure that the engine speed (RPM) and transmission gear are at the same settings as when used for spraying. After you have traveled the course, use the following equation:

$$\text{MPH} = (\text{distance (ft)} \times 60) / (\text{time (sec)} \times 88)$$

After GPM, W, and MPH have been determined, plug these values into Equation 1 and solve.

**Changing GPA.** Equation 1 will allow you to determine sprayer output in terms of gallons-per-acre. However, if

GPA is too high or too low, change GPM (by increasing pressure or changing sprayer nozzles) or change the driving speed.

Increasing spray pressure will increase GPM, but only slightly. To illustrate, spray pressure will have to be quadrupled in order to double GPM. Since most spray nozzles are not rated to operate over such a large range of pressures, adjusting pressure is simply a way to “fine tune” sprayer output. Large adjustments in GPM are best achieved by changing to different size nozzles or changing driving speed.

**What GPA is common?** GPA varies depending on the type of application. As a general rule, carrier volumes that range from 15–30 gallons per acre will perform very well. If a specific GPA is desired, Equation 1 can be reorganized—as in the example below—to solve for GPM.

### Equation 2

$$\text{GPM} = (\text{GPA} \times \text{MPH} \times \text{W}) / 5940$$

In this example, inputting the desired GPA, speed (MPH), and nozzle spacing (W), will give the exact amount of water that must be caught from 1 nozzle in 1 minute (GPM). However, the equation will give the answer in gallons per minute. Since gallons are difficult to measure with accuracy, convert the answer to ounces or milliliters. Multiplying GPM by 128 (for ounces) or 3786 (for milliliters) will give the amount of ounces or milliliters that will need to be caught from 1 nozzle in 1 minute to achieve the desired GPA.

## 1/128th Acre Method

The 1/128th acre method is a simplified form of calibration based on spraying 1/128th acre. There are 128 ounces per gallon; therefore, the number of ounces sprayed per 1/128th acre is equal to the number of gallons sprayed per acre. The advantage of this method is that, because little or no math is involved, there are fewer opportunities for mistakes. This procedure is ideal for “boom-type” sprayers, but is less effective for “boomless” sprayers. If calibrating a boomless sprayer, use the 5940 equation. A boom-type applicator can accurately be calibrated by following the steps below.

1. Determine nozzle spacing or swath width. (This is the W term from Equation 1).

2. Using Table 1, determine the course length you will need to travel, relative to nozzle spacing. Measure and mark the distance required and prepare to drive that distance.
3. Record the time required to drive the length of calibration course at gear, engine rpm, and implement settings to be used while spraying.
4. Park sprayer, maintain engine rpm used to drive course, and turn on sprayer.
5. Collect all spray from one nozzle for the amount of time determined in Step 3.
6. Measure the ounces caught. Ounces caught is equal to gallons per-acre of spray applied.
7. Repeat Steps 5 and 6 for several other nozzles to ensure accuracy.

Table 1.

Swath Width or Nozzle Spacing (in)*	Course Distance (ft)
16	255
18	227
20	204
22	186
24	170
*If the necessary nozzle spacing is not listed, the spacing can be calculated using the following equation: Course Distance (ft) = 340 / (Nozzle Spacing (ft))	



# Boom Sprayer Nozzle Performance Test<sup>1</sup>

Frederick M. Fishel<sup>2</sup>

## Introduction

Calibration is adjusting equipment to determine the amount of material being applied to the target area. The main reason for calibration of liquid spray equipment is to determine how much pesticide to put into the sprayer's tank, so you can apply the recommended volume to the target site at a determined speed. Making sure all nozzle tips on the spray boom function uniformly is the fundamental first step of sprayer calibration. The nozzle tips can be affected by several things. Age, lack of maintenance, or type and amount of spray can cause nozzle tips to wear or clog. Worn or clogged nozzle tips make a boom sprayer unable to deliver a uniform spray pattern. The use of a boom sprayer that has a non-uniform nozzle tip output will very likely result in a misapplication.

## Why You Need to Calibrate Equipment

Applicators are legally liable for injuries or damage caused by improper pesticide application. Several problems are associated with applying a pesticide at the incorrect volume.

- *Illegal residues.* Applying higher than legal volumes of a pesticide may result in residues on crop plants that exceed the legal tolerance level. If over-application results in illegal residues on plant surfaces, regulators have the authority to confiscate and destroy an entire crop to protect consumers.
- *Impact on effective pest control.* Pesticide registrants and/or manufacturers of pesticides spend millions of dollars researching ways to use their products correctly and effectively. This research includes determining the right amount of pesticide to apply to control target pests. Using less than the labeled rate is legal in most cases but may result in inadequate control, wasting time and money. Application volumes that are too low also may lead to problems such as pest resistance and resurgence. Using higher than the labeled rates is illegal and wastes pesticides and using too much pesticide may adversely affect natural enemies of the pest being controlled.
- *Human health concerns.* Pesticides applied at higher than label rates could endanger the health of pesticide handlers, field workers, yourself, and other people working in or around an area where you applied them.
- *Environmental concerns.* Pesticide concentrations higher than label directions may cause serious environmental problems. Calibrating equipment to maintain application volumes within label requirements reduces the potential for contaminating surface water, groundwater, and the air.
- *Impact on treated plant surfaces.* Certain pesticides are phytotoxic (injurious to plants) and damage treated plant surfaces when used at higher than label-prescribed rates. Manufacturers evaluate these potential problems while testing their products, so they can determine safe concentrations.
- *Soil contamination.* Using too much pesticide increases the chance of building up excessive residues in the soil. A buildup of certain pesticides sometimes seriously limits

1. This document is PI-23, one of a series of the Agronomy Department, UF/IFAS Extension. Original publication date April 1998. Revised March 2005, March 2008, and February 2011. Reviewed March 2017. Visit the EDIS website at <http://edis.ifas.ufl.edu>.

2. Frederick M. Fishel, professor, Agronomy Department and director, Pesticide Information Office; UF/IFAS Extension, Gainesville, FL 32611.

the types of future crops that can safely be grown in the treated area.

- *Wasting resources.* Using the improper amount of pesticide wastes time and adds unnecessary costs to the application.

## Conducting the Test

Begin by making certain the boom sprayer has clean water in its tank, is mechanically sound, and has clean screens and intact plumbing. Make sure that all of the nozzle tips on the boom are the same type and size (for example, all tips are AI8002).

Commercial tip testers that measure nozzle flow rate are available but not necessary (Figure 1). Only a few simple items are needed for conducting the test (Figure 2), including the following: a clipboard, a nozzle performance data form (Table 1 located on the last page), a pencil, a wrist-watch with a second hand or stopwatch, and a hand-held graduated container marked in milliliters and/or ounces.



Figure 1. Commercially-available flow meter for testing tip output.  
Credits: UF/IFAS Pesticide Information Office

## Steps to Perform the Test

1. Using the graduated container, catch the output from each nozzle for a predetermined time; either 30 seconds or 1 minute is usually adequate (Figure 3). Write down the nozzle outputs by nozzle on the data form.
2. Sum total amounts from each nozzle. Divide by the number of nozzles to get the average nozzle output. Write down the average output on the data form.

3. Determine the tolerance value by multiplying the average nozzle output by 0.10. In other words, you will replace any nozzle that is applying more or less than 10% of the average nozzle output.
4. Determine the upper limit by adding the tolerance value to the average nozzle output, and determine the lower limit by subtracting the tolerance value from the average nozzle output.
5. If output from any nozzle is greater than the upper limit, the nozzle tip is probably worn out, and a new tip is needed. If output from any nozzle is less than the lower limit, cleaning may bring it into the correct range. If not, replace the nozzle, and repeat the test.
6. If tips are replaced after the initial test, repeat steps 1–5.

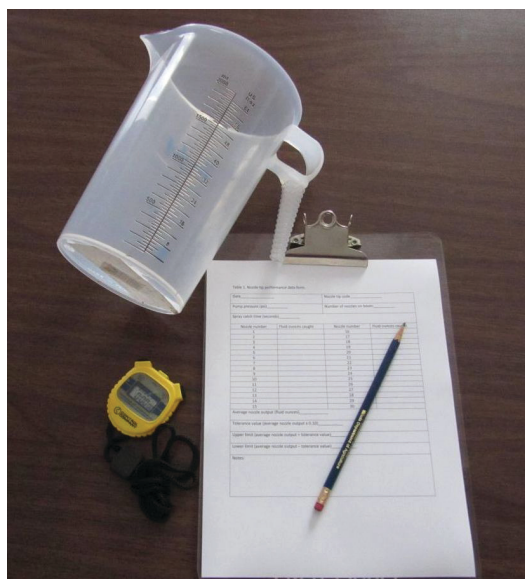


Figure 2. Simple items needed for performing a nozzle performance test.

Credits: UF/IFAS Pesticide Information Office



Figure 3. Performing a nozzle output check.  
Credits: UF/IFAS Pesticide Information Office

## Example Calculation

1. You have a boom with 8 nozzles and catch the following outputs in 30 seconds per nozzle:

- Nozzle 1: 16 ounces
- Nozzle 2: 12 ounces
- Nozzle 3: 15 ounces
- Nozzle 4: 16 ounces
- Nozzle 5: 16 ounces
- Nozzle 6: 15 ounces
- Nozzle 7: 14 ounces
- Nozzle 8: 19 ounces

2. The average nozzle output is 15.4 ounces ( $123 \div 8$ ).

3. The tolerance value is 1.5 ( $15.4 \times 0.10$ ).

4. The upper limit is 16.9 ( $15.4 + 1.5$ ), and the lower limit is 13.9 ( $15.4 - 1.5$ ).

5. Nozzles 2 and 8 should be replaced and the test repeated.

## Additional Information

Dean, T.W. and F.M. Fishel. 2008. *Broadcast Boom Sprayer Calibration*. Gainesville: University of Florida Institute of Food and Agricultural Sciences. <http://edis.ifas.ufl.edu/pi016>.

J.A. Ferrell, B.A. Sellers, and R. Leon. 2012. *Calibration of Herbicide Applicators*. Gainesville: University of Florida Institute of Food and Agricultural Sciences. <http://edis.ifas.ufl.edu/wg013>.

Table 1. Nozzle tip performance data form

Date		Nozzle tip code	
Pump pressure (psi)		Number of nozzles on boom	
Spray catch time (seconds)			
Nozzle number	Fluid ounces caught	Nozzle number	Fluid ounces caught
1		16	
2		17	
3		18	
4		19	
5		20	
6		21	
7		22	
8		23	
9		24	
10		25	
11		26	
12		27	
13		28	
14		29	
15		30	
Average nozzle output (fluid ounces)			
Tolerance value (average nozzle output x 0.10)			
Upper limit (average nozzle output + tolerance value)			
Lower limit (average nozzle output – tolerance value)			
Notes:			

# Soil Testing for Plant-Available Nutrients—What Is It and Why Do We Use It?<sup>1</sup>

George Hochmuth, Rao Mylavarapu, and Ed Hanlon<sup>2</sup>

Farmers need soil-testing procedures to assess soils for potential plant-available nutrients. Soil testing is the foremost best management practice (BMP). It helps farmers achieve profitable crops while protecting the environment from excessive fertilization and nutrient losses. This publication describes the important steps required to test soil for potential plant-available nutrients. This information will be useful to county UF/IFAS Extension agents when training farmers and crop consultants about proper soil testing and nutrient management.

Scientists generally accept 17 elements as essential for plant growth (Barker and Pilbeam 2007). These elements are carbon (C), hydrogen (H), oxygen (O), phosphorous (P), potassium (K), nitrogen (N), sulfur (S), calcium (Ca), magnesium (Mg), iron (Fe), boron (B), manganese (Mn), copper (Cu), zinc (Zn), molybdenum (Mo), nickel (Ni), and chlorine (Cl). A certain amount of each of these nutrients—the crop nutrient requirement (CNR)—is critical for crops to complete their life cycles and to produce an optimal yield. Carbon and oxygen are supplied from air, and hydrogen from water. The remaining nutrients can be supplied from the soil; however, the soil may not always contain enough of these nutrients for optimal crop production. Farmers need to know the portion of the CNR that can be supplied from the soil, because these nutrients are essentially free to the farmer. If the CNR cannot be supplied entirely from the soil, then the soil-supplied nutrients can be augmented with fertilizers or other nutrient sources such

as manures or composts. Nearly 150 years ago, scientists developed chemical tests to assess the concentrations of plant-available nutrients in a soil sample and then to use that assessment to make recommendations for supplemental fertilizer.

## What is soil testing?

The Soil Science Society of America defines soil testing as “the application of soil science research to the rapid chemical analyses to assess the available nutrient status of a soil.” Agronomic soil tests do not measure the total amount of a plant nutrient in the soil, or even the exact amount of plant-available nutrient for the season. Soil tests provide an index (i.e., indication, or assessment) of the nutrient-supplying capacity of the soil (see “Soil text index” section below). Soil testing is most applicable to nutrients of low mobility in soils—such as P, K, Mg, Ca, and micronutrients—because these nutrients will remain in the soil after the soil has been tested. This low mobility is in contrast to mobile soil nutrients—such as nitrogen—that may rapidly transform or leach from the soil in the time between soil testing and crop planting.

## Why do we use soil testing?

We test soil to determine how to get the best crop yields and how to use fertilizer and other nutrient sources most efficiently. When soil testing was originally developed, the

1. This document is SL408, one of a series of the Department of Soil and Water Sciences, UF/IFAS Extension. Original publication date May 2014. Reviewed December 2017. Visit the EDIS website at <http://edis.ifas.ufl.edu>.

2. George Hochmuth, professor; Rao Mylavarapu, professor; and Ed Hanlon, professor emeritus; Department of Soil and Water Sciences, UF/IFAS Extension, Gainesville, FL 32611.

The Institute of Food and Agricultural Sciences (IFAS) is an Equal Opportunity Institution authorized to provide research, educational information and other services only to individuals and institutions that function with non-discrimination with respect to race, creed, color, religion, age, disability, sex, sexual orientation, marital status, national origin, political opinions or affiliations. For more information on obtaining other UF/IFAS Extension publications, contact your county's UF/IFAS Extension office.

U.S. Department of Agriculture, UF/IFAS Extension Service, University of Florida, IFAS, Florida A & M University Cooperative Extension Program, and Boards of County Commissioners Cooperating. Nick T. Place, dean for UF/IFAS Extension.

goal was to enhance crop yields by identifying productive soils. Today, crop productivity is still a goal, but another goal is to avoid excessive fertilizer applications and, thereby, protect the environment.

The soil test is a process that includes the following five activities: (1) collecting the soil sample, (2) processing the soil sample in the lab, (3) analyzing the sample for its extractable nutrient content, (4) interpreting the results of the analysis, and (5) using the information to make a fertilizer recommendation (Sikora and Moore 2014). Activities 1 through 4 are discussed in this publication, and activity 5 is discussed in the EDIS publication [SS623, Fertilizer Recommendation Philosophies](#) (Hochmuth et al. 2014).

## Collecting the Soil Sample

The usefulness of the soil-testing process depends on the quality of the soil sample. A quality soil sample is representative of the soil for the field in question, and a quality sample is collected properly, in terms of depth and numbers of subsamples.

### Depth

Soil samples for predicting fertilizer needs are collected from the top six inches of soil in the field, because the top six inches is the part of the soil typically tilled with plows and disks and the upper six-inch layer of soil also contains a large portion of the nutrient-absorbing roots.

### Number of Subsamples

Before sampling, the field should be divided into “management units,” which are representative of areas that will receive different cultural practices, such as different crops or different planting dates (Figure 1). Management units may also represent soil types with different native mineral composition. (Current management units may be different from previous cropping-system-management units and may also have different nutrient content.) Your different management units should be sampled separately, because they may require different approaches to fertilization. A large field may have enough inherent variability to justify determining individual management units of 20 to 40 acres. To take a soil sample from a management unit, first collect 20 subsamples with a soil sampling probe, and then composite the subsamples in a plastic bucket and mix them. Take a sample volume of about a half-pint from the bucket of mixed soil and submit it to the lab in the paper bag provided for soil-testing submissions. Additional information on management units and soil sampling schemes can be found in the EDIS document [SS402, UF/IFAS Nutrient](#)

*Management Series: Soil Sampling Strategies for Precision Agriculture* (Mylavarapu and Lee 2014).

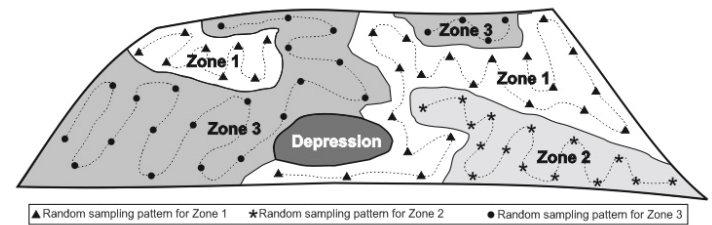


Figure 1. Scheme illustrating random soil sampling on a commercial agricultural farm or a landscape.

Credits: Greg Means, UF/IFAS

## Additional Information Needed

In addition to the soil sample, the lab will require you to fill out some forms to provide information about the crop to be grown and the specific nutrient analyses being requested. This information will help the lab make the best fertilizer recommendation for the farmer.

## Soil Sampling and Precision Agriculture

Typically, soil testing and fertilizer recommendations are made for the entire management unit, even though there may be considerable variation across the management unit, which may be 20 acres in size. However, some growers are adopting precision agricultural techniques. For example, some farmers are applying fertilizers in precise techniques where the fertilizer rate is varied throughout a field according to the nutrient levels in the soil. Precision agriculture uses *variable-rate application* of fertilizers so that areas in the field needing more or less fertilizer can receive the appropriate rate. For variable-rate application to work, soil samples need to be taken on a more detailed basis. One way to take more detailed soil samples is to use a grid-sampling approach. Grids may be as small as two acres each. Other techniques for variable-rate application of fertilizers have been based on changes in soil type as described by Natural Resources Conservation Service (NRCS) soil maps, yield maps derived from previous crop yields, and various combinations of these and other techniques (Mylavarapu and Lee 2014).

## Processing and Analyzing the Soil Sample

When the sample arrives at the laboratory, most labs analyzing agricultural soils use the following steps:

1. The soil is dried at approximately 100°F to remove soil moisture.

2. The soil is sieved to remove old plant parts and stones. A clay-dominated soil may need pulverizing to break up clods.
3. A small portion of the sample is taken for processing in the lab.
4. The soil sample is mixed (usually by shaking) with a solution called an “extractant.”
5. After mixing, the sample’s liquid portion is filtered and analyzed for its nutrient content. Analytical equipment will vary, depending on the nutrients being determined and the individual lab design and setup.
6. The concentration of extracted nutrient from the liquid portion is converted to the dried-soil basis and is referred to as the *soil-test index*.
7. The index is then given an *interpretation* as to the ability of that soil to provide enough of a nutrient for optimal crop yield. For example, a *low* interpretation means that the soil cannot supply all of a particular nutrient for crop production. A *high* interpretation, however, means that the soil can supply all of a particular nutrient for crop production.
8. The final step is for the lab to make a fertilizer recommendation for those soil samples that received interpretations of less than *high*. The fertilizer recommendation provides the recommended rate, but the rate is not the only part of a recommendation. A complete recommendation also contains guidelines about placement and timing of the fertilizer application, which can help farmers use fertilizer efficiently while also protecting the environment.

## The Role of Soil Test Extractants

The extractant, a solution that is mixed with the soil sample, is crucial to the soil test. Briefly, the extractant is developed for specific types of soils and growing conditions, such as soil reaction (pH) and the need for micronutrient results. The extractant is often a solution of various chemicals including water, acids, and certain organic chemicals. For example, the UF/IFAS Extension Soil Testing Lab now uses the Mehlich-3 soil test extractant—which is composed of acetic acid, ammonium nitrate, nitric acid, ammonium fluoride, and ethylene diamine tetra acetic acid (EDTA). There are at least a dozen soil test extractants in common usage by agricultural soil testing labs in the United States, but not all extractants are useful for all agricultural regions. Each extractant was developed to meet particular goals, but some extractants were developed to have wide applicability

among soil types and tested nutrients. These latter extractants are called *universal extractants*, and Mehlich-3 is one such extractant. The Mehlich-3 extractant is more applicable than Mehlich-1 (used by UF/IFAS Extension until August 2013) for Florida’s high-pH agricultural soils (Mylavarapu et al. 2014).

## Interpreting the Results of the Soil Test Index

As mentioned earlier, the concentration of nutrients extracted from the soil sample is called an *index*. The soil test index is an indication of the soil’s nutrient-supplying capacity and its expected relative yield (Table 1). The total amount of a nutrient in the soil is of little importance in determining fertilizer recommendations, because only a portion of a nutrient may be available for plant use during the growing season. For example, a soil’s nutrient availability includes a myriad of chemical reactions that a nutrient may undergo with time, and a nutrient may reside in multiple forms (some insoluble). Therefore, the soil test index is often referred to as an *availability index*. The availability index tells us, based on previous research, the relative level of a nutrient that will probably contribute to the crop nutrient requirement during the growing season.

Table 1. Soil-test-index interpretation with expected crop yield.

<b>Low</b>	<b>= less than 75%</b>
<b>Medium</b>	<b>= 75% to 100%</b>
<b>High</b>	<b>= 100% of expected yield</b>

The extractant used by a lab must be *correlated* with crop response (Mitchell and Mylavarapu 2014). This correlation means that if the extracting process results in a low interpretation, then that unfertilized soil will produce a low-yield crop. If the extracting process results in a high interpretation, then the unfertilized soil will produce a high-yield crop. Further, the extractant must be *calibrated*, which means that the lab using the extractant can accurately associate a fertilizer recommendation with each soil test result interpretation. The greatest amount of fertilizer will be recommended for *low*-testing soil, less for medium-testing soils, and likely no fertilizer for *high*-testing soils.

Sometimes farmers send a portion of the same sample to several labs and question why the soil test indexes are different among labs. The use of different extractants probably explains the difference. There must be considerable soil testing and crop response research conducted to develop the soil test. Farmers should ask the lab about the particular soil test extractant and its research base. We will discuss correlation and calibration in more detail in EDIS

publication [SS622](#), *How a Soil Test Is Developed—Correlation and Calibration* (Hochmuth, Mylavarapu, and Hanlon 2014).

## Important Guidance about the Soil Test Index

The soil test index is usually expressed as a nutrient concentration in the air-dry soil. For example, it may be expressed in parts per million (ppm) or milligrams per kilogram (mg/kg). These two expressions are equivalent. The instruments accurately determine the nutrient concentration in the soil using these units of expression.

However, these determinations are occasionally converted into other units for making fertilizer recommendations. In doing this, sometimes an inaccurate and faulty assumption is made—that an acre of six-inch-deep surface soil weighs 2 million pounds. Using that faulty assumption, the concentration value (ppm) is multiplied by 2 to result in the new expression of “pounds per acre.” The inaccuracy occurs because soils of different textures and organic-matter contents result in different bulk densities of soils and will, therefore, have differing mass per unit volume.

Another potential fallacy of this particular conversion approach is that the expression “pounds per acre” may be open to misuse in making fertilizer recommendations. Even if the expression “pounds per acre” is employed, it is still an index and must be interpreted as *low*, *medium*, or *high*. The index “lb per acre” cannot be used directly to determine a fertilizer amount by arithmetic.

### EXAMPLE

Let’s assume the maximum phosphorus ( $P_2O_5$ ) for a crop is 150 lb per acre (this rate would only be recommended on a *low* index), and further assume that the soil test index was 25 ppm for a submitted soil sample. The index was converted to 50 lb/acre of P by multiplying the concentration index by 2 as explained above. Next, to convert the index from lb/acre P to lb/acre  $P_2O_5$ , the index is multiplied by 2.3 to get 115 lb per acre  $P_2O_5$ . Then, 115 is subtracted from 150 to get 35 lb per acre  $P_2O_5$ , and this rate is used as the fertilizer recommendation.

This series of calculations and assumptions result from a misunderstanding of the soil test index. Using the current IFAS Mehlich-3 interpretation, the index of 25 would be interpreted as *low* and a recommendation of 150 lb per acre of  $P_2O_5$  would be recommended, not 35 lb. So, a concentration index should not be converted to a rate value such as lb per acre, because the index is a concentration and must

be interpreted before a recommended fertilizer rate can be determined. Conversion of the index in ppm to another unit (such as “pounds per acre”) is unnecessary, and it does not matter if the index is in elemental or oxide form, in the case of phosphorus or potassium.

## Frequency of Soil Testing

Soil testing should be a regular, annual process in most cases. However, for high-value crops, soil testing should be carried out on a seasonal basis. Records (see “Soil test and fertilization records” section below) of soil testing results are important to help determine sampling frequency. For example, if several successive years of soil testing show no decline in the index for a particular nutrient, then sampling frequency can be reduced to every two or three years. Unless farmer experience and records indicate otherwise, annual soil testing is recommended in Florida. Buildup of nutrients is less likely to happen in our sandy, low cation-exchange-capacity soils, so annual soil testing will help you avoid planting crops on low nutrient-content soils.

## Soil Test and Fertilization Records

Farmers should maintain records of a field’s soil test history and fertilization practices. These records will help track fertilizer inputs and can help increase the efficiency of fertilizer use. Records will also help track buildup of certain nutrients that may be detrimental to crop productivity and may have negative environmental impacts. For example, if phosphorus builds up to excessive levels, then loss of soil by erosion could result in phosphorus enrichment of a nearby water body. Or, as another example, leaching may be a problem in some sandy soils of Florida.

## Summary

Soil testing is important for determining the portion of the crop nutrient requirement that can be supplied from the soil. Soil testing is most effective in regard to nutrients that are not highly mobile in the soil. Soil testing is an important best management practice. Farmers practicing correlated and calibrated soil testing will benefit from proper fertilizer-rate applications and will protect the environment from nutrient pollution due to inappropriate fertilization practices.



## Other Publications in this Series on Soil Testing

Hochmuth, George, Rao Mylavarapu, and Ed Hanlon. 2014. *Developing a Soil Test Extractant—The Correlation and Calibration Processes*. Gainesville: University of Florida Institute of Food and Agricultural Sciences. <http://edis.ifas.ufl.edu/ss622>.

Hochmuth, George, Rao Mylavarapu, and Ed Hanlon. 2014. *Fertilizer Recommendation Philosophies*. Gainesville: University of Florida Institute of Food and Agricultural Sciences. <http://edis.ifas.ufl.edu/ss623>.

Hochmuth, George, Rao Mylavarapu, and Ed Hanlon. 2014. *The Four Rs of Fertilizer Management*. Gainesville: University of Florida Institute of Food and Agricultural Sciences. <http://edis.ifas.ufl.edu/ss624>.

## References

Barker, A. V., and D. J. Pilbeam. 2007. *Handbook of Plant Nutrition*. CRC Press, Taylor and Francis Group. Boca Raton, FL.

Mitchell, C. C., and R. Mylavarapu. 2014. *Soil Test Correlation and Calibration for Recommendations*. In *Soil Test Methods from the Southeastern United States*. Southern Cooperative Series Bulletin No. 419. USDA-SERA-IEG-6. ISBN 1-58161-419-5.

Mylavarapu, R., and W. D. Lee. 2014. *UF/IFAS Nutrient Management Series: Soil Sampling Strategies for Precision Agriculture*. Gainesville: University of Florida Institute of Food and Agricultural Sciences. <http://edis.ifas.ufl.edu/ss402>.

Mylavarapu, R., T. Obreza, K. Morgan, G. Hochmuth, V. Nair, and A. Wright. 2014. *Extraction of Soil Nutrients Using Mehlich-3 Reagent for Acid Mineral Soils of Florida*. Gainesville: University of Florida Institute of Food and Agricultural Sciences. <http://edis.ifas.ufl.edu/ss620>.

Sikora, F. J., and K. P. Moore (eds.). 2014. *Soil test methods from the southeastern United States*. Southern Cooperative Series Bulletin No. 419. ISBN 1-58161-419-5.

# Fertilizing and Liming Forage Crops<sup>1</sup>

Y. C. Newman, C. Mackowiak, R. Mylavarapu, and M. Silveira<sup>2</sup>



Plants require many essential nutrients for growth. To be specific, they require 17 of them. Those nutrients required by plants in large quantities are called macronutrients, and they can be either primary or secondary. Primary macronutrients are required in high quantities and they are nitrogen (N), phosphorus (P), and potassium (K). Those required in moderate quantities are called secondary nutrients, and they are calcium (Ca), magnesium (Mg), and sulfur (S). There are also nutrients that are needed in very little amounts but are as essential for plant growth as the macro and secondary nutrients, and they are called micronutrients (iron, copper, zinc, manganese, boron, molybdenum, chlorine, and nickel). The soil can supply the plant with most, if not all, of the macro - secondary, and

micronutrients, but often the supply of one or more of the nutrients is insufficient for optimum growth.

Nitrogen is the nutrient that grass pastures use the most, and when used in a balanced fertilization, it often results in increased forage quality and production. Phosphorus may be deficient in some soils, but other Florida soils are high in native P. Some forage crops may extract sufficient P from the subsoil, even when the P level in the surface soil is low. Potassium (K) may be needed by some forage crops. Under intensive hay or silage production where nutrients are removed from the land, annual applications of N, P, and K are typically required. Potassium is fairly mobile in sandy soils and can quickly become deficient. Calcium, magnesium, sulfur, and some micronutrients may also become deficient in the soil if soil fertility is overlooked.

While routine soil tests do not include a micronutrient analysis, it is suspected that in some areas of Florida S deficiency may be seen in some years and on some crops. Sulfur deficiency may be seen under intensive hay or silage production. Sulfur deficiency symptoms are pale green leaves mainly in young leaves, similar to nitrogen deficiency, but nitrogen deficiency symptoms show pale leaves in older and new leaves. If a producer is concerned or suspects a sulfur deficiency, some sulfur may be added by using ammonium sulfate as the nitrogen source in the first spring application (just be aware that ammonium

1. This document is SS-AGR-176, one of a series of the Agronomy Department, UF/IFAS Extension. Original publication date March 2003. Revised January 2008 and March 2014. Reviewed July 2017. Visit the EDIS website at <http://edis.ifas.ufl.edu>. This publication is also part of the *Florida Forage Handbook*, an electronic publication of the Agronomy Department, originally written by C.G. Chambliss; revised by Yoana Newman. For more information you may contact the editor of the *Florida Forage Handbook*, Y. C. Newman ([ycnew@ufl.edu](mailto:ycnew@ufl.edu)).

2. Y. C. Newman, assistant professor, Agronomy Department; C. Mackowiak, assistant professor, Department of Soil and Water Sciences; R. Mylavarapu, professor, Department of Soil and Water Sciences; and M. Silveira, associate professor, Department of Soil and Water Sciences; UF/IFAS Extension, Gainesville, FL 32611.

The Institute of Food and Agricultural Sciences (IFAS) is an Equal Opportunity Institution authorized to provide research, educational information and other services only to individuals and institutions that function with non-discrimination with respect to race, creed, color, religion, age, disability, sex, sexual orientation, marital status, national origin, political opinions or affiliations. For more information on obtaining other UF/IFAS Extension publications, contact your county's UF/IFAS Extension office.

U.S. Department of Agriculture, UF/IFAS Extension Service, University of Florida, IFAS, Florida A & M University Cooperative Extension Program, and Boards of County Commissioners Cooperating. Nick T. Place, dean for UF/IFAS Extension.

sulfate is an acidifying fertilizer). Use of other S fertilizers such as sul-po-mag or gypsum is another option when no additional N is needed or if your pH is moderately acidic.

Under most circumstances, micronutrients are not deficient in pastures and therefore should not be applied until a deficiency of a specific nutrient is confirmed. A suggestion for new plantings of forages on unplanted and unfertilized flatwood soils is to apply 3 lb./acre of copper with the initial fertilization.

Only the nutrients that are needed by the crop should be included in the fertilizer. For example, if a soil test indicates that phosphorous is adequate, no phosphorus should be included in the fertilizer. Banking fertilizer in the soil is not a profitable method for managing the nutrition of crops, plus there is a high risk of environmental pollution.

How does a manager decide if fertilizer or lime should be applied to a pasture or forage crop? Fertilizer and/or lime should be applied if (1) an increase in forage growth can be expected, (2) if the extra forage is needed, and (3) a return on the investment can be expected. The experience of the forage manager, along with soil testing for pH, P, and K, can be used in making a decision about liming and fertilizing with P and K especially for hay or silage production. There is no point in fertilizing to reach maximum yields if the extra forage produced is not used. To make a profit on the investment, the forage must be utilized or harvested, and the product (animal weight gain, milk, hay, or silage) must be marketed.

Fertilizer should usually be applied at the beginning of the growing season. Warm-season perennial grasses should be fertilized in the early spring (February to March). Spring fertilization stimulates production at a critical time. Some pasture grasses may be given an additional application of N in late season (June) if extra forage is needed, but this is usually not the case for a beef cow/calf operation. The June or late season application is recommended as long as there is no standing water or the water table is not near the surface, in which may cause environmental problems. Although bahiagrass gives little, if any, response to a late-summer/fall application, limpograss, rhodesgrass, and stargrass do. These grasses can be fertilized in the late summer or early fall to extend the grazing season or, in the case of limpograss, for stockpiling. Timely application of fertilizer can be used to increase forage yield and quality, improve stand persistence, and provide for better distribution of forage across the growing season. The producer should consider that the response obtained from an application of fertilizer is influenced by other factors,

such as solar radiation, temperature, soil moisture, and grazing management. For example, overgrazing or excessive defoliation limits the ability of the plant to respond to the added nutrients and thereby reduces potential yield.

Some grasses, such as the stargrasses and some of the hybrid bermudagrasses, need to be fertilized annually or maintained in a high-fertility environment in order to keep a good stand. On the other hand, some ranch managers with large, extensive operations may only fertilize their bahiagrass once every three years. This grass can persist under minimum fertility if they are not overgrazed or mismanaged.

## Fertilization Recommendations for Specific Forages

### Fertilizing for Establishment of Perennial Grasses

Applying nutrients on a clean-tilled seedbed before plant roots are present increases the risk of losing the nutrients through leaching. Heavy rainfall events on the sandy soils of Florida can move nutrients downward in the soil profile and out of reach of plant roots that will be developing later. Therefore, it is suggested that, where possible, nutrients (fertilizer) not be applied until plant roots are present to take them up. On the other hand, biosolids, poultry litter, manures, and composts can be lightly incorporated into the seedbed. They have a slower nutrient release than mineral fertilizers and the organic matter may provide some additional tilth and moisture retention to the soil.

For establishment of new plantings, apply 100 lb. N/acre and split application as follows: apply 30 lb. N/acre, all of the soil test recommended  $P_2O_5$ , and 50% of the  $K_2O$  as soon as plants emerge. Apply the remaining  $K_2O$  and 60–70 lb. N/acre 30–50 days later.

When the new plants are small, only a limited amount of N and  $K_2O$  are applied, with additional N and  $K_2O$  being applied later to encourage the new plants to continue growing, spreading, and developing into a full and complete stand of grass.

### Fertilizing Bahiagrass

#### GRAZED BAHIAGRASS

#### Phosphorus Fertilization

In order to receive phosphorus fertilizer recommendations for established bahiagrass, soil AND tissue samples should be submitted to the Extension Soil Testing Lab (ESTL) at

the same time. As per the preliminary research findings, soil tests alone are not adequate to determine bahiagrass P needs. A companion tissue test has therefore been added to the testing procedures along with the soil test to determine the P fertilization needs. Producers are strongly encouraged to simultaneously test soil and tissue samples if bahiagrass pastures have not received P fertilization for long periods. Phosphorus should not be applied if tissue P concentrations are at or above 0.15%, even if soil tested Low in P. For Medium and High soil P levels, P application is not recommended since there is no added benefit of P fertilization on bahiagrass yields.

If P recommendations are not desired and the producer is only interested in either the test for soil pH and lime requirement recommendations or the test for soil pH, lime requirement, K, Mg, and Ca recommendations, the soil sample alone can be submitted to the ESTL. In this case, the soil test report will not include P fertilizer recommendations. (Please choose the appropriate test from the Producer Sample Submission Form.)

Both the consolidated representative soil and the tissue samples should be collected simultaneously from each field of up to 40 acres.

ESTL testing procedures and recommendations for P for bahiagrass may be adjusted as and when field research data becomes available.

## MAINTENANCE FERTILIZATION

Four fertilization options are presented below for established bahiagrass pastures. Choose the option which most closely fits your fertilizer budget, management objectives, and land capability. If you will be grazing only your bahiagrass, you should carefully consider the potential for economical return on your investment in fertilizer before using the Medium-Nitrogen or High-Nitrogen options described below. The added forage produced for grazing animals may not be worth the added cost.

- **Low-Nitrogen Option:** Do not use this option if you cut hay, since nutrient removal by hay is much greater than by grazing animals. This option results in the lowest cost of purchased fertilizer. Apply 50–60 lb. N/acre in the early spring. Do not apply K, recognizing that N will be the limiting nutrient in this low-cost option. Apply 25 lb.  $P_2O_5$ /acre if your soil tests Low in P and tissue P concentration is below 0.15%. Do not apply P if tissue P concentration is at or above 0.15%, even if the soil tests Low in P. For Medium and High soil P levels, neither P application

nor tissue analysis is recommended since there will be no added benefit of P fertilization on bahiagrass yields.

- **Medium-Nitrogen Option:** Apply 100 lb. N/acre in the early spring. Apply 25 lb.  $P_2O_5$ /acre if your soil tests Low in P and tissue P concentration is below 0.15%. Do not apply P if tissue P concentration is at or above 0.15%, even if the soil tests Very Low or Low in P. For Medium and High soil P levels, neither P application nor tissue analysis is recommended since there will be no added benefit of P fertilization on bahiagrass yields. Apply 50 lb.  $K_2O$ /acre if your soil tests Low in K and none if it tests Medium or High.
- **High-Nitrogen Option:** Apply 160 lb. N/acre in two applications of 80 lb. N/acre in early spring and early summer. Apply 40 lb.  $P_2O_5$ /acre if your soil tests Low in P and tissue P concentration is below 0.15%. Do not apply P if tissue P concentration is at or above 0.15%, even if the soil tests Low in P. For Medium and High soil P levels, neither P application nor tissue analysis is recommended since there will be no added benefit of P fertilization on bahiagrass yields. Apply 80 lb.  $K_2O$ /acre if your soil tests Low in K and 40 lb.  $K_2O$ /acre if it tests Medium. No K should be applied if your soil tests High in K. The fertilization rates suggested in this option are high enough to allow bahiagrass pasture to achieve well-above-average production. Management and environmental factors will determine how much of the potential production is achieved and how much of the forage is utilized. A single cutting of hay can be made without need for additional fertilization.

## BAHIAGRASS CUT SOMETIMES FOR HAY

For a single cut per year from pastures:

- If you used the **Low-N option** of pasture fertilization, apply 80 lb. N/acre no later than six weeks before the growing season ends. Apply 50 lb.  $K_2O/A$  if your soil tests Low in K, and none if it tests Medium or High. Apply 25 lb.  $P_2O_5$ /acre if your soil tests Low in P and tissue P concentration is below 0.15%. Do not apply P if tissue P concentration is at or above 0.15%, even if the soil tests Very Low or Low in P.
- If you used the **Medium-N option** of pasture fertilization, apply an additional 80 lb. N no later than six weeks before the growing season ends. Apply 50 lb.  $K_2O$ /acre if your soil tests Low in K, and none if it tests Medium or High. Apply 25 lb.  $P_2O_5$ /acre if your soil tests Low in P and tissue P concentration is below 0.15%.
- If you used the **High-N option** of pasture fertilization, you do not need any additional N fertilization to make

one cut of hay. Apply 80 lb.  $K_2O$ /acre if your soil tests Low in K and 40 lb.  $K_2O$ /acre if it tests Medium. Apply 40 lb.  $P_2O_5$ /acre if your soil tests Low in P and tissue P concentration is below 0.15%.

### **BAHIAGRASS GROWN ONLY FOR HAY**

*For multiple cuts of hay:* Apply 80 lb. N/acre in early spring. Also in spring, apply 80 lb.  $K_2O$ /acre if your soil tests Low in K, and 40 lb.  $K_2O$ /acre if it tests Medium. Apply 40 lb.  $P_2O_5$ /acre if your soil tests Low in P and tissue P concentration is below 0.15%. Apply an additional 80 lb. N and 40 lb.  $K_2O$ /acre after each cutting, except the last in the fall. Include 20 lb. of  $P_2O_5$ /acre after each cutting if the soil tested Low in P.

### **BAHIAGRASS FOR SEED PRODUCTION**

Apply 60–80 lb. N/acre in February or March. At the same time, apply 80 lb.  $K_2O$ /acre if your soil tests or Low in K, and 40 lb.  $K_2O$ /acre if it tests Medium. Apply 40 lb.  $P_2O_5$ /acre if your soil tests Low in P and tissue P concentration is below 0.15%. Graze until May, June, or July, depending on variety. Remove cattle before seed heads start to emerge, and apply an additional 60–80 lb. N/acre.

If the bahiagrass is not grazed, do not apply fertilizer in February or March since this may stimulate excessive top growth. Mowing from February to April may be needed to remove excessive top growth. Apply 60–80 lb. N/a before seed heads first appear. Apply 25 lb.  $P_2O_5$ /acre if your soil tests Low in P and tissue P concentration is below 0.15%. Do not apply P if tissue P concentration is at or above 0.15%, even if the soil tests Very Low or Low in P. For Medium and High soil P levels, neither P application nor tissue analysis is recommended. Apply 50 lb.  $K_2O$ /acre if your soil tests Low in K and none if it tests Medium or High. Fertilize Pensacola in March/April and Argentine and Paraguay in May/June.

### **Special Note if Applying Manure or Biosolids**

A different set of economic factors are usually considered when waste materials rather than purchased fertilizer are supplying the nutrients. Additionally, it is often impractical to follow the application timings discussed in this publication when using waste materials from other operations.

## **Fertilizing Established Pastures of Bermudagrass, Stargrass, Digitgrass (Pangola), Rhodesgrass, and Suerte**

For grazed stands, apply 80 lb. N/acre, all of the soil test recommended  $P_2O_5$ , and 50% of the  $K_2O$  in early spring. Apply an additional 60–80 lb. N/acre and the remaining  $K_2O$  at midseason. In central and south Florida, the mid-season application can be delayed and applied in September to early October for fall production on stargrass, hybrid bermudagrasses, and rhodesgrass. Under intensive management in central and south Florida, up to 200 lb. N/acre/year may be economically viable for stargrass and bermudagrass. In this situation, apply 80 lb. N/acre, all of the  $P_2O_5$ , and 50% of the  $K_2O$  in early spring. Follow with 50 lb. N/acre in midseason, and 70 lb. N/acre and the other 50% of the  $K_2O$  in mid-to-late September.

## **Fertilizing Established Pastures of Limpograss**

For grazed stands, apply 60 lb. N/acre and the entire soil test recommended  $P_2O_5$  and  $K_2O$  in late winter or early spring. Apply an additional 60 lb. N/acre in late summer or early fall. For a minimum fertilization alternative, ignore the P and K recommendation and apply only 60 lb. N/acre/year.

## **Fertilizing for Hay or Silage Production from Perennial Grasses (excluding bahiagrass)**

*For multiple cuts:* Apply 80 lb. N/acre and all of the recommended  $P_2O_5$  and  $K_2O$  in early spring. Apply an additional 80 lb. N and 40 lb.  $K_2O$ /acre after each cutting, except the last in the fall. Include 20 lb. of  $P_2O_5$ /acre in the supplemental fertilizer if the soil tested low or medium in P.

*For a single, late season cut from pasture:* Apply 80 lb. N/acre if you have not applied N in the past two months, and apply the soil test recommended amount of  $P_2O_5$  and  $K_2O$ . If you have applied N in the past two months, do not apply any nitrogen now, but do apply the soil test recommended amount of  $P_2O_5$  and  $K_2O$ . Any application of fertilizer should be made no later than six weeks before the growing season ends.

## Summer Annual Grasses

Species included are sorghum-sudan hybrids, pearl millet, brown top millet, and Japanese millet.

Apply 30 lb. N/acre, 50% of the soil test recommended  $K_2O$ , and all of the  $P_2O_5$  fertilizer in a preplant or at-planting application. Apply 50 lb. N/acre and the remaining  $K_2O$  after the first grazing period. Apply an additional 50 lb. N/acre after each subsequent grazing period, except the last.

## Warm-Season Legumes or Legume-Grass Mixtures

Species included are aescynomene, Alyce clover, desmodiums, hairy indigo, stylo, perennial peanut, and other tropical legumes. Apply all of the soil test recommended  $P_2O_5$  and  $K_2O$  in spring or early summer when seedlings or regrowth are 3–4 inches tall.

## Perennial Peanut Hay Production

Apply all of the soil test recommended  $P_2O_5$  and  $K_2O$  in early spring. Make an annual application of 20–30 lb. sulfur/acre applied as a sulfate (e.g., gypsum, ammonium sulfate, magnesium sulfate, potassium sulfate, potassium magnesium sulfate). After each hay harvest, apply an additional 15 pounds of  $P_2O_5$  and 40 pounds of  $K_2O$  per ton of hay removed, unless the soil tests high or very high.

## Cool-Season Annual Grasses

When planting on a prepared seedbed, apply 30 lb. N/acre, 50% of the soil test recommended  $K_2O$ , and all of the  $P_2O_5$  fertilizer in a preplant or at-planting application. Apply 50 lb. N/acre and the remaining  $K_2O$  after the first grazing period. Apply an additional 50 lb. N/acre after each subsequent grazing period. When overseeding established perennial grasses with cool-season annual grasses, apply 50 lb. N/acre plus all of the  $P_2O_5$  and  $K_2O$  after emergence. Apply an additional 50 lb. N/acre after each subsequent grazing period.

## Cool-Season Legumes or Legume-Grass Mixtures

Species included are all true clovers (white, red, arrowleaf, crimson, subterranean), vetches, lupines, and sweet clover. If legumes such as white clover are already established, or if reseeding annual legumes such as crimson clover are re-establishing from natural seed, apply all of the soil test recommended  $P_2O_5$  and  $K_2O$  fertilizer in late fall. For new plantings, apply the recommended  $P_2O_5$  and  $K_2O$  in a

preplant or at-planting application. If legumes are planted in combination with oat, rye, wheat, and/or ryegrass, apply 30 lb. N/acre in a preplant or at-planting application plus one additional 50 lb. N/acre application after the grass is well established. These recommendations are made assuming adequate soil moisture is available from either rainfall or irrigation. In southern Florida, lack of adequate rainfall during the cool season frequently causes stand failure or limits growth. Under nonirrigated conditions in southern Florida, the probability of inadequate moisture is high and the likelihood that the crop will benefit from applied fertilizer is low, especially on the drier soils.

## Alfalfa

Apply all of the soil test recommended  $P_2O_5$  and 50% of the  $K_2O$  fertilizer in late fall. Apply the remaining  $K_2O$  in early spring. If the alfalfa is mechanically harvested rather than grazed, apply an additional 30 lb.  $P_2O_5$  and 60 lb.  $K_2O$ /acre after each harvest. An additional application of 100 lb.  $K_2O$ /acre in June or July may increase summer survival of alfalfa. Apply 3 lb. boron/acre per year to alfalfa in three 1 lb./acre applications. Copper and zinc fertilizer may be needed if soil pH is above 6.5. The lime requirement shown on the soil test report is adequate for established alfalfa. However, if the alfalfa has not yet been planted, apply and incorporate one ton of lime/acre if the soil pH is below 6.6. Lime is especially important for alfalfa establishment. It is not practical to incorporate lime once the alfalfa is planted. Fertilizer should contain 15–20 lb. sulfur/acre; apply as a sulfate (e.g., gypsum, ammonium sulfate, magnesium sulfate, potassium sulfate, potassium magnesium sulfate) since elemental sulfur reacts too slowly to supply the sulfur needs of the current crop and elemental sulfur may decrease soil pH.

## Liming

The primary reasons for liming acidic soils are to increase crop yield and to enhance fertilizer efficiency. Lime also affects the solubility of other elements; therefore, some plant nutrients are made more available by liming, while toxicities caused by excessive concentrations of other plant nutrients are reduced. In addition to neutralizing soil acidity, calcitic limestone supplies the plant nutrient calcium, and dolomitic limestone supplies both calcium and magnesium. While a correct liming program is beneficial for plant growth, excessive liming can be detrimental. Deficiencies and imbalances of certain plant nutrients may result from excessive lime application.

To obtain maximum benefit from liming and to determine the type and quantity of lime to apply, soil and plant factors must be taken into account. The first step is to properly collect a soil sample from the area to be limed. Samples are normally taken to a depth of 4–6 inches. The soil sample should be sent to a reputable soil testing laboratory for determination of pH and lime requirements.

Lime should be incorporated into the soil whenever possible since lime reacts with soil that it comes in contact with. However, it has little immediate effect on the soil pH below the top inch or so. Therefore, lime should be applied and incorporated 3–6 months prior to planting. The frequency of lime application will depend on many factors, including fertilization program, soil type, and crop. Typically, lime application should seldom be more frequent than every three years, with the exception of intensive hay fields that receive high ammonium-nitrogen fertilizer application rates.

If the soil is at or above the target pH, soil calcium in the soil should be sufficient for optimum plant growth. If the soil pH needs to be increased and the level of magnesium is low, liming with dolomitic limestone is a relatively inexpensive method for adjusting the pH and supplying magnesium. Magnesium can be added to the fertilizer.

The target pH for various forage crops is listed in Table 1. All of the recommendations shown in Table 1 are part of the standardized fertilization recommendation system of the UF/IFAS Extension Soil Testing Laboratory. Cool-season legumes are pH-specific, and most of them require high pH of 6 or higher. Warm-season perennial grasses, on the other hand, perform well at a lower pH. Appropriate lime recommendations are automatically recorded as part of the soil test report.

## Other Important Considerations

When applying manure, biosolids, and waste materials, producers may apply higher rates than those recommended for mineral fertilizers since the nutrients present in the waste materials need to be converted into forms that the plants can use. However, the producer should not go above rates that are environmentally acceptable. Additionally, timing of nutrient application may be different than those previously recommended.

When applying lime-stabilized biosolids, attention should be given to the liming effect of this material. Soil pH should be carefully monitored to avoid pH conditions above 6.5. It has been demonstrated that bahiagrass growing in soil

conditions of pH 7.0 or above will, very likely, perform poorly compared to bahiagrass growing at lower pH conditions.

For additional information see:

- EDIS IFAS fact sheet SL179 *Using Waste Products in Forage Production*.
- EDIS IFAS fact sheet SS-AGR-152 *Fertilization of Agronomic Crops* for a more extensive discussion of micronutrients.
- Forages of Florida website at <http://agronomy.ifas.ufl.edu/ForagesofFlorida/index.php>.

Table 1. Target pH for different forage crops grown on mineral soils.

Crop Category	Crops Included	Target pH
Bahiagrass	bahiagrass	5.5
Other improved perennial grasses	bermuda, star, rhodes, suerte, and digitgrass	5.5
	limpograss	5.0
Warm-season annual grasses	corn, sorghum, sorghum-sudans, and millets	6.0
Cool-season annual grasses	small grains and ryegrass	6.0
Warm-season legumes or legume-grass mixtures	perennial peanut, stylo, desmodiums, aeschynomene, Alyce clover, hairy indigo, and other tropical legumes	6.0
Cool-season legumes or legume-grass mixtures	All true clovers (white, red, arrowleaf, crimson, subterranean), vetches, lupines, and sweet clover	6.0–7.0
Alfalfa	Alfalfa	7.0

Table 2. Interpretation for bahiagrass soil and tissue test.

Soil Test	Tissue Test	Recommendations
P MEDIUM/HIGH	NO TISSUE TEST	0
P LOW	P ≥ 0.15%	0
P LOW	P < 0.15%	25 or 40 lb. P <sub>2</sub> O <sub>5</sub> /acre <sup>†</sup>

<sup>†</sup> Recommended amount of P<sub>2</sub>O<sub>5</sub> depends upon nitrogen option chosen.



# Getting the Most out of Bahiagrass Fertilization<sup>1</sup>

C. L. Mackowiak, A. R. Blount, R. O. Myer, E. A. Hanlon, and M. L. Silveira<sup>2</sup>

## Introduction

Florida has about 5 million acres of improved pasture. Bahiagrass is the most adapted pasture grass in Florida. Some of its popularity is attributable to its ability to survive and even thrive where other grasses fail due to pests, drought, flooding, or low soil fertility. However, despite its adaptation, it still requires nutrients whether it is used for hay, sod, or in a pasture system. As with other grasses, bahiagrass can remove considerable quantities of nutrients from the soil (Table 1), which need to be replenished based on a soil test report and interpretation.

The Florida Department of Agriculture and Consumer Services (FDACS) and UF/IFAS have partnered through research and outreach to establish agricultural best management practices (BMPs). The BMPs aim to accomplish optimum agro-economic viability and environmental protection through optimum forage fertilization recommendations. The detailed UF/IFAS N, P, and K fertilizer recommendations for bahiagrass can be viewed on-line (Mylavarapu et al. 2007). The historic record of recommendation development is also available (Hanlon et al. 2006). Information on pasture fertilizer options, including waste materials are available (Mackowiak et al. 2008). Additional management information can be found in the FDACS Cow-calf and Vegetable/Agronomic Crop BMP manuals, and the forage hay interim measure BMP recommendations (<http://www.floridaagwaterpolicy.com>).

## Soil Sufficiency Ranges

Plant-available soil nutrients are determined using various acid extracting solutions, such as Mehlich-1 (also called “double-acid”) or Mehlich-3. The soil fertilization recommendations provided by UF/IFAS are based on Mehlich-1 extractable nutrients (Tables 2 and 3). Use only the soil-test interpretation that matches your soil extraction method. Nitrogen fertilization recommendations are based on forage use (the University of Florida Extension Soil Testing Lab (ESTL) does not provide soil N analysis).

Soil micronutrient availability for proper bahiagrass growth throughout Florida is usually not a problem. However, a micronutrient soil test is available to detect potential deficiencies. Many soil micronutrient deficiencies can be offset by maintaining an appropriate soil pH regime for bahiagrass. Table 3 provides critical Mehlich-1 soil test values for Florida agricultural lands.

## Soil pH

Regardless of soil type or bahiagrass use, maintaining a proper soil pH (5.5–6.5) is essential for adequate nutrient availability and uptake. If the soil is too alkaline, several micronutrient deficiencies may occur. If the soil is too acidic, sulfur and molybdenum (Mo) deficiencies may occur and manganese (Mn) may become toxic. The pH of some southern flatwoods soils can be 4.8 or lower, which can reduce forage yield. Additionally, if these highly acidic

1. This document is SL249, one of a series of the Soil and Water Sciences Department, UF/IFAS Extension. Original publication date April 2008. Reviewed January 2017. Visit the EDIS website at <http://edis.ifas.ufl.edu>.
2. C. L. Mackowiak, assistant professor, Soil and Water Sciences Department, UF/IFAS North Florida Research and Education Center; A. R. Blount, associate professor, Agronomy Department, UF/IFAS NFREC; R.O. Myer, professor, Animal Science, UF/IFAS NFREC; E. A. Hanlon, professor emeritus, Soil and Water Sciences Department, Southwest Florida REC; and M. L. Silveira, assistant professor, Soil and Water Sciences Department; UF/IFAS Extension, Gainesville, FL 32611.

The Institute of Food and Agricultural Sciences (IFAS) is an Equal Opportunity Institution authorized to provide research, educational information and other services only to individuals and institutions that function with non-discrimination with respect to race, creed, color, religion, age, disability, sex, sexual orientation, marital status, national origin, political opinions or affiliations. For more information on obtaining other UF/IFAS Extension publications, contact your county's UF/IFAS Extension office.

U.S. Department of Agriculture, UF/IFAS Extension Service, University of Florida, IFAS, Florida A & M University Cooperative Extension Program, and Boards of County Commissioners Cooperating. Nick T. Place, dean for UF/IFAS Extension.

soils receive only N, bahiagrass stand persistence may be compromised. For example, acidic soils in north Florida that received unbalanced N fertilization may have contributed to a dollar spot (*Sclerotinia homoeocarpa*) outbreak in 2001 (Blount et al. 2002) and mole cricket infestations (Adjei and Rechcigl 2004). Fertilizer recommendations for bahiagrass are precluded by a soil liming recommendation when pH is 5.3 or lower in order to reach a target pH of 5.5. This ensures that there will be good fertilizer uptake by the plant.

Materials other than lime can influence soil pH. Inorganic fertilizers containing ammonium ( $\text{NH}_4$ ) will have some acidifying effect, while “lime stabilized” organic fertilizers, e.g., biosolids and litters, will provide a liming effect. Untreated manures and litters tend to have a slight to moderate acidifying effect. Let your soil analysis report be your guide to liming rates. In general, sandy soils (associated with flatwoods and the central Florida ridge) require less lime to raise soil pH, and the change will be short-lived compared with liming a more loamy soil. Lime applied to pasture without mechanical incorporation rarely penetrates more than 2 or 3 inches into the soil over a year or two. If you frequently add lime, be sure that every few years you check the soil pH at the top 2 inches and compare with the lower 6 to 8 inches to verify that the top sample is within a range of pH 5.5 to 6.5. This range helps avoid nutrient deficiencies, particularly in the spring when the soil is cool and bahiagrass shoot growth begins.

## Plant Tissue Nutrient Ranges

Forage tissue along with soil can be used to diagnose and address a nutritional concern. UF/IFAS recommendations for bahia fields with low soil P include forage sampling to verify P fertilization requirements (Mylavarapu et al. 2007). When sampling bahiagrass for tissue analysis, cut only actively growing plants and do not sample when dormant. Cut from 3 to 4 inches above the ground and from several places in your pasture and composite the sample. Be sure not to include any topsoil in your sample and avoid manure piles. Silveira et al. (2007) provides details on bahiagrass forage sampling. Additionally, your county extension agent may provide guidance on sampling technique and further explanation of the laboratory interpretation of tissue test results.

Table 4 provides suggested dry bahiagrass (above-ground) nutrient composition values for Florida. These values are guidelines based on forage yield and economic return. Table 4 will be periodically updated as we improve our understanding of bahiagrass nutritional requirements as

they relate to forage use, varietal improvements, fertilizer sources, economic return and environmental protection.

Bahiagrass is prone to leaf yellowing (chlorosis) particularly in the spring and whenever leaf growth is rapid. This leaf yellowing is likely due to root uptake not keeping pace with plant micronutrient needs, particularly iron (Fe). Yellowing often occurs in combination with cool soil temperatures. Maintaining the soil pH from 5.5 to 6.5 seems to minimize the problem.

No reports have shown that leaf yellowing reduces forage yield, but in the case of sod, stand integrity may be compromised with time due to increased susceptibility to mole cricket damage. Iron and other micronutrients may be spray-applied to alleviate the chlorosis. A chelated iron source, plus a manganese (e.g. manganese sulfate) source, should be applied in spring and again in fall to correct any observed deficiencies (e.g. excessive yellowing).

## Establishment Fertilization

Preplant fertilization of a clean-tilled seed bed is not encouraged since the risk of fertilizer loss is greater at that time compared with waiting until after emergence when the roots can take up the fertilizer. After emergence, apply 30 lbs N/acre, all the recommended  $\text{P}_2\text{O}_5$  rate, and 50% of the recommended  $\text{K}_2\text{O}$  rate. After another month when the stand has established, apply the remaining  $\text{K}_2\text{O}$  and 70 lbs/acre of N.

## Grazing

The current UF/IFAS fertilization recommendations for Florida pastures provide for low, medium, or high N input systems. Bahiagrass fertilized with a low N option does not remove much P or K. Mineralized manure and urine supply additional nutrients, making it unnecessary to apply P or K for several years. Fertilizer applications (if required) should be made in spring to encourage plant nutrient uptake and rapid growth, which is especially important for cattle coming off winter pastures (Table 5). The low N option prevails with an optimum stocking rate of approximately 3 acres per cow. If higher stocking rates are used, then higher forage production (i.e. fertilization) may be needed to sustain the livestock.

A single hay cutting at the end of the growing season does not require any additional fertilizer after August. Omitting fertilization after August will ensure complete fertilizer utilization. If you cut hay once per season using the low or medium N input option, then follow the cutting with 80

lbs N/acre and 50 lbs  $K_2O$ /acre if soil tests very low or low in K. Apply 25 lb/acre  $P_2O_5$  if soil tests very low or low and tissue P < 0.15%. The high N option under grazing requires no additional N for a single hay cutting since ample N was supplied during the season. Apply 80 lb/acre  $K_2O$  if soil tests very low or low and 40 lb/acre if soil tests medium. Apply 40 lb/A  $P_2O_5$  if soil tests very low or low and tissue P < 0.15%.

There are other nutritional considerations when using bahiagrass in pastures as related to animal nutrition and health. It is recommended that bahiagrass tissue sulfur (S) be kept at or below 0.35%. High forage S can have a negative effect on copper (Cu) availability in cattle.

## Hay/Silage

For multiple hay cuts, apply 80 lbs N/acre and recommended rates (based on soil test and tissue results) of  $P_2O_5$  and  $K_2O$  in spring. Apply 80 lbs/acre N, 40 lbs/acre  $K_2O$ , and 20 lbs/acre  $P_2O_5$  (if soil  $P_2O_5$  test was very low or low) following each cutting, except the final fall cut. Do not apply any fertilizer after mid-August.

As mentioned earlier, bahiagrass removes large quantities of nutrients per ton of forage (Table 1). The removed forage nutrients must be replaced, first from the soil and second from added fertilizer if the soil content is not sufficient. Knowing the fertility of your subsoil (below 8 inches) as well as your topsoil (0 to 8 inches) may help refine your fertilization program. Nitrogen, P, and K tend to be in greatest concentration near the soil surface, but other nutrients like S, Mg, and some trace elements may be found in greater concentrations in the subsoil. Established perennial forages tend to have root systems that grow more than 4 ft deep, and bahiagrass has a great mass of stoloniferous tissue to store nutrients. Therefore, bahiagrass tends to be more tolerant of low-fertility soils. However, fertilizing bahiagrass hay fields, particularly with N, may increase yields by more than 50% compared with fields that are rarely fertilized.

## Seed Production

For seed production in pastures, apply 60 to 80 lbs N/acre and soil-test “spring multiple hay cuts” recommended P and K fertilizer rates in February or March to provide for spring grazing. (hay fields do not require this late winter application.) When seed heads appear, remove cattle and apply another 60 to 80 lbs N/acre. Hay fields with excessive dead grass may require burning in January or February and/or mowing through April. Apply 60 to 80 lbs N/acre and soil-test recommended P and K rates before seed

heads appear. Seed is usually ready for harvest in July for the Pensacola variety and August for the Argentine variety. After seed harvest, the remaining forage can be grazed or harvested. Ammonification of this hay can improve its nutritive value (Newman et al. 2007).

## Sod

In Florida, many bahiagrass pastures are harvested for sod or utility turf. As with any sod operation, fertilizer and seeding rates are generally higher compared with a pasture situation. Most of the following recommendations were taken from McCarty (1994): Apply N at 40 to 45 lbs/acre and  $K_2O$  at 20 to 40 lbs/acre following the first hay cutting. The additional  $K_2O$  may improve stress tolerance and promote better rooting of the turf. A subsequent fertilizer application should be made following the second cutting. Continue cutting and fertilizing every 4 to 6 weeks until the grass develops a full sod. Total seasonal N input should be on the order of 100 to 200 lbs/acre. Post-sod removal fertilization rates depend upon removal strip size (from 1 ft to the entire field) and reseeding rate (from 12 lbs/acre to 200 lbs/acre) (Chambliss 2002; Trenholm et al. 2003).

## Silvopasture

Bahiagrass is often a component of the agroforestry practice that combines trees, forage, and livestock, also known as silvopasture systems. The following fertilization recommendations are adapted from Tyree and Kunkle (2003): In general, current fertilizer recommendations for silvopasture are based on those for an open pasture. Bahiagrass establishment should follow the establishment recommendations mentioned above. After establishment, N and  $K_2O$  fertilizers are split-applied according to UF/IFAS bahiagrass pasture recommendations in spring and summer. Annual application rates of 100 lbs N/acre N, 50 lbs  $P_2O_5$ /acre and 65 lbs  $K_2O$ /acre provided the highest net returns from the system as a whole (forage, cattle and pines) (Tyree and Kunkle 2003).

## Crop Rotation

Bahiagrass has been introduced in a crop rotation to interrupt disease cycles and improve soil quality in cash crop systems (Katsvairo et al. 2006). Establishment fertilization recommendations are the same as provided above. Additionally, if grazing will occur during the bahiagrass portion of the rotation, then the grazing fertility guidelines should be followed. If the bahiagrass will be used for hay, then the hay/seed recommendations should be followed. A well-managed bahiagrass rotation (including good fertility management) can provide disease and soil quality benefits

to the succeeding cash crop in only 2 years. The benefits of a bahiagrass rotation might take longer to achieve if the grass is not properly managed or if managed or by using the low N input management option.

## Winter Overseeding

Overseeding dormant bahiagrass pastures is a common practice for livestock operations. It provides grazing during the cool season, particularly in north Florida. The fertilization recommendations for winter forages are provided by Mylavarapu et al. (2007). A potential obstacle to good winter forage growth in a bahiagrass pasture is competition from bahiagrass for water and nutrients. Therefore, do not fertilize bahiagrass any later than late summer (approximately mid-August). Do not fertilize the winter forages until bahiagrass growth has stopped or slowed considerably. Since Argentine becomes dormant earlier than Pensacola or Tifton-9, it is the preferred sod for overseeding winter annuals. Overseeding with legumes can provide a source of N for the bahiagrass in the spring. The legume overseeding may be particularly beneficial for bahiagrass pastures receiving the low N input management option. Blount et al. (2007) provides winter forage recommendations for north Florida. The principal overseeding option for central and south Florida is annual ryegrass.

## Summer Legume Overseeding

After a 30+ year hiatus, interest in overseeding summer legumes into bahiagrass pastures is returning. Carpon desmodium and perennial peanut (perennials), and aeschynomene and hairy indigo (annuals) are among some of more popular pasture choices (Newman and Chambliss 2007). Legumes seem to perform better in Pensacola or Tifton-9 pastures, which have less prostrate growth, than in Argentine. Fertilizer inputs should be limited to no more than 50 lb/acre N to lessen grass competition with the legume. Further work is required by UF/IFAS researchers to determine the best fertilization schedule for mixed pastures.

## Recommended Reading

Adjei, M. B., and J. E. Rechcigl. 2004. Interactive effect of lime and nitrogen on bahiagrass pasture. *Soil and Crop Science Society of Florida Proceedings*. 63:52–56.

Blount, A.R., R. D. Barnett, G. M. Prine, K. H. Quesenberry and Y.C. Newman. 2007. *2007 Fall forage update*. SS-AGR-84. Gainesville: University of Florida Institute of Food and Agricultural Sciences. (<http://edis.ifas.ufl.edu/aa266>).

Blount, A.R., W. Dankers, M.T. Momol, and T.A. Kucharek. 2002. A severe outbreak of dollar spot (*Sclerotinia homoeocarpa*) on bahiagrass pastures in North Florida. SS-AGR-38. Gainesville: University of Florida Institute of Food and Agricultural Sciences. (<http://edis.ifas.ufl.edu/ag145>).

Chambliss, C.G. 2002. Forage planting and establishment methods. SS-AGR-161. Gainesville: University of Florida Institute of Food and Agricultural Sciences. (<http://edis.ifas.ufl.edu/ag107>).

Hanlon, E.A, R. Mylavarapu, I.V. Ezenwa. 2006. Development of Bahiagrass Fertilization Recommendations: 1990–2005. SL237. Gainesville: University of Florida Institute of Food and Agricultural Sciences. (<http://edis.ifas.ufl.edu/ss456>).

Katsvairo, T.W., D. L. Wright, J. J. Marois, D. Hartzog, P. J. Wiatrak, and J. R. Rich. 2006. Sod/livestock-based peanut/cotton production system: Why we recommend it! SS-AGR-126. Gainesville: University of Florida Institute of Food and Agricultural Sciences. (<http://edis.ifas.ufl.edu/ag258>).

Mackowiak, C.L., Mackowiak, J.B. Sartain, M.L. Silveira, E.A. Hanlon. 2008. Enhancing nitrogen fertilizer efficiencies in pastures. EDIS publication (in press).

McCarty, L.B. 2006. Sod production in Florida. Gainesville: University of Florida Institute of Food and Agricultural Sciences. (<http://edis.ifas.ufl.edu/lh066>).

Mylavarapu, R., D. Wright, G. Kidder, and C.G. Chambliss. 2007. UF/IFAS standardized fertilization recommendations for agronomic crops. SL129. Gainesville: University of Florida Institute of Food and Agricultural Sciences. (<http://edis.ifas.ufl.edu/ss163>).

Newman, Y.C. and C.G. Chambliss. 2007. Warm season (summer) forage legume guide. SS-AGR-48. Gainesville: University of Florida Institute of Food and Agricultural Sciences. (<http://edis.ifas.ufl.edu/ds126>).

Newman, Y.C., C. Mackowiak, R. Mylavarapu, and M. Silveira. 2007. Fertilizing and liming forage crops. SS-AGR-76. Gainesville: University of Florida Institute of Food and Agricultural Sciences. (<http://edis.ifas.ufl.edu/ag179>).

Silveira, M.L., J.M. Vendramini, L. Sollenberger, C.L. Mackowiak, and Y. Newman. 2007. Tissue analysis as a nutrient management tool for bahiagrass pastures. SL252.

Gainesville: University of Florida Institute of Food and Agricultural Sciences. (<http://edis.ifas.ufl.edu/ss475>).

Trenholm, L.E., J.L. Cisar, and J. Bryan Unruh. 2003. Bahiagrass for Florida Lawns. ENH6. Gainesville: University of Florida Institute of Food and Agricultural Sciences. (<http://edis.ifas.ufl.edu/lh006>).

Tyree, A.B., and W. E. Kunkle. 2003. Managing pine trees and bahiagrass for timber and cattle production. CIR1154. Gainesville: University of Florida Institute of Food and Agricultural Sciences. (<http://edis.ifas.ufl.edu/AN023>).

Table 1. Nutrient removal (lbs per acre) by some forages grown for hay in Florida.

Nutrient	Bahiagrass (5 tons/acre)	Bernudagras (5 tons/acre)	Per. Peanut (5 tons/acre)
	<b>lb/A</b>		
Nitrogen (N)	192	240	288*
Phosphate (P <sub>2</sub> O <sub>5</sub> )	53	60	55
Potash (K <sub>2</sub> O)	223	240	229
Magnesium (Mg)	24	23	54
Sulfur (S)	19	26	18
Calcium (Ca)	32	37	145
Manganese (Mn)	1.5	0.8	1.3
Iron (Fe)	0.6	0.6	0.4
Zinc (Zn)	0.31	0.27	0.23
Boron (B)	0.04	0.04	0.28
Copper (Cu)	0.07	0.06	0.04

\*Per. peanut = perennial peanut (obtains nitrogen from the air via symbiotic fixation by Rhizobium bacteria).

Table 2. Mehlich-1 soil nutrient interpretation ranges.

Soil Content	P	K	Mg
		ppm	
Very Low	<10	<20	----
Low	10-15	20-35	<15
medium	16-30	36-60	15-30
High	31-60	61-125	>30
Very High	>60	>125	----

Table 3. Critical low Mehlich-1 soil-test values for micronutrients.

Soil pH	Mn	Cu	Zn
		----- ppm -----	
5.5–6.0	3–5	0.1–0.3	0.5
6.0–6.5	5–7	0.3–0.5	0.5–1.0
6.5–7.0	7–9	0.5	1-3

Table 4. Plant tissue nutrient requirements (dry basis) for bahiagrass forage grown in Florida.

Element	Sufficiency Range
	(%)
Nitrogen (N)	1.5–2.5
Phosphorus (P)	0.15–0.35
Potassium (K)	1.2–2.5
Magnesium (Mg)	0.16–0.40
Sulfur (S)	0.18–0.40
Calcium (Ca)	0.3–1.0
	(ppm)
Manganese (Mn)	20–200
Iron (Fe)	50–400
Zinc (Zn)	20–100
Boron (B)	5–50
Copper (Cu)	4–20
Molybdenum (Mo)	0.1–4.0

Table 5. UF/IFAS spring fertilizer recommendations for grazing.

Fertilizer	Low Input	Medium Input	High Input
	lb/A		
N	50–60	100	160 <sup>†</sup>
K <sub>2</sub> O	0	50 <sup>‡</sup>	80 <sup>‡</sup>
P <sub>2</sub> O <sub>5</sub>	25 <sup>§</sup>	25 <sup>§</sup>	40 <sup>§</sup>

<sup>†</sup> Split application (1/2 in early spring; 1/2 in early summer).  
<sup>‡</sup> Split application and apply only if soil test result is very low or low.  
<sup>§</sup> Apply only if soil test result is very low or low AND forage tissue P is < 0.15%.

# Forage Testing<sup>1</sup>

J. M. Vendramini, M. S. Silveira, J. D. Arthington, and A. R. Blount<sup>2</sup>

## Why Test Forage?

Forage testing provides useful information about the nutritive value of forage. This information can be used to adjust the amount and composition of nutritional supplements offered to livestock consuming forage. The correct adjustments can reduce costs of forage production and optimize the amount of nutrients imported to the property.

## Where to Send Forage Samples and What Testing Results Will Be Provided

The UF/IFAS Forage Extension Laboratory is located at the Range Cattle Research and Education Center in Ona, Florida. The laboratory provides forage testing for Florida's livestock producers and forage producers. Results of the tests include crude protein (CP) and total digestible nutrients (TDN).

Mail samples to Forage Extension Laboratory, UF/IFAS, Range Cattle REC, 3401 Experiment Station, Ona, FL, 33865.

Beyond understanding the nutrient quality of your forage, it is also valuable to understand how your forage samples compare with other such samples submitted to

the laboratory. On an annual basis, the Forage Extension Laboratory publishes the average forage nutritive values by forage species (Table 1).

## Nutritive-Value Parameters and Definitions

The nutritive-value parameters reported by the Forage Extension Laboratory are as follows:

1) Dry matter (DM): DM refers to the portion of the forage after water is excluded. All nutritive-value parameters are reported on a “dry matter basis,” thus results of samples with different DM concentrations can be compared. Dry matter concentration is important for conserved forage — such as hay, haylage, and silage — because this measure indicates how the conservation process may impact forage nutritive value. Dry matter concentration for hay should be approximately 85%–92%, haylage 40%–60%, and silage 30%–40%.

2) Crude protein (CP): CP is the nitrogen and amino acids in feeds. An estimate of forage total crude protein is obtained by multiplying total nitrogen concentration by a constant of 6.25. Adequate CP concentrations in the forage are dependent on forage species and animal requirements. For more information, see EDIS Publication AN190, *Basic*

1. This document is SS-AGR-63, one of a series of the *Florida Forage Handbook*, Agronomy Department, UF/IFAS Extension. Original publication date April 2001. Revised June 2015 and July 2018. Visit the EDIS website at <http://edis.ifas.ufl.edu>.

2. J. M. Vendramini, associate professor, Agronomy Department, Range Cattle Research and Education Center, Ona, FL; M. S. Silveira, associate professor, Soil and Water Science Department, Range Cattle REC; J. D. Arthington, professor, Agronomy Department, and director, Range Cattle REC; and A. R. Blount, professor, Agronomy Department, North Florida REC, Marianna, FL; UF/IFAS Extension, Gainesville, FL 32611.

The use of trade names in this publication is solely for the purpose of providing specific information. UF/IFAS does not guarantee or warranty the products named, and references to them in this publication do not signify our approval to the exclusion of other products of suitable composition.

The Institute of Food and Agricultural Sciences (IFAS) is an Equal Opportunity Institution authorized to provide research, educational information and other services only to individuals and institutions that function with non-discrimination with respect to race, creed, color, religion, age, disability, sex, sexual orientation, marital status, national origin, political opinions or affiliations. For more information on obtaining other UF/IFAS Extension publications, contact your county's UF/IFAS Extension office. U.S. Department of Agriculture, UF/IFAS Extension Service, University of Florida, IFAS, Florida A & M University Cooperative Extension Program, and Boards of County Commissioners Cooperating. Nick T. Place, dean for UF/IFAS Extension.

*Nutrient Requirements of Beef Cows* (<http://edis.ifas.ufl.edu/an190>).

3) Total digestible nutrients (TDN): TDN represents the energy concentration in the forage, the sum of digestible fiber, starch, sugars, protein, and fat in the forage. Energy is the nutrient required by cattle in the greatest amount and usually accounts for the largest proportion of feed costs.

4) Neutral detergent fiber (NDF): NDF represents plant cell wall components (hemicelluloses, cellulose, lignin), which are more or less degradable, depending on the stage of maturity and degree of lignification of the forage. In general, as NDF increases, voluntary forage intake is reduced.

5) Acid detergent fiber (ADF): The ADF component of forage is determined when either the NDF residue or an intact forage sample is processed in a detergent solution primarily containing sulfuric acid. The remaining fiber residue, mostly cellulose and lignin, is called ADF. In general, as ADF increases, forage digestibility is reduced.

## How to Collect a Sample

Properly collecting and identifying a sample is very important. A sampling device or tool is needed for collecting hay samples. Several commercial types are available. These tools usually consist of a tube — with a cutting edge on one end and a shank on the other — that is fastened in the chuck of an electric drill or hand brace. The sampler is driven into the end of a rectangular bale or the rounded side of the round bale. Collect a single core sample from each of 12 bales for a particular lot of hay. To ensure the sample is representative, combine the 12 cores into one sample. The outer layer of weathered round bales should be pulled away before sampling. Each hay cutting, type of hay, etc., should be sampled and analyzed separately. Each hay cutting or lot should be identified and stored separately.

Silage samples can be collected from the face of a bunker silo as it is being fed and from the unloader of an upright silo. Bagged silage can be sampled by cutting small slits along the side of the bag and penetrating the hay sampler to collect the material. Producers must reseal the slit with waterproof tape after collection.

Collect silage from five or six places along the bag, mix well, and extract a single sample to send to the laboratory. Immediately place the sample in a plastic bag and seal it. If the sample is not mailed right away, place the sample in a refrigerator or freezer.

Pasture samples can be collected and analyzed by plucking the forage with your fingers at the height the animals are grazing it. However, keep in mind that, when adequate pasture forage is available, cattle may select forage with a better nutritive value than the forage sampled by hand plucking. One practical example of selection can be found in limpgrass pastures with good forage availability. In this example, cattle will typically select leaves that have greater nutritive value than hand-plucked samples collected with leaves and stems. In this case, forage testing results may suggest that cattle would respond to protein supplementation. However, in fact, the animals are already consuming adequate amounts of protein from forage selection and may not respond to supplementation.

Scissors or some other cutting device also can be used. If possible, these samples should be dried before sending to the laboratory. If drying is not possible, mail the sample immediately after it is harvested. Your results are only as good as your sample!

## Additional Information and Testing Procedures

Nutritive value results (Table 1) are reported by forage species. Forage species not included in this publication were not received by the laboratory in sufficient numbers to be included in this annual report. Crude protein and TDN were analyzed in all samples. Dry matter (DM), NDF, and ADF were analyzed in selected samples submitted by dairy producers participating in the Southeast Dairy, Inc., Check-Off Program.

The UF/IFAS Forage Extension Laboratory sample processing and analyses are as follows:

- Forage samples are dried at 55°C in a forced-air oven for DM determination.
- Total digestible nutrients (TDN) are estimated using the “in vitro” dry matter digestibility (IVDDM) procedure described by Goering and Van Soest (1970). (USDA-ARS Agric. Handb. 379. U.S. Gov. Print. Office, Washington, DC). modified for the Ankom Daisy II In Vitro Digester (Ankom Technol. Corp., Fairport, NY).
- Crude protein was calculated by multiplying nitrogen concentration by 6.25.
- Nitrogen is determined by combustion using the Flash EA 1112 Series (Thermo Electron Corporation, Waltham, MA).



- Neutral detergent fiber (NDF) and acid detergent fiber (ADF) are analyzed using an Ankom 2000 Fiber Analyzer (Ankom Technology Corp., Fairport, NY).

Many laboratories provide forage testing results based on the NIRS procedure. The NIRS procedure is often valid, depending upon the set of forage samples originally used to establish the procedure's equations. In general, wet chemistry procedures are more accurate.

If you do not know how to interpret the results, contact your County Agricultural Extension Office, or the UF/IFAS Forage Extension Laboratory at [jv@ufl.edu](mailto:jv@ufl.edu).

The authors sincerely thank the Dairy Check-Off Program for sponsoring forage testing for the Southeast Dairy, Inc. producer samples.

## References

Ankom Technology Corporation. 1998. "Method for Determining Acid Detergent Fiber, Neutral Detergent Fiber and Crude Fiber, Using the Ankom Fiber Analyser." Ankom Technology Corporation, 14 Turk Hill Park, Fairport, New York 14450, USA.

Goering, H.K., and P.J. Van Soest. 1970. "Forage fiber analysis (apparatus, reagents, procedures, and some applications)." *USDA Agric. Handb.* 379. U.S. Gov. Print. Office, Washington, DC.

Hersom, Matt. 2007. *Basic Nutrient Requirements of Beef Cows*. Gainesville: University of Florida Institute of Food and Agricultural Sciences. <http://edis.ifas.ufl.edu/an190>.

Table 1. Dry matter (DM), crude protein (CP), total digestible nutrients (TDN), acid detergent fiber (ADF), and neutral detergent fiber (NDF) of forage samples submitted to the Forage Extension Laboratory at the Range Cattle Research and Education Center – Ona, FL (October 2006 to December 2017)

Forage Species	Number of Samples	CP	TDN	ADF	NDF
Bahiagrass <sup>a</sup>	598	6.3 ± 3.0	50 ± 4	--	--
Bermudagrass	1012	11.7 ± 3.8	53 ± 2	41 ± 3	74 ± 3
Stargrass	379	8.9 ± 3.4	52 ± 7	47 ± 9	70 ± 15
Limpograss	873	4.1 ± 2.7	53 ± 9	41 ± 4	70 ± 6
Corn Silage	112	8.2 ± 2.2	76 ± 8	30 ± 3	41 ± 9

<sup>a</sup>ADF and NDF analysis performed only on samples submitted by dairy producers. Bahiagrass was not analyzed for these nutrient constituents.

Mailing Address (please print)

Name \_\_\_\_\_ Phone \_\_\_\_\_

Address \_\_\_\_\_

City \_\_\_\_\_ FL Zip \_\_\_\_\_

Date \_\_\_\_\_ E-mail \_\_\_\_\_

Forage Species: \_\_\_\_\_

Type of forage: Please mark one

Hay  Haylage  Silage  Pasture  Stockpiled Forage

Enterprise:

Beef  Dairy  Horse  Hay  Others

Fill in one line per sample and additional sheets for more than 4 samples

Lab use Only	Sample ID

Payment in full is required with your sample submission; invoicing, is not available.

Total # samples: \_\_\_\_\_ x \$ 7.00 per sample = total payment: \$ \_\_\_\_\_

Check \_\_\_\_\_ Money Order \_\_\_\_\_ Cash \_\_\_\_\_

Checks: pay to the order of "University of Florida"

# Harvesting, Storing, and Feeding Forages as Round Bale Silage<sup>1</sup>

Matt Hersom and William E. Kunkle<sup>2</sup>

## Introduction

Perennial warm-season grasses grown in Florida are often dried and harvested as hay. Florida weather data shows less than a 20% probability of 3 consecutive drying days from mid-June through August. These frequent rains often delay harvest and/or cause considerable field losses of forages. Maintaining a regular harvest schedule (every 4 to 5 weeks) during the summer months is essential for good forage quality.

Forages are often harvested at high moisture and ensiled when field drying is not feasible or possible. High costs for equipment and structures needed to chop, haul, and store silage have limited its use for perennial warm-season forages, especially for the medium and small beef and dairy producers. Forages have additional challenges because yields at each harvest are lower than corn or sorghums, they are cut several times during the summer, and they need to be wilted prior to ensiling, which is not compatible with storing in bunker silos or in piles.

Development of systems for ensiling chopped forage in long polyethylene tubes was very applicable to timely harvest of warm-season perennial forages in Florida. However, this system required costly specialized equipment for chopping and bagging the forage that limited its application to small

and medium beef and dairy producers. Round bale silage was developed in Europe and has been used since the mid-1980s in the US. Round bale silage is harvested with the same equipment used for making hay, requiring only the addition of a plastic wrapper for applying the “stretch wrap” to the bales. Round bale silage offers flexibility in harvesting small quantities at one time, requires less additional equipment to purchase than chopped silage systems, offers flexibility of making hay when weather permits and silage when the weather necessitates, and does not require much additional equipment operation and repair skills. This paper will review the research, experiences, and challenges of the round bale harvesting, storing, and feeding system.

## Forage Quality Declines with Maturity

Bermuda and star grasses produce large yields during the warm season but quality declines rapidly after 4 weeks of regrowth (Table 1). These grasses are not high in quality at four weeks regrowth, and allowing them to grow past six weeks does not increase yearly dry matter production and forage quality is near maintenance (QI - 1.0) or below. Growing or lactating cattle fed these forages will require more supplement to attain desired performance. Digit and limpo grasses are higher in quality than bermuda and star

1. This document is AN145, one of a series of the Department of Animal Sciences, UF/IFAS Extension. Original publication date September 2003. Revised September 2011. Reviewed October 2017. Visit the EDIS website at <http://edis.ifas.ufl.edu>.
2. Matt Hersom, associate professor; and William E. Kunkle, professor (deceased), Department of Animal Sciences; UF/IFAS Extension, Gainesville, FL 32611.

The use of trade names in this publication is solely for the purpose of providing specific information. UF/IFAS does not guarantee or warranty the products named, and references to them in this publication do not signify our approval to the exclusion of other products of suitable composition.

The Institute of Food and Agricultural Sciences (IFAS) is an Equal Opportunity Institution authorized to provide research, educational information and other services only to individuals and institutions that function with non-discrimination with respect to race, creed, color, religion, age, disability, sex, sexual orientation, marital status, national origin, political opinions or affiliations. For more information on obtaining other UF/IFAS Extension publications, contact your county's UF/IFAS Extension office.

U.S. Department of Agriculture, UF/IFAS Extension Service, University of Florida, IFAS, Florida A & M University Cooperative Extension Program, and Boards of County Commissioners Cooperating. Nick T. Place, dean for UF/IFAS Extension.

grasses at similar maturity, but they also decline in quality during regrowth as the proportion of stem increases.

Research from Louisiana further emphasizes the importance of regrowth interval on forage quality (Table 2). The decline in quality reflected in gains of steers is more rapid in bermudagrass grown during the summer than in bermudagrass grown during the spring. Summer regrowth may have lower quality because higher temperatures increase lignin deposition and high rainfall increases growth rates and maturation. This further emphasizes the need to cut warm-season perennial grasses every 4 weeks to retain quality.

Round bale silage allows for harvest of forage every 4 to 5 weeks when the quality is better. This decreases or eliminates the need for supplements when feeding the forage to livestock. We suggest developing a plan to cut warm-season grasses by the calendar; make hay when the weather allows, and make round bale silage when the weather will not allow you to make hay.

## Wrapping, Storing, and Feeding

**Allowing air into ensiled forage will reduce the quality of round bale silage.** Preservation of wet forages requires that air (oxygen) be kept out. Molds and other organisms that rot wet forages need air to grow. If air enters, the forage molds initially, and then rots over time. This has been the biggest problem for producers using the round bale system.

Round bale silage was first stored in individual bale bags that were put on bales lifted off the ground then gathered and tied with string to seal (Cromwell et al. 1994a). The bag cost (\$6 to \$8/bag) and labor to put bales in bags limited adoption of this approach. Another approach tried was to store bales in long plastic tubes (a long bag), and mechanized bale tube stuffers were developed. The long tube was more cost effective (\$4 to \$5/bale) and is still used by some producers. Our experience was that small hole(s) in one end allowed air to move freely in the tube, resulting in molding of bales in too many instances. A more recent version of this system has tubes that are stretched in diameter while loading bales, which reduces air space and movement.

The “stretch-wrap” round bale silage system has been used for over 20 years and has become the most widely used round bale silage storage system in Florida and across the U.S. The following discussion will address experiences with the stretch-wrap storage system.

**Stretch-wrap plastic quality.** The intense sunlight for many months in Florida can cause the plastic to lose its pliability and break up in pieces. Conditions in Florida require more additives in stretch-wrap plastic to resist sunlight degradation compared to other areas of the U.S. In the early 1990s, four tests (each a year long) were conducted to evaluate stability of plastic in sunlight (Cromwell et al. 1997b). Some samples of plastic were stable in sunlight for less than a month, while others were stable for over a year. Sunlight stability was a noted problem when we started the tests but problems decreased over the years. Most problems occurred with companies or employees new to the industry, poor mixing of ingredients prior to making stretch-wrap plastic, or problems with the manufacturing equipment. The frequency of failures has declined over the years, but several producers no longer make round bale silage because of their bad experience with plastic. If you notice sunlight degradation of stretch-wrap plastic, it is suggested to feed this forage before it rots or rewrap the bales. Many problems can be avoided by testing new sources of stretch wrap on a few bales for one or more years before risking a considerable portion of your harvested forage.

Other problems with stretch-wrap plastics have been air entry and spoilage without visible sunlight breakdown or visible holes. This problem has not been frequent and was usually traced to too few layers of stretch wrap, inappropriate stretching of the film (50%–60% usually suggested), or reprocessed resins used in manufacturing of stretch wrap. Six layers of stretch wrap are recommended to reduce holes and keep the air out. Although four layers have been used successfully, spoilage has been found in a few instances when no holes were present. These problems may have been caused by using reprocessed resin to make stretch-wrap plastic. Stretch-wrap plastic manufacturers that used this cost-cutting approach usually have not continued to market stretch-wrap plastic.

**Wrapping machine.** The most common system in Florida is in-line wrapping machines that wrap bales with stretch wrap in a long line. Round bales are loaded on this machine end to end, and wrapped with stretch wrap continuously. The wrapped bales move over rollers that gradually lower them to the ground as the machine moves ahead. In-line wrappers are less likely to damage stretch wrap after wrapping (they don't move wrapped bales or drop them to the ground), and they use about half as much stretch wrap for each bale as machines that wrap bales individually. Although in-line wrappers cost a bit more initially, the savings in plastic and labor may offset this in many situations.

Although most of the older bale wrappers applied 20-inch-wide stretch wrap, most of the newer bale wrappers apply 20- and 30-inch-wide stretch wrap, and 30-inch is used widely by producers for cost and time reasons. The pretensioner must evenly stretch the plastic at the specified amount, usually 50%–60%. Occasionally pretensioners will under- or overstretch plastic wrapping machines, tilting their wrapping table for the bale to roll off the machine after wrapping. An uneven soil surface, rocks, stubble, etc., can puncture the stretch wrap or cause excessive stretching in a small area, which can lead to a hole after a few months of weathering. A table attachment on the wrapper that lowers the bale to the ground and decreases the distance a bale will roll is an option that can reduce plastic damage and reduce problems under some conditions.

**Time of wrapping.** How long can I wait from baling to wrapping bales? This has been a common question. Producers have observed that wet bales will heat if allowed to sit a few hours before wrapping. Air exposure and high moisture allow plant respiration and fungus (mold) growth, producing heat that is not dissipated once the wet forage is in a bale. Both plant respiration and fungus growth use water-soluble sugars that are the primary substrates for producing organic acids that lower the pH and ensile the forage. With this reasoning, it seems obvious that wrapping soon after baling is recommended. However, forage producers know that labor is limited, equipment breaks down, and rains and lightning are common during the summer. A study evaluating the effects of delaying wrapping up to 48 hours was conducted over 2 years to help answer this question (Garces-Yopez et al. 1992). Bale temperatures reached over 150°F when wrapping was delayed 48–52 hours (Table 3). Bale temperatures declined and within 1 week after wrapping temperatures were below 140°F, which is considered critical to avoid lowering protein digestibility caused by the high temperatures. Low acid detergent fiber nitrogen (ADFN) concentrations and similar concentrations across all time delays indicate higher temperatures did not increase ADFN, which is indirectly related to reduced protein digestibility. Acid detergent fiber nitrogen concentrations averaged 8% and 6% of total nitrogen in the two trials. Differences in dry matter recovery percentages, in vitro digestibilities, and pH values for delaying wrapping up to 48 hours were not found in this trial. A visual evaluation of molding on the bales did not show differences either. This trial did not evaluate animal preferences, intakes, or performance, but large differences in forage preservation due to delaying wrapping up to 48 hours were not found. However, it is recommended to wrap bales the same day.

**Storage issues: holes in the plastic resulting in molding and rotting of the forage have been the biggest problem with round bale silage.** Animals and birds can and sometimes do make holes in the plastic. Problems with cattle, deer, hogs, raccoons, groundhogs, cats, rats, mice, and various birds have been reported. Choosing a storage area where problems with these animals are less likely is the most workable solution. Tree limbs, hail, and soldier fly larva can also cause holes. Ants may not make the hole but have been observed to enter the bales and increase spoilage. Weekly monitoring of plastic for holes and patching with tape designed for this purpose is highly recommended. Bales with holes should be fed soon after holes are made (even if patched) or rewrapped if feeding time is a few months away. Bales damaged during wrapping should be rewrapped or separated so they can be fed first (patched areas tend to fail before undamaged plastic). Selecting bales with damaged plastic to feed first can help reduce losses.

Stacking bales has been tried but it is not recommended for most situations. Only bales wrapped individually can be stacked. Bales containing forage baled when too wet often shrink, and these change in shape after a few months of storage. Piling wet bales results in additional distortion in shape that causes air leakage and bales falling off the pile. If storage space is limited and piling is necessary, consider stacking on end. Moving the wrapped bales with equipment that does not damage the plastic is essential.

**Feeding issues.** Round bale silage can be handled and fed much like hay. Plastic is usually removed and left in the storage area. Using a round bale feeder or unwrapping bales helps to reduce trampling and waste. Bales may start to heat after 2 to 4 days in the open air, but this heating is usually not as much of a problem as with chopped silage. Presumably, the dense bale slows the air entry that causes the heating. Offering round bale silage that will be consumed in 4 days or less has worked well. However, longer feeding periods are possible during cooler weather. Molding and rotting can occur from holes in plastic, and some of this forage will not be eaten. Molded forage that is consumed has not caused problems in most situations. White, pink, gray, and blue mold have been observed, but problems with cattle deaths or noticeable reductions in performance have not been reported. Horse deaths from botulism have been reported when round bale silage was fed. This was associated with dead animals (rats, mice, etc.) trapped during baling.

**Plastic and wrapper costs.** Round bale silage can be cost-effective in some situations. Typical costs of equipment depreciation and plastic are itemized for the individual bale

and in-line wrapping systems at different annual uses (Table 4).

These are extra costs above those for making hay. Feedback from producers with automated wrappers (wrappers with power supplies and automatic start and stop) that already haul their hay to storage areas indicated labor required to fluff hay prior to raking was similar to labor required to wrap silage bales. Costs associated with extra labor to wrap forage need to be added in some situations. Part of added costs for round bale silage will be offset by reduced field and storage losses compared to hay stored outside. Added costs range from \$3.50 to \$8.50/bale or \$11 to \$27/ton of dry forage.

## Forage Management Is Important

Harvesting hay or round bale silage preserves the forage for feeding at a later time. Neither system improves the quality of harvested forage; therefore, harvesting high quality forage is essential. Ensiling forage requires an anaerobic environment (no oxygen) that allows fermentation of sugars to organic acids. Organic acids such as lactic acid lower the pH, and this inhibits bacteria growth and fermentation. If fermentable sugars are gone before the pH is low enough, clostridia bacteria can grow, breaking down lactic acid and protein to undesirable end products. Bermudagrass is difficult to ensile because of low sugar concentration (usually less than 4% fermentable sugars; Bates et al. 1989a), high buffering capacity (more lactic acid needed to lower pH), and fermentation of some substrates (malic and oxaloacetic acids) to weak acids (acetic) that buffer near pH 5. Wilting forage to 35% or higher dry matter is a strategy used to preserve forages like bermudagrass that are difficult to ensile. Higher dry matter inhibits the growth of the clostridia bacteria.

**Wilting.** Bermudagrass cut at 4 to 6 weeks regrowth is typically 18%–28% dry matter at cutting. Wilting bermudagrass for 2 to 4 hours during good summer drying conditions increased dry matter 20 percentage units to 46% dry matter, reduced bale weights over 100 pounds, and increased dry matter in each bale over 200 pounds (Table 5). Wilting forage 2 to 4 hours resulted in 19% higher dry matter intake and 0.4 pounds per day greater gains in growing cattle. Bermudagrass wilted and stored as round bale silage had bale dry matter weight and cattle gains similar to those associated with forage harvested as hay, but storage and feeding losses were 4 to 6 percentage units better for hay. Wilting compared to direct cut round bale silage also reduces number of bales and storage costs by over 35%.

Most perennial forages (bermudagrass, stargrass, limpo-grass, perennial peanut) should benefit from wilting prior to baling. Annual forages such as millet and sudangrass are very high in moisture when cut, and wilting to increase dry matter is essential for good quality silage.

**Additives.** Microbial inoculants, enzymes, sugars, ammonia, and other additives can be added to enhance fermentation and preservation of silage. Limited research has been conducted with these additives on round bale silage. Microbial inoculants have been shown to increase the rate of fermentation and result in a lower final pH with chopped silage, and similar results have been found with round bale silage (Bates et al. 1989a). Trials evaluating microbial inoculants that provide fast-growing, lactic-acid-producing bacteria often show advantages in silage fermentation, but trials showing advantages in dry matter recovery and cattle performance are limited. Research evaluating effects of microbial inoculation of bermudagrass round bale silage produced mixed results. Growing cattle fed microbial-inoculated (lactic acid bacteria) bermudagrass round bale silage had 0.16 pounds per day greater gains (0.08 versus 0.24 pounds per day) than those fed uninoculated direct cut silage (70%–75% moisture), but microbial inoculation did not improve performance (0.50 versus 0.44 pounds per day) in wilted (50%–60% moisture) bermudagrass round bale silage. This research showed greater intakes and performance for inoculated direct cut bermudagrass silage, but gains of these cattle were still below gains of cattle fed wilted silage, indicating wilting was more important than inoculation. An evaluation of several experiments suggests that microbial inoculants often give improvements when ensiling conditions are marginal.

Ammonia is a mold inhibitor and has been shown to reduce visible molds on the outside of bales (Bates et al. 1989b). Unfortunately, ammoniation (1% of dry matter) has been associated with an undesirable fermentation in direct cut bermudagrass round bale silage characterized by more acetic acid and a higher pH. Enzyme additives to bermudagrass silage have shown promising results by increasing the fermentable substrate (Bates et al. 1989b); however, the specific enzymes and quantities (activities) needed for the optimal effect have not been determined.

## Summary

The round bale storing system allows harvesting warm-season grasses every 4 to 5 weeks when the quality is good. This will reduce or eliminate the need for supplements when feeding the forage to beef cattle. Plan to cut warm-season grass by the calendar, make hay when the weather

allows, and make round bale silage when the weather will not allow drying for hay. Quality of round bale silage is dependent on excluding air from the ensiled forage. Holes in the plastic resulting in molding and rotting of the forage have been the biggest problem with round bale silage. Wilting warm-season grasses to increase dry matter 40%–50% before baling reduces the number of bales and storage costs, decreases storage losses, and improves cattle performance.

## Literature Cited

Bates, D.B., W.E. Kunkle, C.G. Chambliss, and R.P.

Cromwell. 1989a. “Effect of dry matter and additives on bermudagrass and rhizoma peanut round bale silage.” *J. Prod. Agric.* 2:91-96.

Bates, D.B., W.E. Kunkle, T.E. Dawson, A. Berthe, S.C. Denham, C.G. Chambliss, R. C. Cromwell, J.G. Wasdin, and D.L. Wakeman. 1989b. “Round bale silage - A forage harvesting alternative.” *Proc. 38<sup>th</sup> Annual Beef Cattle Short-course*, pp 45-55, Univ. of Florida.

Berthe, A., W.E. Kunkle, and D.B. Bates. 1991. “Effects of harvesting system and wilting on bermudagrass intake and liveweight change of growing heifers.” *J. Anim. Sci.* 69:283 (Suppl. 1).

Brown, W.F., and R.S. Kalmbacher. 1998. “Nutritional value of native range and improved forages: A perspective from central and south Florida.” *Proc. 47<sup>th</sup> Annual Beef Cattle Shortcourse*, pp 79-87, Univ. of Florida, Gainesville.

Cromwell, R.P., W.E. Kunkle, and C.G. Chambliss. 1994a. “Equipment for preserving forage as round-bale silage.” Cooperative Extension Service, Circular 1071, 7 pp, Univ. of Florida, Gainesville.

Cromwell, R.P., W.E. Kunkle, G.D. Sadler, and C.G. Chambliss. 1994b. “The plastic wrapper is the key to making high quality round bale silage.” UF/IFAS Extension, Circular 1072, 6 pp, Univ. of Florida, Gainesville.

Yepez, P.G., W.E. Kunkle, and D.B. Bates. 1992. “Effect of delaying storage on the dry matter recovery and quality of bermudagrass ensiled in round bales wrapped with plastic.” *J. Anim. Sci.* 70:191 (Suppl. 1).

Table 1. Effects of grass and maturity (age in weeks) on forage quality.<sup>a</sup>

Grass	TDN <sup>b</sup>			Voluntary intake <sup>c</sup>			Quality index <sup>d</sup>		
	4	6	8	4	6	8	4	6	8
Bahia	56	55	54	2.3	2.1	1.7	1.2	1.1	0.9
Bermuda	57	52	44	2.3	2.2	1.8	1.3	1.1	0.8
Star	60	53	49	2.4	2.5	2.1	1.4	1.3	1.0
Digit	60	58	57	2.5	2.7	2.2	1.5	1.5	1.2
Limpo	63	63	56	2.5	2.3	2.2	1.5	1.4	1.2

<sup>a</sup> Adapted from Brown and Kalmbacher, pp 79-87, in 47<sup>th</sup> Florida Beef Cattle Shortcourse Proc., May 1988.  
<sup>b</sup> Total Digestible Nutrients, percentage of dry matter.  
<sup>c</sup> Intake of dry matter expressed as percent of body weight.  
<sup>d</sup> Voluntary TDN intake relative to maintenance requirement: 1.0 = maintenance.

Table 2. Quality of coastal bermudagrass hay harvested at different maturities and seasons.<sup>a</sup>

Item	Weeks of regrowth	Harvest date				
		06/14	07/12	08/09	09/06	10/04
TDN, % DM <sup>b</sup>	4	55	57	52	53	46
	6	52	51	47	49	48
	8	52	51	46	47	44
QI <sup>c</sup>	4	1.4	1.4	1.3	1.3	1.1
	6	1.3	1.4	1.0	1.2	1.2
	8	1.3	1.1	0.9	1.1	0.8
ADG, lb <sup>d</sup>	4	0.57	0.78	0.72	0.63	0.28
	6	0.34	0.48	-0.04	0.42	0.22
	8	0.16	0.07	-0.39	0.07	-0.39

<sup>a</sup> Adapted from Nelson, et al., 1980, Louisiana Agr. Exp. Sta. Bul. 730.  
<sup>b</sup> Total Digestible Nutrients, percentage of dry matter.  
<sup>c</sup> Voluntary TDN intake relative to maintenance requirement: 1.0 = maintenance.  
<sup>d</sup> Daily gains, in pounds; feeding trial conducted with steers from December through February for all hays.



Table 3. Effects of delaying time from baling to wrapping on bermudagrass round bale silage.<sup>a</sup>

	Time from baling to wrapping, hr				
	1-4	19-22	27-31	48-52	S.E.
Year 1989 <sup>b</sup>					
Dry matter recovery, %	99.5	96.0	101.6	100.8	3.0
ADF-N <sup>c</sup> , % DM	0.17	0.15	0.13	0.14	0.02
IVOMD, % <sup>d</sup>	50.0	50.3	52.4	50.7	0.92
pH	5.81	6.02	5.99	5.95	0.07
Temperature, (days 9-14)					
- Peak, F°	88	93	95	104	1.4
- Average, F°	83	86	87	91	1.1
Year 1990 <sup>e</sup>					
Dry matter recovery, %	96.5	97.1	98.5	98.9	2.0
ADF-N <sup>c</sup> , % DM	0.08	0.08	0.08	0.10	0.01
IVOMD, % <sup>d</sup>	39.0	42.1	42.4	41.7	0.93
pH	5.40	5.47	5.46	5.77	0.11
Temperature, (days 3-8)					
- Peak, F°	118	133	136	150	1.8
- Average, F°	112	121	123	136	0.7

<sup>a</sup> Garces-Yepe, et al., 1992.  
<sup>b</sup> Bales made on October 31, 1989; bale weight averaged 1,035 lb; 37.3% dry matter.  
<sup>c</sup> Acid detergent fiber nitrogen as a percent of dry matter.  
<sup>d</sup> In-vitro organic matter digestibility.  
<sup>e</sup> Bales made on September 6, 1990; bale weight averaged 1,275 lb; 38.0% dry matter.

Table 4. Depreciation and plastic costs for two round bale silage wrapping systems.<sup>a</sup>

Bales/year <sup>b</sup>	Individually wrapped bales			In-line wrapped bales		
	500	1,000	2,000	500	1,000	2,000
Hay, tons <sup>c</sup>	180	360	720	180	360	720
Wrapper depreciation, \$/bale <sup>de</sup>	5.00	2.50	1.25	6.00	3.00	1.50
Stretch-wrap plastic, \$/bale	3.50	3.50	3.50	2.00	2.00	2.00
Total cost, \$/bale	8.50	6.00	4.75	8.00	5.00	3.50
Total cost, \$/ton dry forage	27.00	19.00	15.10	25.40	15.90	11.10

<sup>a</sup> Added costs above hay harvest, additional labor required in some situations.  
<sup>b</sup> Bales 4 feet wide by 5 feet high, 1,400 lb, 45% dry matter, 630 lb dry matter/bale.  
<sup>c</sup> Tons of hay with equivalent dry forage.  
<sup>d</sup> Individual bale wrapper \$12,500 cost; depreciated over 5 years, \$2,500/year.  
<sup>e</sup> In-line bale wrapper \$15,000 cost; depreciated over 5 years, \$3,000/year.

Table 5. Effects of wilting bermudagrass round bale silage on forage preservation and performance of growing cattle.<sup>ab</sup>

	Wilting time, hours			Hay
	None	1-2	2-4	
Forage dry matter, %	26.8	36.2	45.9	87.4
Wet bale weight, lb	1,450	1,425	1,340	710
Dry bale weight, lb	390	515	620	620
Storage losses, %	12.5	11.5	8.8	3.0
Feeding losses, %	10.1	12.7	16.8	12.5
Dry matter intake, lb <sup>c</sup>	8.58	9.55	10.20	9.82
Daily gain, lb	-0.15	+0.02	+0.26	+0.28

<sup>a</sup>Berthe et al., 1991; Research conducted over two years, bermudagrass cut after 5 to 6 weeks regrowth in Year 1 and 6 to 7 weeks regrowth in Year 2.

<sup>b</sup>Bales were 4 feet wide and 4.5 feet high made with New Holland 848 baler. High moisture forage wrapped with 4 layers of stretch-wrap plastic.

<sup>c</sup>Cattle weighed 550 lb at start of trial in Year 1; cattle weighed 520 lb at start of trial in Year 2.

# Comparison of Hay or Round Bale Silage as a Means to Conserve Forage<sup>1</sup>

Matt Hersom, Todd Thrift, and Joel Yelich<sup>2</sup>

## Introduction

Conservation of forage during the summer for deferred use is a common production practice for beef cattle enterprises. Pasture forage production is not always adequate to meet beef cow intake or nutrient requirements. Conservation of forage provides feed and nutritional resources to meet beef cow nutritional requirements during annual seasonal deficits in pasture forage production to maintain adequate cow productivity.

Florida's climate makes conserving forages for later feeding challenging. Forage for hay production must be harvested when the humidity is low to ensure optimal drying conditions. Additionally, Florida growing conditions make conserving the quality of forage difficult, since frequently it must be harvested when it has matured past its nutritional peak. Scientists are exploring alternative methods of forage conservation suited to Florida's challenges. Extensive work with the development and utilization of round bale silage (RBS) has previously been examined by Kunkle (2003). Round bale silage offers an alternative method of forage harvesting and storage to traditional hay harvest and storage. Traditional hay harvest systems require optimal cutting, drying, and baling weather conditions. The use of round bale silage overcomes several of the challenges to hay production in Florida and offer an attractive compliment to traditional hay harvest systems.

Certainly, RBS offers several advantages. A primary advantage is that RBS can mitigate adverse weather and drying conditions for hay production that frequently occur in Florida during the summer (Figure 1). Incorporation of a RBS system increases the flexibility of the forage harvest window. Sequential days of dry weather are not required for the conservation of forage in the RBS system. This flexibility allows for the timely harvest of forages to capture forage nutrients before they are lost due to maturity or weathering. Additionally, RBS does not require as much drying time as hay; therefore, less plant material is lost due to processing and handling. Appropriate preservation dry matter targets for hay (approximately 85%) and RBS (approximately 50%) should be utilized. Excessive moisture in either hay or RBS will increase the opportunity for spoilage and ultimately decrease the quality and consistency of the conserved forage. Because it protects silage from weathering, an RBS system may retain more of the nutrients in the forage than a traditional system. Finally, RBS-conserved forage maintains its quality out of doors, thus no hay barn structures are required.

## Application

A demonstration was conducted at the Santa Fe-Boston Farm Beef Research Unit located in northern Alachua County Florida. A 50-acre Tifton-85 Bermudagrass field was divided into two 25-acre sections. One section was managed to produce hay only. Forage was harvested as large

1. This document is AN266, one of a series of the Department of Animal Sciences, UF/IFAS Extension. Original publication date August 2011. Reviewed October 2017. Visit the EDIS website at <http://edis.ifas.ufl.edu>.

2. Matt Hersom, associate professor; Todd Thrift, associate professor; and Joel Yelich, former associate professor; Department of Animal Sciences, UF/IFAS Extension, Gainesville, FL 32611.

The Institute of Food and Agricultural Sciences (IFAS) is an Equal Opportunity Institution authorized to provide research, educational information and other services only to individuals and institutions that function with non-discrimination with respect to race, creed, color, religion, age, disability, sex, sexual orientation, marital status, national origin, political opinions or affiliations. For more information on obtaining other UF/IFAS Extension publications, contact your county's UF/IFAS Extension office.

U.S. Department of Agriculture, UF/IFAS Extension Service, University of Florida, IFAS, Florida A & M University Cooperative Extension Program, and Boards of County Commissioners Cooperating. Nick T. Place, dean for UF/IFAS Extension.

round hay bales (5-foot diameter) as growing conditions and weather permitted. The other section was managed on a 4-week harvest schedule. Forage was harvested and stored as large round hay bales when weather/drying conditions permitted. When weather did not allow for harvest as hay, forage was harvested and stored as RBS. The hay only section was fertilized four times (1–90 lb N/acre, 3–80 lb N/acre) from April through August; the hay-RBS section received five applications of fertilizer (1–90 lb N/acre, 3–80 lb N/acre, 1–68 lb N/acre) because an additional forage harvest occurred.

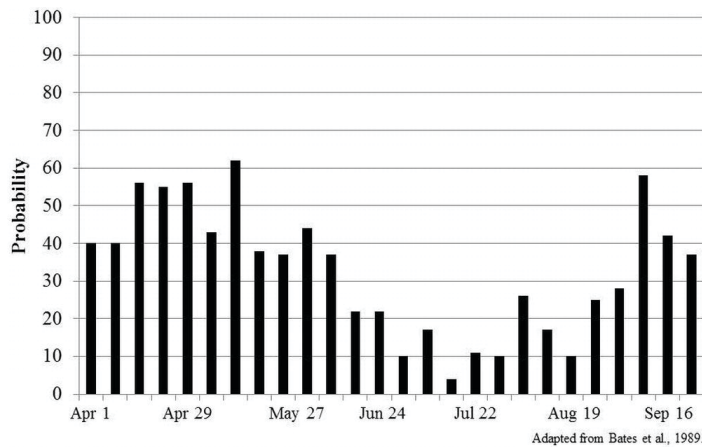


Figure 1. Probability of three consecutive dry days each week during the spring and summer.

Credits: Adapted from Bates et al. (1989)

Hay production typically required 3 to 4 days of drying time with 1 to 2 rakings to facilitate dry-down of the forage. The RBS was baled in a similar manner to dry hay using a large round baler. It was preserved with an Anderson in-line hay wrapper. Production of RBS utilized a 3- to 4-hour wilting time between cutting and baling and no raking. Bales for RBS were wrapped within 2 hours of baling. Hay and RBS bale weights and core samples were collected on every 10<sup>th</sup> bale produced on the day of harvest. Analysis of hay and RBS samples was performed by Dairy One (Ithaca, NY) NIRS analysis. This analysis provided detailed information about bale dry matter, protein, total digestible nutrient, fiber fractions, and other nutrients. Bale weights were obtained after baling, and either prior to storage as hay or RBS. Total number of bales was recorded at each harvest to calculate total pounds of forage harvested for each system.

## Outcome

More cuttings of forage were taken from the hay-RBS field, which was managed to remove forage on a regular interval compared to the hay field (Table 1). The increase in the number of cuttings resulted in an increased total number of bales, total wet forage harvested, and total forage dry matter

harvested from the hay-RBS compared to the hay-only production system. The hay-RBS section included one cutting of forage that was harvested as hay. Mean bale weight produced from the hay-RBS section was 42% greater than mean bale weight from the hay section. Forage dry matter was very different between the two harvest sections because of the large portion of forage harvested as RBS. Hay section bale dry matter was 45.7 units greater than bales produced from the hay-RBS section. Mean bale crude protein (CP) and total digestible nutrient (TDN) % were greater for forage harvested from the hay-RBS section compared to the hay section. When expressed on a dry matter basis, mean bale weight and bale TDN supply was greater for the hay section than the hay-RBS section. However, mean bale CP amount did not differ between the two harvest systems.

When the forage conservation method (hay vs. RBS) was examined, mean bale weight was greater for RBS than for hay bales (Table 2). This is a result of the lower dry matter percentages associated with RBS compared with hay. Additionally, CP and TDN percentages for bales produced during the summer harvest period were greater for RBS bales than for hay bales. In contrast, greater mean hay bale dry matter yield and TDN yield occurred in hay bales compared to hay RBS, but CP yield did not differ. The improvement in hay CP and TDN percentages between Table 2 and 3 occurs because the hay described in Table 3 includes hay produced from the hay-RBS section. Hay bales from the hay-RBS section were slightly greater in quality compared to hay only because of the regular harvest schedule that helped to capture forage quality through managing forage maturity. Management of forage maturity mitigates the increases in fiber fractions, decrease in protein concentration, and increase in stem:leaf ratio as grasses grow and mature. A common misconception is that the ensiling process that RBS undergoes improves the nutritive value of the RBS product. In fact, the nutritive value of the forage is set when the forage is harvested; wrapping RBS just preserves what is present in the forage.

Any forage conservation system will benefit from analysis to quantify the economic parameters of hay and RBS production. This analysis should include comparisons between hay and RBS cost of production and the cost benefit to producing and storing high-quality stored forage. Table 3, using inputs from the demonstration reported in Table 2, presents a cost comparison between hay and RBS production. However, in this example forage is conserved exclusively as either hay or RBS. The calculations and comparisons between hay and RBS in the example are sensitive to the dry matter percentage of the RBS and

estimated storage loss difference between hay and RBS (Table 5). Likewise, the different production inputs for hay and RBS (number of raking, baling costs, and fertilizer applications) and differing costs for these production inputs will drive production costs differences (Table 6). Additionally, the number and size of hay or RBS bales produced will affect total production costs; more and larger bales spread production costs over more output, thus decreasing the production costs per unit produced (i.e., tons of forage, bales).

## Summary

Harvesting forage as round bale silage works very well as an alternative to traditional hay harvest. Forage harvest can occur on a regular schedule to optimize forage quantity and quality. To optimize the investment in round bale silage production, harvest forage at its nutritional peak to capture superior quality and to increase production. Additionally, the decreased storage loss associated with round bale silage improves the economic viability of round bale silage as a complement or alternative to hay production.

## Literature Cited

Bates, D. B., W. E. Kunkle, T. E. Dawson, A. Berthe, S. C. Denham, C. G. Chambliss, R. C. Cromwell, J. G. Wasdin, D. L. Wakeman. (1989). "Round Bale Silage—A Forage Harvesting Alternative." *Florida Beef Cattle Short Course*. [http://animal.ifas.ufl.edu/beef\\_extension/bcsc/1989/pdf/bates.pdf](http://animal.ifas.ufl.edu/beef_extension/bcsc/1989/pdf/bates.pdf) (accessed May 17, 2011)

Collins, M., D. Ditsch, J. C. Henning, L. W. Turner, S. Isaacs, and G. D. Lacefield. Round Bale Hay Storage in Kentucky. Univ. of Kentucky Coop. Ext. Serv. AGR-171. <http://www.ca.uky.edu/agc/pubs/agr/agr171/agr171.pdf> (accessed May 17, 2011)

Edwards, W., and A. Johanns. 2010 Iowa Farm Custom Rate Survey. Iowa State University A3-10. <http://www.extension.iastate.edu/agdm/crops/pdf/a3-10.pdf> (accessed December 8, 2010)

Kunkle, W. E. (2003). *Harvesting, Storing, and Feeding Forages as Round Bale Silage*. AN145. Gainesville: University of Florida Institute of Food and Agricultural Sciences. <http://edis.ifas.ufl.edu/AN145> (accessed May 17, 2011)

Table 1. Effect of forage production management system on conserved forage production and quality.

Item	Hay-Only Field	Hay-RBS Combination Field
Number of cuttings	3	5
Number of bales produced	259	479
Total harvest, lbs as fed	219,123	709,131
Total harvest, lbs dry matter	202,743	312,728
Mean bale		
Wet weight, lbs	847	1,470
Dry matter, %	92.5	46.8
Crude protein, %	10.1	12.9
Total digestible nutrients,%	54	57
Dry matter, lbs	783	645
Crude protein, lbs	79	82
Total digestible nutrients, lbs	418	369

Table 2. Effect of hay or round bale silage preservation method on the characteristics of representative bales

Item	Hay	RBS
Mean bale		
Wet weight, lb	824	1,556
Dry matter, %	92.5	41.3
Crude protein, %	10.4	13.1
Total digestible nutrients,%	54	57
Dry matter, lbs	769	638
Crude protein, lbs	78	83
Total digestible nutrients, lbs	416	365

Table 3. Cost comparison of the production and storage of hay or round bale silage forage.

Inputs and Production		Hay	Round Bale Silage
Field Size	acres	25	25
# of cuttings		3	5
# of rakings		6	5
# of bales produced		259	479
Average bale weight	lbs	847	1556
# of fertilization applications		4	5
Forage dry matter (DM)	%	93%	41%
Forage total digestible nutrients (TDN)	%	54%	57%
Forage crude protein (CP)	%	10%	13%
Estimated Storage Loss <sup>1</sup>	%	28%	5%
Total as-fed production	lbs	219,373	745,324
Total DM production	lbs	202,920	305,583
DM TDN produced	lbs	109,577	174,182
DM CP produced	lbs	20,292	39,726
Total as-fed available	lbs	157,949	708,058
Total DM available	lbs	146,102	290,304
TDN available	lbs	78,895	165,473
CP available	lbs	14,610	37,739
Production Economics		Hay	Round Bale Silage
Total baling cost <sup>2</sup>	\$	\$ 7,670.55	\$ 12,143.10
as-fed cost per acre	\$/acre	\$306.82	\$485.72
DM cost per acre	\$/acre	\$331.70	\$ 1,184.69
As-fed forage cost	\$/ton	\$69.93	\$32.58
Dry matter forage cost	\$/ton	\$75.60	\$79.48
As-fed bale cost	\$/bale	\$29.62	\$25.35
Dry matter bale cost	\$/bale	\$32.02	\$61.83
Cost of DM	\$/lb	\$0.04	\$0.04
Cost of TDN	\$/lb	\$0.07	\$0.07
Cost of CP	\$/lb	\$0.38	\$0.31
Final Forage Economics (includes spoilage loss)		Hay	Round Bale Silage
As-fed forage cost	\$/ton	\$97.13	\$34.30
Dry matter forage cost	\$/ton	\$105.00	\$83.66
As-fed bale cost	\$/bale	\$41.13	\$26.69
Dry matter bale cost	\$/bale	\$44.47	\$65.09
Cost of DM	\$/lb	\$0.053	\$0.042
Cost of TDN	\$/lb	\$0.097	\$0.073
Cost of CP	\$/lb	\$0.525	\$0.322

<sup>1</sup> Estimate from Table 5.

<sup>2</sup> Prices found in Table 6.

Table 4. Hay and round bale silage cost comparison worksheet.

Inputs and Production		Hay		Round Bale Silage
Field Size	acres	_____		_____
# of cuttings		_____		_____
# of rakings		_____		_____
# of bales produced		_____		_____
Average bale weight	lbs	_____		_____
# of fertilization applications		_____		_____
Forage dry matter (DM)	%	_____		_____
Forage total digestible nutrients (TDN)	%	_____		_____
Forage crude protein (CP)	%	_____		_____
Estimated storage loss	%	_____		_____
Total as-fed production <i># of bales x average bale weight</i>	lbs	_____		_____
Total DM production <i>total as fed production x forage DM %</i>	lbs	_____		_____
DM TDN produced <i>total DM production x forage TDN %</i>	lbs	_____		_____
DM CP produced <i>total DM production x forage CP %</i>	lbs	_____		_____
Total as-fed available <i>total as fed production x (100-storage loss %)</i>	lbs	_____		_____
Total DM available <i>total DM production x (100-storage loss %)</i>	lbs	_____		_____
TDN available <i>DM TDN produced x (100-storage loss %)</i>	lbs	_____		_____
CP available <i>DM CP produced x (100-storage loss %)</i>	lbs	_____		_____
Production Economics		Hay		Round Bale Silage
Total baling cost <sup>2</sup> <i>((# cuttings ((# cuttings x (mowing cost, \$/acre x acres)) + (# rakings x (raking cost, \$/acre x acres)) + ((fertilizer application cost, \$/acre x acres)+(fertilizer cost, \$/acre x acres) x # of fertilizer applications) + (baling cost, \$/bale x # of bales) + (bale moving cost, \$/bale x # of bales)</i>	\$	_____		_____
As-fed cost per acre <i>total baling cost ÷ # of acres</i>	\$/acre	_____		_____
DM cost per acre <i>as fed cost per acre ÷ forage DM%</i>	\$/acre	_____		_____
As-fed forage cost <i>total baling cost ÷ (total as fed production ÷ 2000)</i>	\$/ton	_____		_____
Dry matter forage cost <i>total baling cost ÷ (total DM production ÷ 2000)</i>	\$/ton	_____		_____
As-fed bale cost <i>total baling cost ÷ # of bales</i>	\$/bale	_____		_____
Dry matter bale cost <i>as fed bale cost ÷ forage DM %</i>	\$/bale	_____		_____
Cost of DM <i>total baling cost ÷ total DM production</i>	\$/lb	_____		_____
Cost of TDN <i>total baling cost ÷ lbs DM TDN produced</i>	\$/lb	_____		_____



Cost of CP <i>total baling cost ÷ lbs DM CP produced</i>	\$/lb	_____	_____
<b>Final Forage Economics (includes spoilage loss)</b>		<b>Hay</b>	<b>Round Bale Silage</b>
As-fed forage cost <i>total baling cost ÷ (total as fed available production ÷ 2000)</i>	\$/ton	_____	_____
Dry matter forage cost <i>total baling cost ÷ (total DM production ÷ 2000)</i>	\$/ton	_____	_____
As-fed bale cost <i>as fed bale cost ÷ (100-storage loss %)</i>	\$/bale	_____	_____
Dry matter bale cost <i>DM bale cost ÷ (100-storage loss %)</i>	\$/bale	_____	_____
Cost of DM <i>total baling cost ÷ total DM available</i>	\$/lb	_____	_____
Cost of TDN <i>total baling cost ÷ total DM TDN available</i>	\$/lb	_____	_____
Cost of CP <i>total baling cost ÷ total DM CP available</i>	\$/lb	_____	_____
<sup>1</sup> Estimate from Table 5.			
<sup>2</sup> Prices found in Table 6.			

Table 5. Estimated forage storage loss for different storage methods.<sup>1</sup>

Storage method	Estimated % loss
Bare ground with no cover	28
On gravel with no cover	24
Bare ground under tarp	13
On gravel under tarp	9
Under roof with no sides	8
Inside building	5
Bare ground with plastic wrap (round bale silage)	5

<sup>1</sup>Adapted from Collins et al.

Table 6. Custom rate prices for hay and round bale silage production.<sup>1</sup>

Action		Hay	Round Bale Silage
Mowing/conditioning	\$/acre	\$12.40	\$12.40
Raking	\$/acre	\$5.65	\$5.65
Baling	\$/bale	\$9.80	\$11.00
Moving round bales to storage	\$/bale	\$2.90	\$2.90
Fertilizer application	\$/acre	\$4.15	\$4.15
Fertilizer cost	\$/acre	\$25.00	\$25.00

<sup>1</sup> Adapted from Iowa State University Farm Custom Rate Survey A3-10  
<sup>2</sup> Includes the cost of plastic wrap using a tube wrapper.  
<sup>3</sup> Fertilizer cost is highly variable based on soil test, production needs, and choice of fertilizer applied.

# Self-Treatment Methods for Livestock—Backrubbers<sup>1</sup>

E. N. I. Weeks and P. E. Kaufman<sup>2</sup>

Backrubbers are a method of pesticide self-treatment for cattle. When bothered by insects or other pests, cattle tend to rub against objects. Backrubbers provide a rubbing surface that is treated with a pesticide. Cattle self-treat during rubbing, which reduces the number of flies, particularly horn flies and parasites such as lice, on the animal. Backrubbers may be purchased commercially or constructed from easily available materials. A properly designed backrubber that supplies pesticide reliably to the animal can be a valuable addition to an integrated pest management program.

The position of the backrubber is of highest importance. Positioning should “force” animals to use the devices frequently so that they will be effective. Backrubbers should be installed in high-traffic areas where animals travel through frequently, such as between mineral and salt stations, or feeding and watering areas and pastures (Figure 1). To ensure treatment of the head, the backrubber should be positioned low enough so that the animals are forced to drop their heads to pass under. Underbrush often will compete with backrubbers for scratching, so locations with shrubs should be avoided. Placement of devices between feed, water, or supplement improves fly control, but use should be monitored. Each animal must contact the backrubber every two to three days to be effective.



Figure 1. Backrubbers correctly positioned in high-traffic areas. Credits: P. E. Kaufman (top two photos) and J. F. Butler (bottom left photo), University of Florida; C. Sheppard, University of Georgia, Bugwood.org (bottom right photo).

## Materials Needed for a Cable-Type Backrubber

- Two four-inch eyelets or eyebolts
- Hog rings and pliers, as needed
- 15 to 20 ft of 9 gauge cable or chain
- 18 to 20 burlap bags (can be new or used)
- Two 8 ft by 6 inch diameter posts, pressure treated
- 30 to 40 strands binder twine (15 inch long)
- 20 to 25 strands baling wire (12 inch long)

1. This document is ENY279, one of a series of the Department of Entomology and Nematology, UF/IFAS Extension. Original publication date July 1997. Revised September 2012, September 2015, and October 2018. Visit the EDIS website at <http://edis.ifas.ufl.edu>.

2. E. N. I. Weeks, assistant research scientist; and P. E. Kaufman, associate professor/Extension entomologist. First published in 2005 by P. G. Koehler, professor/Extension entomologist; and J. F. Butler, professor, Department of Entomology and Nematology; UF/IFAS Extension, Gainesville, FL 32611.

The Institute of Food and Agricultural Sciences (IFAS) is an Equal Opportunity Institution authorized to provide research, educational information and other services only to individuals and institutions that function with non-discrimination with respect to race, creed, color, religion, age, disability, sex, sexual orientation, marital status, national origin, political opinions or affiliations. For more information on obtaining other UF/IFAS Extension publications, contact your county's UF/IFAS Extension office.

U.S. Department of Agriculture, UF/IFAS Extension Service, University of Florida, IFAS, Florida A & M University Cooperative Extension Program, and Boards of County Commissioners Cooperating. Nick T. Place, dean for UF/IFAS Extension.

## Construction of Cable-Type Backrubbers (see Figure 2)

1. Attach bags lengthwise on the chain using hog rings at 10 inch intervals (Figure 2-1).
2. Roll bags tightly and tie securely around the chain with binder twine (Figure 2-2).
3. Wrap the rolled bags with a second layer of burlap, making sure to overlap the areas between bags (Figure 2-3).
4. Twist baling wire every 8 inches along the backrubber. Clip the wires and push the cut ends into the burlap (Figure 2-4).
5. Hang the backrubber between the posts so that it will sag to within 1–1½ ft off the ground (Figure 2-5).
6. Pour one gallon of recommended pesticide on 15–20 ft of backrubber (Figure 2-6).

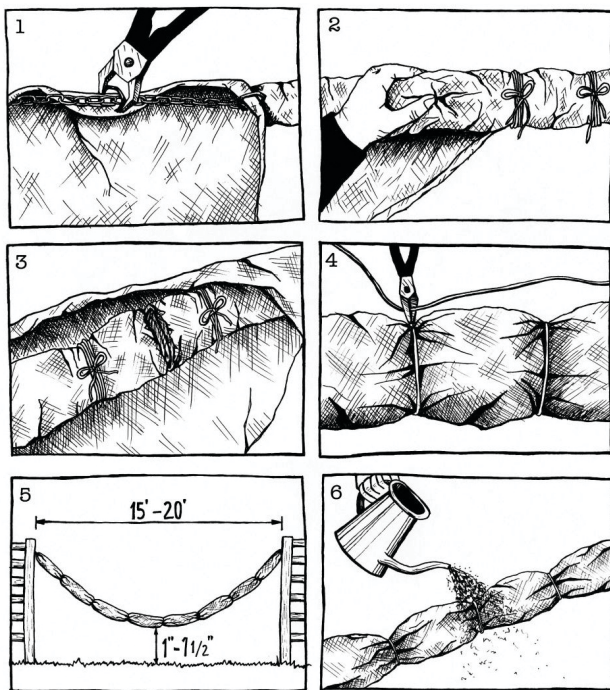


Figure 2. Construction of a cable-type backrubber.  
Credits: E. N. I. Weeks, University of Florida, and L. J. Weeks.

## Use of Cable-Type Backrubbers

- Backrubbers may be modified to suit the management practices of any farm. The treated backrubber may be attached to trees or braced with wire and/or posts (Figure 3).

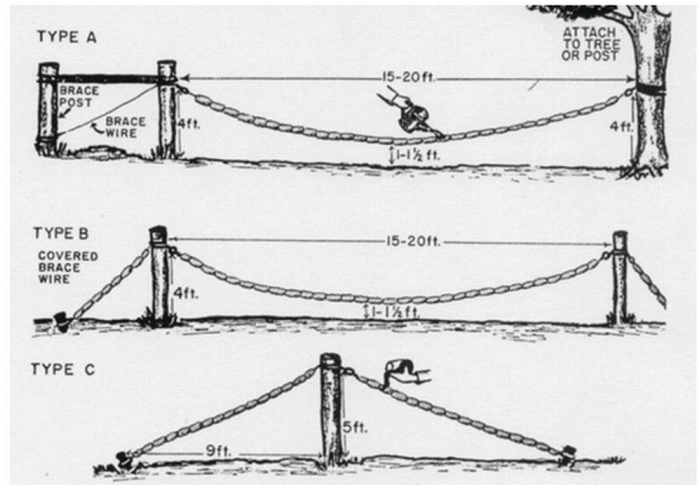


Figure 3. Methods for securing backrubbers.  
Credits: J. R. Strayer and J. F. Butler, University of Florida.

- Approximately one gallon of recommended pesticide should be used to treat a 15 to 20 ft backrubber.
- The backrubber should not be dripping; adjust volume added accordingly.
- One gallon oil cans work well for applying the pesticide oil suspension to the backrubber.
- Re-treat the backrubber every 2–3 weeks.
- One 15 to 20 ft backrubber should be available for every 50–75 animals.
- The addition of 18 inch strips of cloth at 4 to 6 inch intervals increases the area of contact and can increase insect control.
- Use livestock-grade mineral oil unless otherwise recommended on the pesticide label.
- Rotate pesticide classes between treatments.
- DO NOT use wettable powder formulations. They are unsuitable for backrubber use.
- DO NOT use diesel or kerosene because these oils evaporate quickly, which means that transfer of the pesticide will be low. These oils also may irritate the animals' skin.
- DO NOT use motor oil, transformer oil, or oil of unknown origin.
- DO NOT use vegetable oil because it encourages licking and accidental ingestion of the pesticide.
- DO NOT spray pesticide oil suspensions directly onto animals.

## Keys to Pesticide Safety

1. Before using any pesticide, stop and read the precautions.
2. Read the label on each pesticide container before each use. Heed all warnings and precautions.
3. Store all pesticides in their original containers away from food or feed.
4. Keep pesticides out of the reach of children, pets, and livestock.
5. Apply pesticides only as directed.
6. Dispose of empty containers promptly and safely.

Recommendations in this document are guidelines only. The user must insure that the pesticide is applied in strict compliance with label directions.

The Food and Drug Administration has established residue tolerances for certain pesticides in the meat of certain animals. When these and other approved pesticides are applied according to recommendations, the pests should be effectively controlled, and the animals' products will be safe for consumption.

The improper use of pesticides may result in residue in milk or meat. Such products must not be delivered to processing plants. To avoid excessive residues, use the pesticides recommended at the time recommended and in the amounts recommended.

## Locating an Approved Pesticide

In 2014, a group of livestock entomologists, as a part of Multistate Hatch Project S-1060, developed an online system for obtaining the names of registered pesticides appropriate for use with livestock and pets. This is a state-specific database (only certain states are represented, and Florida is one of these); if you are in another state, you must be certain that your state is represented in the dropdown list.

This database is easily searchable by the type of animal or site that you want to treat (such as a barn), as well as the targeted pest. From these two selections, you can then choose the "Method of Application" and the "Formulation Type." To use this system, please visit the following URL: [http://veterinaryentomology.ucr.edu/vet\\_pesticides.html](http://veterinaryentomology.ucr.edu/vet_pesticides.html).

Although the group continuously strives to keep this database current, it is ultimately your responsibility to ensure that the product that you choose is registered in the state that you plan to make the application and that you use the product in accordance with the label requirements and local laws and ordinances. Remember, "the label is the law" for pesticide use, and the uses indicated on the label, including the site of application and targeted pest(s) must be on the label.

If you have any challenges with this system, please contact your local UF/IFAS Extension Office (<http://sfyl.ifas.ufl.edu/find-your-local-office/>)

## Selected References

- Harvey, T. L., and J. R. Brethour. 1986. "Dust bag and backrubber applications of insecticides for control of pyrethroid resistant horn flies, *Haematobia irritans* (L)." *Prev. Vet. Med.* 3: 537–540.
- Iowa State University. 2009. Fly control measures. [http://www.cfsph.iastate.edu/BRMForProducers/English/Route-SpecificInformation/fly\\_control.pdf](http://www.cfsph.iastate.edu/BRMForProducers/English/Route-SpecificInformation/fly_control.pdf) (24 October 2018).
- Johnson, G. 2009. Horn flies on cattle: biology and management. <http://msuextension.org/publications/AgandNaturalResources/MT200912AG.pdf> (24 October 2018).
- Kessler, H., and W. L. Berndt. 1971. "Comparison of dust bags to backrubbers for control of horn flies and face flies Diptera-Muscidae on beef cattle in East-Central South Dakota." *J. Econ. Entomol.* 64: 1465–1466.
- Mock, D. E. 1987. Managing insect problems on beef cattle. <http://www.k-state.edu/historicpublications/pubs/C671.pdf> (24 October 2018).
- Palmer, W. A., and D. E. Bay. 1984. "A computer simulation model for describing the relative abundance of the horn fly, *Haematobia irritans irritans* (L.), under various ecological and pest management regimes." *Prot. Ecol.* 7: 27–35.
- Strayer, J. R. and J. F. Butler. 1972. *External Parasite Control for Livestock*. Gainesville: University of Florida Institute of Food and Agricultural Sciences.

# ANIMALS: FLY CONTROL IN LIVESTOCK FACILITIES

## Dairy Barns, Swine Barns, Livestock Sheds, Other Animal Buildings

Nancy C. Hinkle, Veterinary Entomologist

### RESIDUAL AND BAIT SPRAYS<sup>1</sup>

INSECTICIDE <sup>2</sup>	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	REMARKS
<i>Beauveria bassiana</i> balEence	biological	7.5 oz/4 gal water/25000 sq ft of adult fly resting sites.	Safe for Animals or people to re-enter when dry	Use a higher rate to treat maggot habitat. BalEence is potentially hazardous to bees. Do not contaminate surface water with balEence or its rinsate.
<i>beta-cyfluthrin</i> Tempo 1SC Ultra Tempo 10WP Tempo 20WP	3A	8-16 ml 1SC in sufficient water to cover 1000 sq ft 10-20 grams 10WP in sufficient water to cover 1000 sq ft.	Safe for Animals or people to re-enter when dry	Remove animals before spraying and do not return them until spray dries. Do not contaminate feed, drinking water, milk, or milk-handling equipment. Do not apply as a space spray. Do not apply directly to animals. Direct as a coarse, wetting spray to surfaces in livestock facilities where flies congregate, such as ceilings, walls, fences, posts, and manure. Apply to point of runoff (1 gal spray/500-1000 sq ft). Repeat as needed. For bait solutions add 1 lb sugar/gal of spray.
<i>bifenthrin</i> ActiShield	3A	0.33-1 fl oz 0.66EC/gal water 1000 sq ft.	Safe for Animals or people to re-enter when dry	For adult fly control in and around animal facilities, spray application should target areas where flies will rest.
<i>chlorpyrifos</i> Durashield	1B	Restricted use pesticide. For use by certified applicators.		Restricted use pesticide, for use by certified applicators. Apply according to label directions to adult fly resting sites.
<i>cyfluthrin</i> Optashield CS	3A	Mix 1-2 fl oz with 1 gal water.		Apply 1 gal/1000 sq ft.
<i>deltamethrin</i> 0.02% Annihilator Insecticide Premise	3A	Ready-to-use when purchased.	None	Apply thoroughly to surfaces until wet. Repeat as necessary, but not more than once/week. Do not spray animals or humans, or apply to animal feed or watering equipment.
<i>diazinon</i> 50%WP, OP	1B	Residual Spray: Mix 2 lb or 4 lb of 50% WP in 25 gal of water. To make a bait spray mix 1 lb of sugar or 2 cups of syrup or molasses in the spray mixture.		Remove animals from buildings or corrals prior to treatment and keep animals out until dry. Do not apply in dairy barns, milk rooms and poultry houses. Apply 1 gal of residual spray as an overall spray at the rate of 1 gal/350-750 sq ft to ceilings and walls of livestock sheds, calf barns, hog barns, loafing sheds, and other farm buildings.
<i>dichlorvos</i> Vapona	1B	Ready-to-use		Apply as coarse spray, 1 pint/1000 sq ft of surface.
<i>esfenvalerate</i> Endure 35WP Onslaught	3A	Mix 1 or 2 scoops with 1 gal of water and spray 1 gal/1000 sq ft.		Do not apply when feed is present.
<i>gamma-cyhalothrin</i> StandGuard 5.9	3A	Mix 0.16 fl oz (5 ml)/gal of water.		Spray 1 gal of diluted spray to treat 500-1000 sq ft of fly resting surfaces.
<i>imidacloprid</i> QuickBayt 10%EC Spot Spray.	4A	Mix at the rate of 1 lb/gal of water to treat 1000 sq ft of fly resting areas.		Product can be sprayed on virtually any surface (out of reach of animals) where flies rest or congregate, indoors or outdoors. Examples include posts, beams, ceilings, railings, door frames, windows, and walls. Residual activity of up to 6 weeks indoors and 2 weeks outdoors.
<i>lambda-cyhalothrin</i> Grenade ER 9.7% Insecticide Demand CS	3A	Mix 0.2-0.4 oz (6-12 ml)/gal water.		Make a directed application to fly-resting surfaces and allow to dry before reintroduction of animals. Do not apply when animals are present.

## FLY CONTROL IN LIVESTOCK FACILITIES

### RESIDUAL AND BAIT SPRAYS<sup>1</sup>

INSECTICIDE <sup>2</sup>	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	REMARKS
<i>permethrin</i> Atroban 05.7 EC Ectiban 25% WP Insectrin 11% EC Insectrin 40% EC	3A	5.7% EC is ready-to-use as a mist-spray OR mix 1 qt. 5.7% EC in 12.5 gal of water Mix 6.67 oz 25% WP in 10 gal of water Mix 1 pt 11% EC in 10 gal of water Mix 90-118 ml 40% EC in 10 gal water.		Do not apply more often than once every 2 weeks. Do not apply directly to livestock or poultry. Do not apply in milk rooms or egg storage areas. Do not spray manure or litter. Apply as a residual surface spray to fly resting areas. Apply 5.7% EC undiluted at 4 oz/1000 sq ft of surface area or apply diluted WP and EC mixtures at 1 gal/750 sq ft.
<i>spinosyn</i> Elector 2.46%	5	0.08% spinosad – 20 oz (around 600 ml)/5 gal water.		Spray fly-inhabiting surfaces in animal premises to the point of runoff. Use approx. 1 gal of spray/500-1000 sq ft. Repeat as needed, but not more often than once/week. Spray in early morning when flies are resting. Lactating and non-lactating dairy and beef cattle may be present at time of premise treatment; horses not intended for human consumption may be present during premise treatment. Do not use in poultry, swine, or sheep facilities when animals are present; allow surfaces to dry completely before readmitting animals.
<i>spinosad</i> Elector PSP spinosyn 44.2%	5	Dilute according to label chart.		Spray fly-resting surfaces. Do not apply where birds are present. Follow label directions.
<i>tetrachlorvinphos</i> Rabon 50 WP	1B	Mix 0.5 lb in 1.5 gal water.		Spray 1 gal/500 sq ft.
Rabon EC		Mix 5 oz/gal water		Apply 1 gal spray/500-1000 sq ft, treating fly resting sites.
<i>tetrachlorvinphos</i> + <i>dichlorvos</i> Ravap EC	1B	1.25-2.5% spray. Mix 1 gal or 2 gal EC in 25 gal of water.		Apply at a rate of 1 gal of spray/500-1000 sq ft to cover walls, floors, and other resting sites.
<i>thiamethoxam</i> Agita 10 WG	4A	16 oz in 120 fl oz water/1000 sq ft		Water dispersible insecticidal bait for adult house flies. Apply to areas where adult flies rest (ledges, walls, window sills, etc.)

### SPACE SPRAYS (Aerosols, Fogs and Mist-sprays)<sup>3</sup>

INSECTICIDE <sup>2</sup>	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	REMARKS
<i>dichlorvos</i> Vapona or DDVP 2 lb ai/gal (23.4%) EC, OP	1B	0.5% or 1%. Mix 1 pt EC in 3 gal or 6 gal of water.		Apply 1 pt of 1% solution or 1 qt of 0.5% solution/8000 cubic ft as a fog or mist. Repeated applications will provide adult fly suppression. Do not use more often than once every 24 hours. Do not use if animals have been treated with other insecticides within 8 hours. Do not apply directly to animals. Close all doors and windows when fogging. Do not contaminate feed, water, milk, or milking equipment.
<i>permethrin</i> Insectrin 5.7% EC, 40% EC	3A	Mix 1 pt of 5.7% EC in 6.25 gal of diesel fuel or mineral oil OR mix 10-45 ml in 1 gal of water.		Apply fog at 2-4 fl oz/1000 cubic feet of air space in confined facility. Repeat as needed.
<i>pyrethrins</i> 0.1-1% + <i>synergist</i> 0.5-5.0%	3A	Ready-to-use when purchased.		Apply fogs or spray mists at 1 fl oz/1000 cu ft as fine atomized spray. Repeat as needed.

## FLY CONTROL IN LIVESTOCK FACILITIES

### BAITS

INSECTICIDE <sup>2</sup>	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	REMARKS
<i>Beauveria bassiana</i> balEnce Bait	Biological			Use as a house fly bait around livestock and poultry facilities. Keep out of the reach of children and animals.
<i>cyantraniliprole</i> Zyrox Fly Granular bait	28	Ready-to-use when purchased.	None	Apply in bait station that is inaccessible to children, pets, and food animals. Use 2 lb bait/1000 sq ft/yr.
<i>dinotefuran</i> QuikStrike Scatter Bait	4A			Apply around livestock and poultry facilities where house flies are found. Apply as a scatter bait at the rate of 1/4 lb/500 sq ft, or place in bait stations. Do not apply where children or animals might have access.
<i>imidacloprid</i> 0.5% QuickBayt	4A	Ready-to-use when purchased.		Scatter bait directly from container onto dry level surfaces so individual granules lie near each other without forming piles. Or place in any commercial bait station. Or mix 1.5 oz bait with 1 fl oz warm water and stir to create a paste; apply with brush to surfaces where flies rest. Bait should be inaccessible to food-producing animals, children, and pets.
QuickBayt Fly Strip		Ready-to-use when purchased.		QuickBayt Fly Strip: Use in buildings where animals are kept and where flies are a nuisance.
<i>methomyl</i> Blue Streak Golden Malrin Bait	1A	Ready-to-use as a dry bait.		As a dry bait: Scatter on floors, walkways, etc., throughout operation but away from animals. Apply heavy (about 1/4 lb/500-1000 sq ft) until flies are suppressed. Wear rubber gloves when applying baits. Do not allow workers on treated floors without shoes. Do not allow animals to come in contact with baits.
<i>nithiazine</i> QuikStrike 1% fly abatement strip	4	Ready-to-use strip.		Hang 1 strip/100 sq ft or 300 sq ft depending on fly population in enclosed areas that are protected from rain.
<i>spinosad</i> Spinosyn 0.5%	5	Ready-to-use when purchased.		Follow label directions for scatter bait, station/tray bait, or paint/spray bait use. Locate where inaccessible to animals and children.

### LARVICIDES – Treat maggot-infested areas

INSECTICIDE <sup>2</sup>	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	REMARKS
<i>cyromazine</i> 2% Neporex	17	Ready-to-use or spray.		Scatter granules on maggot-infested sites at rate of 1 lb/200 sq ft. Treat edges and spillage areas where manure accumulates. Treat floor area of calf hutches.
novaluron Tekko 10	7C	3 oz in 1 gal water/1000 sq ft		Spray on manure area
<i>pyriproxyfen</i> Archer	7C	1 fl oz/gal of water; 1 fl oz treats 1500 sq ft.		Apply to larval development sites.

<sup>1</sup> Residual sprays can be applied as spot sprays to control maggots in manure accumulations if permitted by the EPA label.

<sup>2</sup> Space sprays are designed to kill only adult flies that are present when the fog or mist is applied. There is little or no residual insecticide deposit remaining after the application. Fogs or mists must come in contact with the fly. These materials are especially effective in enclosed areas where air movement is minimal. Heavy mists can offer good adult fly kill in open areas such as in feed lots.

# BEEF CATTLE EXTERNAL PARASITE AND GRUB CONTROL

Nancy C. Hinkle, Veterinary Entomologist

Find the pest to be controlled, then select the method of application (spray, dust, ear-tag, etc.) from the left column.

To the right are listed the active ingredients available as well as recommendations for effective use.

## INSECTICIDES TO USE AND WAYS TO APPLY THEM TO CONTROL BEEF CATTLE PESTS

### CATTLE GRUBS

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS <sup>1,2,3</sup>
Injectable Pour-on Spot-on	<i>doramectin</i> 0.5% Dectomax pour-on	6	Ready-to-use when purchased.	45 D	Apply 1 ml/22 lb body weight, along midline of the back between withers and tailhead. Safe for all beef cattle and replacement dairy heifers up to 20 months of age.
	<i>eprinomectin</i> Ivomec Eprinex pour-on	6	Pour-on for beef cattle. Contains 5 mg <i>eprinomectin</i> /ml. Ready-to-use when purchased.	0 D	Administer pour-on to cattle 8 weeks of age or older. Apply at the dose of 1 ml/22 lb body weight. Apply pour-on to the top of the animal along the backline from the withers to the tailhead.
	<i>ivermectin</i> Ivomec1% clear, ready-to-use sterile solution.	6	Ready-to-use when purchased.	35 D	Administer subcutaneously only 1 ml (10 mg <i>ivermectin</i> )/110 lb body weight. Restrain animals and inject under the loose skin in front of or behind the shoulder. A sterile, 16-gauge, 1/2-3/4" needle is suggested. Divide doses greater than 10 ml between 2 injection sites to reduce occasional transitory discomfort or site reaction. <b>Waiting period between application and slaughter: 35 days.</b>
	Ivomec pour-on 5 mg <i>ivermectin</i> /ml			48 D	Ivomec pour-on: Apply 1 ml/22 lb of body weight. Apply along the topline in a narrow strip extending from the withers to the tailhead.
	<i>moxidectin</i> Moxidectin 1% injectable Cydectin 10 mg/ml	6	Ready-to-use when purchased.	35 D	Inject 1 mg/110 lb body weight.
	Cydectin Pour-on				Use 22.7 mg/100 lb body weight (mites and lice).

### CATTLE LICE

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS <sup>1,2,3</sup>
Sprays	<i>coumaphos</i> Co-Ral 11.6%	1B	Mix 5 fl oz/4 gal water		Mix 2.5-5 fl oz/4 gal water and spray to complete wetting. Do not treat fewer than 10 days apart.
	<i>dichlorvos</i> Vapona EC	1B	Mix 1 qt 21.8% EC in 6 gal of water. Restricted Use Pesticide.	1 D	Apply 1-2 fl oz as a light mist-spray daily. Spray to cover all parts of the animal. Do not wet the skin. Do not apply more than 2 fl oz/ animal each day.
	<i>permethrin</i> Permethrin EC spray Permethrin II Atroban 11%	3A	Mix 1 qt of 5.7% EC, OR mix 1 pt of 10% EC or 11% EC in 100 gal water or mix 30-18 ml of 40% EC in 25 gal of water or apply 1% pour-on as an undiluted spray.	0 D	Spray animal thoroughly. Re-treat as needed but not more often than once every 14 days. To control lice or mites, a second treatment may be needed 10-21 days later.
	Permethrin EC Spray		Mix 1 cup 42.5% EC in 100 gal water or mix 1 pt 40% EC in 100 gal water.		Apply 1 qt of low concentration spray mixture/animal to control horn flies only. Apply 2 qt of high concentration spray/animal to control all labeled parasites. Repeat treatment as needed but not more than every 14 days.



## BEEF CATTLE EXTERNAL PARASITE AND GRUB CONTROL

### CATTLE LICE

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS <sup>1,2,3</sup>
Sprays (continued)	<i>permethrin</i> Permethrin EC Spray (low pressure)	3A	Mix 1 qt 11% EC in 5 gal water.	0 D	Apply 1-2 oz spray mixture/animal. Spot treat the back, face, legs, and ears.
	<i>phosmet</i> Prolate/Lintox Prolate/Lintox HD	1B	Mix 1 qt in 25-50 gal water (depending on target pest), and spray to run-off.	3 D	Apply as a coarse high pressure spray to thoroughly wet the skin and hair of the animal. Apply up to 1 gal/animal. Do not re-treat within 7 days. Follow label restrictions.
	<i>pyrethrins</i> Pyrethrins - synergized	3A	Ready-to-use when purchased.	0 D	Apply 1-2 fl oz daily or as needed. Apply to wet hair not skin.
	<i>stirofos + dichlorvos</i> Ravap 0.35% <i>stirofos</i> + 0.1% <i>dichlorvos</i> EC spray	1B	Mix 1 pt 28.7% EC in 10 gal of water. Restricted Use Pesticide.	0 D	Apply as a coarse spray. Apply 0.5-1 gal spray/animal. Do not repeat application within 10 days.
	Ravap EC spray 0.5% <i>stirofos</i> + 0.1% <i>dichlorvos</i>		Mix 1 pt 28.7% EC in 6 gal of water. Restricted Use Pesticide.		Apply as a coarse spray. Apply 0.5 gal spray/animal. Do not repeat application within 10 days.
	<i>tetrachlorvinphos</i> Rabon WP spray	1B	Mix 1 lb 50% WP in 18 gal of water.	0 D	Apply as a coarse spray. Apply 2 qts-1 gal/animal to obtain complete wetting.
Dusts	<i>coumaphos</i> Livestock Dust 1% Co-Ral Livestock Dust 1%	1B	Ready-to-use when purchased.		Use shaker can to apply 2 oz/animal over head, neck, shoulders, and back.
	<i>permethrin</i> Permethrin 0.25% dust	3A	Ready-to-use when purchased.	0 D	Use in dust bags or apply up to 2 oz directly to animals. Re-treat 14-21 days later if needed for lice control.
	<i>stirofos</i> or <i>tetrachlorvinphos</i> Rabon 3% Dust	1B	Ready-to-use when purchased.	0 D	Apply 2 oz of dust/animal by hand or duster to thoroughly penetrate hair coat.
	<i>zeta-cypermethrin</i> PYthon dust 0.075%	3A	Ready-to-use when purchased.		Apply up to 2 oz/animal evenly as necessary but not more often than every 3 days.
Ear-Tags and Dust Bags (Self-Treatment)	<i>coumaphos</i> Corathon Insecticide Cattle Ear Tag 15% <i>coumaphos</i> and 35% <i>diazinon</i>	1B	Ready-to-use when purchased.		All mature animals in the herd should be tagged. For optimum control of horn flies, Gulf Coast ticks, and spinose ear ticks, and as an aid in the control of face flies, attach 1 tag to each ear (2/animal). Replace as necessary. Calves less than 3 months of age should not be tagged as ear damage may result. Remove tags at end of fly season, or prior to slaughter.
	<i>diazinon</i> Warrior 40% insecticide ear tag 30% <i>diazinon</i> + 10% <i>chlorpyrifos</i>	1B	Ready-to-use when purchased.	0 D	Attach 1 tag to the inside of 1 or both ears of mature animals. Remove tags when control drops off, at the end of fly or lice season, or before slaughter.
	<i>permethrin</i> Permethrin 0.25% dust	3A	Ready-to-use when purchased.	0 D	Use in dust bags or apply up to 2 oz directly to animals. Re-treat 14-21 days later if needed for lice control.
	<i>tetrachlorvinphos</i> Rabon 3% Dust	1B	Ready-to-use when purchased.	0 D	Apply in dust bags that are hung and protected from rain in dusting stations where cattle are forced to use them. Some control will be obtained by free choice use.
	<i>zeta-cypermethrin</i> PYthon Zetagard 10% insecticide ear tag <i>zeta-cypermethrin</i> 10% + <i>piperonyl</i> <i>butoxide</i> 20%	3A	Ready-to-use when purchased.	0 D	Attach 1 tag to the inside of each ear on mature cattle. Remove tags when control drops off, at the end of fly or lice season, or before slaughter. During the horn fly season, 1 tag/animal can be used on cows. Calves can be tagged with 1 tag as needed.

## BEEF CATTLE EXTERNAL PARASITE AND GRUB CONTROL

### CATTLE LICE

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS <sup>1,2,3</sup>
Backrubbers and Facerubbers	<i>permethrin</i> Permethrin Rubbing Mixture	3A	Mix 1 qt. 5.7% EC in 10 gal diesel fuel or mix 1 pt 10% or 11% EC in 1 gal of #2 diesel fuel or mineral oil or mix 118 ml 40% EC in 10 gal of diesel oil or suitable mineral oil.	0 D	Keep rubbing device charged. Daily forced use provides best results.
	<i>stirofos + dichlorvos</i> Ravap 1% <i>stirofos</i> + 0.25% <i>dichlorvos</i> in oil	3A	Mix 5 oz 28.7% EC in 1 gal of #2 diesel fuel. Restricted Use Pesticide.	0 D	Pour 1 gal of mixture/20 ft of cable. Keep rubbing device charged.
Injectable Pour-on Spot-on	<i>cyfluthrin</i> Cylence 1% pour-on insecticide.	3A	Ready-to-use when purchased.	0 D	Apply pour-on along the top of the back and top of the head. For horn fly and face fly control apply 4 ml to animals weighing less than 400 lb, 8 ml to animals weighing 400-800 lb and 12 ml to animals weighing over 800 lb. Do not re-treat within 3 weeks following treatment. Double the dose for biting and sucking lice.
	<i>doramectin 0.5%</i> Dectomax pour-on	6	Ready-to-use when purchased.	45 D	Apply 1 ml/22 lb body weight, along midline of the back between withers and tailhead. Safe for all beef cattle and replacement dairy heifers up to 20 months of age.
	<i>eprinomectin</i> Ivomec Eprinex pour-on for beef cattle. Contains 5 mg <i>eprinomectin</i> /ml	6	Ready-to-use when purchased.	48 D	Administer pour-on to cattle 8 weeks of age or older. Apply at the dose of 1 ml/22 lb body weight. Apply pour-on to the top of the animal along the backline from the withers to the tailhead.
	<i>gamma-cyhalothrin 0.5%</i> StandGuard Pour-on	3A	Ready-to-use when purchased.		For cattle weighing less than 600 lb, apply 10 ml (1/3 fl oz) product along backline. For cattle weighing more than 600 lb, apply 15 ml (1/2 fl oz) along backline.
	<i>ivermectin</i> Ivomec 1% clear, ready-to-use sterile solution.	6	Ready-to-use when purchased.	35 D	Administer subcutaneously only 1 ml (10 mg <i>ivermectin</i> )/110 lb body weight. Restrain animals and inject under the loose skin in front of or behind the shoulder. A sterile, 16-gauge, 0.5-0.75" needle is suggested. Divide doses greater than 10 ml between 2 injection sites to reduce occasional transitory discomfort or site reaction. <b>Waiting period between application and slaughter: 35 days.</b>
	Ivomec pour-on 5 mg <i>ivermectin</i> /ml.	6	Ready-to-use when purchased.	48 D	Apply 1 ml/22 lb of body weight. Apply along the topline in a narrow strip extending from the withers to the tailhead. <b>Waiting period: 48 days.</b>
	<i>lambda-cyhalothrin</i> Ultra Saber 1% pour-on insecticide.	3A	Ready-to-use when purchased.	0 D	Apply to beef cattle and calves for lice and horn flies. Apply pour-on down the backline at 10 ml (1/3 fl oz)/animal for cattle weighing less than 600 lb or at a rate of 15 ml (0.5 fl oz)/animal for cattle weighing more than 600 lb. Repeat as needed but not more often than every 2 weeks and not more than 4 applications within a 6-month period.
	<i>lambda-cyhalothrin with piperonyl butoxide</i> Aim-L VetCaps insecticide capsules	3A	Ready-to-use when purchased.		Apply only with a SmartVet Approved Vetcap Application Device according to label directions
	<i>moxidectin</i> Moxidectin 1% injectable Cydectin 10 mg/ml ----- Moxidectin Cydectin Pour-on	6	Ready-to-use when purchased.	35 D	Inject 1 mg/110 lb body weight.  ----- Use 22.7 mg/100 lb body weight (mites and lice).

**BEEF CATTLE EXTERNAL PARASITE AND GRUB CONTROL**

**CATTLE LICE**

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS <sup>1,2,3</sup>
Injectable Pour-on Spot-on  (continued)	<i>permethrin</i> Atroban DeLice 1% pour on	3A	Ready-to-use when purchased.	0 D	Apply 0.5% fl oz (15 cc)/100 lb body weight of animal up to a maximum of 5 fl oz for any 1 animal. Pour correct dose along back and down face.
	Brute Pour-on 10% <i>permethrin</i> Ultra-Boss Pour-on 5% <i>permethrin</i>				Apply 15 cc (10%) or 30 cc (5%)/1000 lb down mid-line of back. Repeat the application in 10-14 days for mites.
	Clean-up Pour-on Insecticide with IGR <i>permethrin</i> 5% + <i>diflubenzuron</i> 5%	3A	Ready-to-use when purchased.		Follow label directions.

**FACE FLIES**

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS <sup>1,2,3</sup>
Sprays	<i>dichlorvos</i> Vapona EC	1B	Mix 1 qt 21.8% EC in 6 gal of water. Ready-to-use when purchased.	1 D	Apply 1-2 fl oz as a light mist-spray daily. Spray to cover all parts of the animal. Do not wet the skin. Do not apply more than 2 fl oz/ animal each day.
	<i>permethrin</i> EC Spray (low pressure)	3A	Mix 1 qt 11% EC in 5 gal water.	0 D	Apply 1-2 oz spray mixture/animal. Spot treat the back, face, legs, and ears.
	<i>pyrethrins</i> Pyrethrins - synergized	3A	Ready-to-use when purchased.	0 D	Apply 1-2 fl oz daily or as needed. Apply to wet hair not skin.
Ear-Tags and Dust Bags (Self-Treatment)	<i>cyfluthrin</i> Beta-cyfluthrin CyLence Ultra Insecticide Cattle Ear Tags 8%	3A	Ready-to-use when purchased.		For control of horn flies, face flies, Gulf Coast ticks and spinose ear ticks on beef and dairy cattle (including lactating). For adequate control of horn flies attach 1 tag/animal. For optimum control of face flies, horn flies, Gulf Coast ticks and spinose ear ticks, attach 1 tag to each ear (2/animal). CyLence Ultra Insecticide Ear Tags have been proven to be effective against face and horn flies for up to five months.
	<i>diazinon</i> OPTimizer 21.4% insecticide ear tag  Patriot 40% insecticide cattle ear tag	1B	Ready-to-use when purchased.	0 D	Attach 1 tag to the inside of each ear on mature cattle. Tags should be removed when control drops off, at the end of the fly season, or before slaughter.  Attach 1 tag to the inside of 1 or both ears of mature animals. Remove tags when control drops off, at the end of fly season, or before slaughter.
	Warrior 40% insecticide ear tag 30% <i>diazinon</i> + 10% <i>chlorpyrifos</i>	1B	Ready-to-use when purchased.	0 D	Attach 1 tag to the inside of 1 or both ears of mature animals. Remove tags when control drops off, at the end of fly or lice season, or before slaughter.
	<i>lambda-cyhalothrin</i> Saber 10% insecticide ear tag 10% <i>lambda-cyhalothrin</i> + 13% <i>piperonyl butoxide</i>	3A	Ready-to-use when purchased.	0 D	Apply 1 tag to the inside of each ear on mature cattle or calves. Remove tags when control drops off, at the end of fly season, or before slaughter.

**BEEF CATTLE EXTERNAL PARASITE AND GRUB CONTROL**

**FACE FLIES**

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS <sup>1,2,3</sup>
Ear-Tags and Dust Bags (Self-Treatment) <i>(continued)</i>	<i>lambda-cyhalothrin</i> Double Barrel/Double Barrel VP 20.8% insecticide ear tag <i>6.8% lambda-cyhalothrin + 14% pirimiphos methyl</i>	3A + 1B	Ready-to-use when purchased.	0 D	Apply 1 tag to the inside of each ear on mature cattle or calves. Remove tags when control drops off, at the end of fly season, or before slaughter.
	<i>permethrin</i> Permethrin 10% Insecticide Ear Tag Gard Star Plus	3A	Ready-to-use when purchased.	0 D	Attach 1 tag to the inside of each ear on mature cattle and calves. Remove tags when control drops off, at the end of fly season, or before slaughter.
	<i>pirimiphos-methyl</i> Dominador 20% insecticide ear tag	1B	Ready-to-use when purchased.	0 D	Attach 1 tag to the inside of each ear on mature cattle. Remove tags when control drops off or in the fall, whichever occurs first.
	<i>tetrachlorvinphos</i> Rabon 3% Dust	1B	Ready-to-use when purchased.	0 D	Apply in dust bags, which are hung and protected from rain in dusting stations where cattle are forced to use them. Some control will be obtained by free choice use.
	<i>zeta-cypermethrin</i> PYthon Magnum 10% insecticide ear tag <i>zeta-cypermethrin 10% + piperonyl butoxide 20%</i>	3A	Ready-to-use when purchased.	0 D	Attach 1 tag to the inside of each ear on mature cattle. Remove tags when control drops off, at the end of fly or lice season, or before slaughter. During the horn fly season, 1 tag/animal can be used on cows. Calves can be tagged with 1 tag as needed.
Injectable Pour-on Spot-on	<i>cyfluthrin</i> Cylence 1% pour-on insecticide	3A	Ready-to-use when purchased.	0 D	Apply pour-on along the top of the back and top of the head. For horn fly and face fly control apply 4 ml to animals weighing less than 400 lb, 8 ml to animals weighing 400-800 lb and 12 ml to animals weighing over 800 lb. Do not re-treat within 3 weeks following treatment. Double the dose for biting and sucking lice.
	<i>permethrin</i> Clean-up Pour-on Insecticide with IGR <i>permethrin 5% + diflubenzuron 5%</i>	3A	Ready-to-use when purchased.		Follow label directions.
Bolus, Feed Additives	<i>diflubenzuron</i> ClariFly 8%	15	Mix according to label instructions based on animal weights.	0 D	Mix according to label instructions and feed at rates stipulated based on cattle weights. Prevents development of fly larvae in manure of treated cattle. Prevents emergence of horn flies, face flies, house flies, and stable flies from manure of treated cattle. Start feeding early in the spring before flies appear and continue until cold weather restricts fly activity. Does not affect adult flies. No withdrawal; no milk withholding.
	<i>methoprene</i> Altosid 0.02% mineral mix or block.	7A	Ready-to-use when purchased.	0 D	Feed free choice at 1/4-1/2 lb/100 lb animal body weight monthly/animal.
	<i>tetrachlorvinphos</i> Rabon 7.76% granular oral larvicide	1B	Pre-mix or ready-to-use blocks and mineral feeds are available commercially.	0 D	Mix 7.76% oral larvicide with concentrate feed as directed on label. Feed ready-to-use block or mineral free choice so each animal will consume 70 mg/100 lb body weight daily. Begin feeding before flies appear in spring. Feed continuously until frost. Does not affect adult flies.

**BEEF CATTLE EXTERNAL PARASITE AND GRUB CONTROL**

**HORN FLIES**

<b>WAYS TO APPLY INSECTICIDES</b>	<b>INSECTICIDE</b>	<b>MOA</b>	<b>MIXING INSTRUCTIONS</b>	<b>WITHDRAWAL TIME</b>	<b>APPLICATION INSTRUCTIONS AND RESTRICTIONS<sup>1,2,3</sup></b>
Sprays	<i>coumaphos</i> Co-Ral 11.6%	1B	Mix 2.5-5 fl oz/4 gal water		Mix 2.5-5 fl oz/4 gal water and spray to complete wetting. Wait at least 10 days between treatments.
	<i>dichlorvos</i> Vapona EC	1B	Mix 1 qt 21.8% EC in 6 gal of water. Restricted Use Pesticide.	1 D	Apply 1-2 fl oz as a light mist-spray daily. Spray to cover all parts of the animal. Do not wet the skin. Do not apply more than 2 fl oz/ animal each day.
	<i>permethrin</i> Permethrin EC Spray Permethrin II Atroban 11%	3A	Mix 1 qt of 5.7% EC OR mix 1 pt of 10% EC or 11% EC in 100 gal water or mix 30-118 ml of 40% EC in 25 gal of water or apply 1% pour-on as an undiluted spray.	0 D	Spray 1 qt of coarse spray per animal. Re-treat as needed but not more than once every 14 days. To control lice or mites, a second treatment may be needed 10-21 days later.
	Permethrin EC Spray (low pressure)	3A	Mix 1 qt 11% EC in 5 gal water.	0 D	Apply 1-2 oz spray mixture/animal. Spot treat the back, face, legs, and ears.
	Permethrin EC Spray		Mix 1 cup 42.5% EC in 100 gal water or mix 1 pt 40% EC in 100 gal water.		Apply 1 qt of low concentration spray mixture/animal to control horn flies only. Apply 2 qt of high concentration spray/animal to control all labeled parasites. Repeat treatment as needed but not more than every 14 days.
	<i>phosmet</i> Prolate/Lintox Prolate/Lintox HD	1B	Mix 1 qt in 60 gal water and spray to run-off.	3 D	Apply as a coarse high pressure spray to thoroughly wet the skin and hair of the animal. Apply up to 1 gal/animal. Do not re-treat within 7 days. Follow label restrictions.
	<i>pyrethrins</i> Pyrethrins - synergized.	3A	Ready-to-use when purchased.	0 D	Apply 1-2 fl oz daily or as needed. Apply to wet hair not skin.
	0.5% <i>stirofos</i> + 0.1% <i>dichlorvos</i> Ravap EC spray	1B	Mix 1 pt 28.7% EC in 6 gal of water. Restricted Use Pesticide.	0 D	Apply as a coarse spray. Apply 1/2 gal spray/animal. Do not repeat application within 10 days.
<i>tetrachlorvinphos</i> or <i>stirofos</i> Rabon WP spray	1B	Mix 1 lb 50% WP in 18 gal of water.	0 D	Apply as a coarse spray. Apply 2 qt-1 gal/animal to obtain complete wetting.	
Dusts	<i>coumaphos</i> 1% Livestock Dust Co-Ral Livestock Dust	1B	Ready-to-use when purchased.		Use shaker can to apply 2 oz/animal over head, neck, shoulders, and back.
	<i>permethrin</i> Permethrin 0.25% Dust	3A	Ready-to-use when purchased.	0 D	Use in dust bags or apply up to 2 oz directly to animals. Re-treat 14-21 days later if needed for lice control.
	<i>tetrachlorvinphos</i> Rabon 3% Dust. Ready-to-use.	1B	Ready-to-use when purchased.	0 D	Apply 2 oz of dust/animal by hand or duster to thoroughly penetrate hair coat.
	<i>zeta-cypermethrin</i> PYthon dust 0.075% <i>zeta-cypermethrin</i>	3A	Ready-to-use when purchased.		Apply up to 2 oz/animal evenly as necessary but not more often than every 3 days.

## BEEF CATTLE EXTERNAL PARASITE AND GRUB CONTROL

### HORN FLIES

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS <sup>1,2,3</sup>
Ear-tags and Dust Bags (Self Treatment)	<i>abamectin</i> abamectin 8% XP-820 Ear Tag	6	Ready-to-use when purchased.		For control of horn flies and ticks. Use 1 tag/animal for up to 3 months of control, or 2 tags/animal for up to 5 months of control for flies, and 4 months for ticks.
	<i>beta-cyfluthrin</i> CyLence Ultra Insecticide Cattle Ear Tags 8%	3A	Ready-to-use when purchased.		For control of horn flies, face flies, Gulf Coast ticks, and spinose ear ticks on beef cattle. For adequate control of horn flies attach 1 tag/animal.  For optimum control of face flies, horn flies, Gulf Coast ticks, and spinose ear ticks, attach 1 tag to each ear (2/animal). CyLence Ultra Insecticide Ear Tags have been proven to be effective against face and horn flies for up to 5 months.
	<i>coumaphos</i> Corathon Insecticide Cattle Ear Tag 15% <i>coumaphos</i> 35% <i>diazinon</i>	1B	Ready-to-use when purchased.		All mature animals in the herd should be tagged. For optimum control of horn flies, Gulf Coast ticks, and spinose ear ticks, and as an aid in the control of face flies, attach 1 tag to each ear (2/animal). Replace as necessary. Calves less than 3 months of age should not be tagged as ear damage may result. Remove tags at end of fly season or prior to slaughter.
	Co-Ral Livestock Dust				Place contents of package in any commercially available dust bag. Suspend bags in areas frequented by cattle or in gateways or lanes through which the animals pass daily for water, feed, or minerals. Bags may also be suspended in loafing sheds or in front of protected mineral feeders. For lactating dairy cows, bags may be suspended in the exit through which cows leave the milking barn. In all cases the bags should be adjusted so that the bottom of the bag will hang 4-6" below the topline of the cattle.
	<i>diazinon</i> OPTimizer 21.4% insecticide ear tag	1B	Ready-to-use when purchased.	0 D	Attach 1 tag to the inside of each ear on mature cattle. Tags should be removed when control drops off, at the end of fly season, or before slaughter.
	Patriot 40% insecticide cattle ear tag				Attach 1 tag to the inside of 1 or both ears of mature animals. Remove tags when control drops off, at the end of fly season, or before slaughter.
	Warrior 40% insecticide ear tag 30% <i>diazinon</i> + 10% <i>chlorpyrifos</i>				Attach 1 tag to the inside of 1 or both ears of mature animals. Remove tags when control drops off, at the end of fly or lice season, or before slaughter.
	<i>lambda-cyhalothrin</i> Saber Extra 10% insecticide ear tag 10% <i>lambda-cyhalothrin</i> + 13% <i>piperonyl butoxide</i>	3A	Ready-to-use when purchased.	0 D	Apply 1 tag to the inside of each ear on mature cattle or calves. Remove tags when control drops off, at the end of fly season, or before slaughter.
	Double Barrel/Double Barrel VP 20.8% insecticide ear tag 6.8% <i>lambda-cyhalothrin</i> + 14.0% <i>pirimiphos methyl</i>	3A	Ready-to-use when purchased.	0 D	Apply 1 tag to the inside of each ear on mature cattle or calves. Remove tags when control drops off, at the end of fly season, or before slaughter.

## BEEF CATTLE EXTERNAL PARASITE AND GRUB CONTROL

### HORN FLIES

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS <sup>1,2,3</sup>
Ear-tags and Dust Bags (Self Treatment) <i>(continued)</i>	<i>permethrin</i> Permethrin 10% Insecticide Ear Tag Gard Star Plus	3A	Ready-to-use when purchased.	0 D	Attach 1 tag to the inside of each ear on mature cattle and calves. Remove tags when control drops off, at the end of fly season, or before slaughter.
	<i>pirimiphos-methyl</i> Dominator 20% insecticide ear tag 20% <i>pirimiphos methyl</i>	3A	Ready-to-use when purchased.	0 D	Attach 1 tag to the inside of each ear on mature cattle. Remove tags when control drops off or in the fall, whichever occurs first.
	<i>tetrachlorvinphos</i> Rabon 3% Dust	1B	Ready-to-use when purchased.	0 D	Apply 2 oz of dust/animal by hand or duster to thoroughly penetrate hair coat. Or, apply in dust bags that are hung and protected from rain in dusting stations where cattle are forced to use them. Some control will be obtained by free choice use.
	<i>zeta-cypermethrin</i> PYthon Magnum 10% insecticide ear tag <i>zeta-cypermethrin</i> 10% + <i>piperonyl butoxide</i> 20%	3A	Ready-to-use when purchased.	0 D	Attach 1 tag to the inside of each ear on mature cattle. Remove tags when control drops off, at the end of fly or lice season, or before slaughter. During the horn fly season, 1 tag/animal can be used on cows. Calves can be tagged with 1 tag as needed.
Backrubbers and Facerubbers	<i>permethrin</i> Permethrin Rubbing Mixture	3A	10% or 11% EC in 1 gal of #2 diesel fuel or mineral oil or mix 118 ml 40% EC in 10 gal of diesel oil or suitable mineral oil.	0 D	Keep rubbing device charged. Daily forced use provides best results.
	<i>stirofos + dichlorvos</i> Ravap 1% <i>stirofos</i> + 0.25% <i>dichlorvos</i> in oil	1B	Mix 5 oz 28.7% EC in 1 gal of #2 diesel fuel. Restricted Use pesticide.	0 D	Pour 1 gal of mixture/20 ft of cable. Keep rubbing device charged.
Injectable Pour-on Spot-on	<i>lambda-cyhalothrin</i> with <i>piperonyl butoxide</i> Aim-L Vetcap	3A			Apply only with a SmartVet Approved Vetcap Application Device according to label directions
	<i>cyfluthrin</i> Cylence 1% pour-on insecticide.	3A	Ready-to-use when purchased.	0 D	Apply pour-on along the top of the back and top of the head. For horn fly and face fly control apply 4 ml to animals weighing less than 400 lb, 8 ml to animals weighing 400-800 lb and 12 ml to animals weighing over 800 lb. Do not re-treat within 3 weeks following treatment. Double the dose for biting and sucking lice.
	<i>doramectin</i> Dectomax Pour-On	6	Ready-to-use when purchased.	45 D	Apply Pour-On along the top of the back and top of the head at the rate of 1 ml/22 lb of body weight. Provides 7 days of horn fly control and 42-77 days of louse suppression.
	<i>eprinomectin</i> Ivomec Eprinex pour-on for beef cattle. Contains 5 mg. <i>eprinomectin</i> /ml.	6	Ready-to-use when purchased.	0 D	Administer pour-on to cattle 8 weeks of age or older. Apply at the dose of 1 ml/22 lb body weight. Apply pour-on to the top of the animal along the backline from the withers to the tailhead.
	<i>gamma-cyhalothrin</i> StandGuard Pour-on 0.5%	3A	Ready-to-use when purchased.		For cattle weighing less than 600 lb, apply 10 ml (1/3 fl oz) product along backline. For cattle weighing more than 600 lb, apply 15 ml (1/2 fl oz) along backline.

BEEF CATTLE EXTERNAL PARASITE AND GRUB CONTROL

HORN FLIES

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS <sup>1,2,3</sup>
Injectable Pour-on Spot-on  (continued)	<i>ivermectin</i> Ivomec pour-on, 5 mg <i>ivermectin</i> /ml	6	Ready-to-use when purchased.	48 D	Apply 1 ml/22 lb of body weight. Apply along the topline in a narrow strip extending from the withers to the tailhead.
	<i>lambda-cyhalothrin</i> Saber 1% pour-on insecticide	3A	Ready-to-use when purchased.	0 D	Apply to beef cattle and calves for lice and horn flies. Apply pour-on down the backline at 10 ml (1/3 fl oz)/animal for cattle weighing less than 600 lb or at a rate of 15 ml (1/2 fl oz)/animal for cattle weighing more than 600 lb. Repeat as needed but not more than every 2 weeks and not more than 4 applications within a 6 month period.
	<i>moxidectin</i> Moxidectin Cydectin Pour-on	6	Inject 1 mg/110 lb body weight	35 D	Use 22.7 mg/100 lb body weight (mites and lice).
	<i>permethrin</i> Atroban DeLice 1% pour on.	3A	Ready-to-use when purchased.	0 D	Apply 0.5% fl oz (15 cc)/100 lb body weight of animal up to a maximum of 5 fl oz for any 1 animal. Pour correct dose along back and down face.
	Brute Pour-on 10% <i>permethrin</i> Ultra-Boss Pour-on 5% <i>permethrin</i>				Apply 15 cc (10%) or 30 cc (5%)/1000 lb down mid-line of back. Repeat the application in 10-14 days for mites.
	<i>permethrin</i> 5% + <i>diflubenzuron</i> 5% Clean-up Pour-on Insecticide with IGR	3A	Ready-to-use when purchased.	0 D	Ready-to-use. Follow label directions.
Bolus, Feed Additives	<i>diflubenzuron</i> <i>diflubenzuron</i> 8% ClariFly	15	Ready-to-use when purchased.		Mix according to label instructions and feed at rates stipulated based on cattle weights. Prevents emergence of horn flies, face flies, house flies, and stable flies from manure of treated cattle. Start feeding treated cattle early in the spring before flies appear and continue until cold weather restricts fly activity. Does not affect adult flies. No withdrawal; no milk withholding.
	<i>methoprene</i> Altosid 0.02% mineral mix or block Altosid IGR 1% Liquid - Feed-through	7A	Ready-to-use when purchased.	0 D	Feed free choice at 1/4-1/2 lb/100 lb animal body weight monthly/animal.  Mix in feed to achieve consumption rate of 1.13 mg/100 lb animal body weight/day.
	<i>tetrachlorvinphos</i> Rabon 7.76% granular oral laticide.	1B	Pre-mix or ready-to-use blocks and mineral feeds are available commercially.	0 D	Mix 7.76% oral larvicide with concentrate feed as directed on label. Feed ready-to-use block or mineral free choice so each animal will consume 70 mg/100 lb body weight daily. Begin feeding before flies appear in spring. Feed continuously until frost. Does not affect adult flies.



## BEEF CATTLE EXTERNAL PARASITE AND GRUB CONTROL

### HORSE FLIES, DEER FLIES, MOSQUITOES, BLACK FLIES, EYE GNATS

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS <sup>1,2,3</sup>
Sprays	<i>dichlorvos</i> Vapona EC	1B	Mix 1 qt 21.8% EC in 6 gal of water. Restricted Use Pesticide	1 D	Apply 1-2 fl oz as a light mist-spray daily. Spray to cover all parts of the animal. Do not wet the skin. Do not apply more than 2 fl oz/animal each day.
	<i>permethrin</i> Permethrin EC spray	3A	Mix 1 qt of 5.7% EC OR mix 1 pt of 10% EC or 11% EC in 100 gal water or mix 30-118 ml of 40% EC in 25 gal of water or apply 1% pour-on as an undiluted spray.	0 D	Spray animal thoroughly. Re-treat as needed but not more often than once every 14 days. To control lice or mites, a second treatment may be needed 10-21 days later.
	Permethrin EC Spray (low pressure)		Mix 1 qt 11% EC in 5 gal water.		
	Permethrin EC Spray Permethrin II Atroban 11%		Mix 1 cup 42.5% EC in 100 gal water or mix 1 pt 40% EC in 100 gals. water.		
	<i>pyrethrins</i> Pyrethrins - synergized	3A	Ready-to-use when purchased.	0 D	Apply 1-2 fl oz daily or as needed. Apply to wet hair not skin.
Ear-Tags and Dust Bags (Self-Treatment)	<i>permethrin</i> Permethrin 0.25% dust	3A	Ready-to-use when purchased.	0 D	Use in dust bags or apply up to 2 oz directly to animals. Re-treat 14-21 days later if needed for lice control.
Backrubbers and Facerubbers	<i>permethrin</i> Permethrin Rubbing Mixture	3A	Mix 1 qt 5.7% EC in 10 gal diesel fuel or mix 1 pt 10% or 11% EC in 1 gal of #2 diesel fuel or mineral oil or mix 118 ml 40% EC in 10 gal of diesel oil or suitable mineral oil.	0 D	Keep rubbing device charged. Daily forced use provides best results.
Pour-on Spot-on	<i>permethrin</i> Atroban DeLice 1% pour-on	3A	Ready-to-use when purchased.	0 D	Apply 0.5% fl oz (15 cc)/100 lb body weight of animal up to a maximum of 5 fl oz for any 1 animal. Pour correct dose along back and down face.
	Brute Pour-on 10% Ultra-Boss Pour-on 5%				Apply 15 cc (10%) or 30 cc (5%)/1000 lb down mid-line of back. Repeat the application in 10-14 days for mites.
	Clean-up Pour-on Insecticide with IGR <i>permethrin</i> 5% + <i>diflubenzuron</i> 5%				Follow label directions.

## BEEF CATTLE EXTERNAL PARASITE AND GRUB CONTROL

### HOUSE FLIES

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS <sup>1,2,3</sup>
Sprays	<i>dichlorvos</i> Vapona EC	1B	Mix 1 qt 21.8% EC in 6 gal of water.  Restricted Use Pesticide	1 D	Apply 1-2 fl oz as a light mist-spray daily. Spray to cover all parts of the animal. Do not wet the skin. Do not apply more than 2 fl oz/animal each day.
	<i>permethrin</i> Permethrin EC spray Permethrin II Atroban 11%	3A	Mix 1 qt of 5.7% EC OR mix 1 pt of 10% EC or 11% EC in 100 gal water or mix 30-118 ml of 40% EC in 25 gal of water or apply 1% pour-on as an undiluted spray.	0 D	Spray animal thoroughly. Re-treat as needed but not more often than once every 14 days. To control lice or mites, a second treatment may be needed 10-21 days later.
	<i>pyrethrins</i> Pyrethrins - synergized	3A	Ready-to-use when purchased.	0 D	Apply 1-2 fl oz daily or as needed. Apply to wet hair not skin.
Ear-Tags and Dust Bags (Self-Treatment)	<i>diazinon</i> OPTimizer 21.4% insecticide ear tag 21.4% <i>diazinon</i> ----- Patriot 40% insecticide cattle ear tag ----- Warrior 40% insecticide ear tag (30% <i>diazinon</i> + 10% <i>chlorpyrifos</i> )	1B	Ready-to-use when purchased.	0 D	Attach 1 tag to the inside of 1 or both ears of mature animals. Remove tags when control drops off, at the end of fly season, or before slaughter.
	<i>lambda-cyhalothrin</i> Saber 10% insecticide ear tag 10% <i>lambda-cyhalothrin</i> + 13% <i>piperonyl butoxide</i>	3A	Ready-to-use when purchased.	0 D	Apply 1 tag to the inside of each ear on mature cattle or calves. Remove tags when control drops off, at the end of fly season, or before slaughter.
	Double Barrel/Double Barrel VP 20.8% insecticide ear tag 6.8% <i>lambda-cyhalothrin</i> + 14% <i>pirimiphos methyl</i>	3A	Ready-to-use when purchased.	0 D	Apply 1 tag to the inside of each ear on mature cattle or calves. Remove tags when control drops off, at the end of fly season, or before slaughter.
	<i>permethrin</i> Permethrin 10% Insecticide Ear Tag Gard Star Plus	3A	Ready-to-use when purchased.	0 D	Attach 1 tag to the inside of each ear on mature cattle and calves. Remove tags when control drops off, at the end of fly season, or before slaughter.
	<i>pirimiphos-methyl</i> Dominator 20% insecticide ear tag	3A	Ready-to-use when purchased.	0 D	Attach 1 tag to the inside of each ear on mature cattle. Remove tags when control drops off or in the fall, whichever occurs first.
	<i>zeta-cypermethrin</i> PYthon Magnum 10% insecticide ear tag <i>zeta-cypermethrin</i> 10% + <i>piperonyl butoxide</i> 20%	3A	Ready-to-use when purchased.	0 D	Attach 1 tag to the inside of each ear on mature cattle. Remove tags when control drops off, at the end of fly or lice season, or before slaughter. During the horn fly season, 1 tag/animal can be used on cows. Calves can be tagged with 1 tag as needed.

**BEEF CATTLE EXTERNAL PARASITE AND GRUB CONTROL**

**HOUSE FLIES**

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS <sup>1,2,3</sup>
Pour-on Spot-on	<i>permethrin</i> Atroban DeLice 1.0% pour-on	3A	Ready-to-use when purchased.	0 D	Apply 0.5% fl oz (15 cc)/100 lb body weight of animal up to a maximum of 5 fl oz for any 1 animal. Pour correct dose along back and down face.
	Brute Pour-on 10% Ultra-Boss Pour-on 5%	3A	Ready-to-use when purchased.		Apply 15 cc (10%) or 30 cc (5%)/1000 lb down mid-line of back. Repeat the application in 10-14 days for mites.
	Clean-up Pour-on Insecticide with IGR <i>permethrin</i> 5% + <i>diflubenzuron</i> 5%	3A + 15	Ready-to-use when purchased.		Ready-to-use. Follow label directions.
Bolus, Feed Additives	<i>diflubenzuron</i> ClariFly (8%)	15	Mix according to instructions based on cattle weights.	0 D	Mix according to label instructions and feed at rates stipulated based on cattle weights. Prevents development of fly larvae in manure of treated cattle. Prevents emergence of horn flies, face flies, house flies, and stable flies from manure of treated cattle. Start feeding early in the spring before flies appear and continue until cold weather restricts fly activity. Does not affect adult flies. No withdrawal; no milk withholding.
	<i>tetrachlorvinphos</i> Rabon 7.76% granular oral laticide	1B	Pre-mix or ready-to-use blocks and mineral feeds are available commercially.	0 D	Mix 7.76% oral larvicide with concentrate feed as directed on label. Feed ready-to-use block or mineral free choice so each animal will consume 70 mg/100 lb body weight daily. Begin feeding before flies appear in spring. Feed continuously until frost. Does not affect adult flies.

**MAGGOTS IN WOUNDS**

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS <sup>1,2,3</sup>
	<i>coumaphos</i> Co-Ral 11.6%	1B	Mix 2.5-5 fl oz/gal water		Mix 2.5-5 fl oz/4 gal water and spray to complete wetting. Wait at least 10 days between treatments.

## BEEF CATTLE EXTERNAL PARASITE AND GRUB CONTROL

### MITES, SCABIES (Psoroptic, Chorioptic, Sarcoptic)

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS <sup>1,2,3</sup>
Sprays	<i>permethrin</i> Permethrin EC spray	3A	Mix 1 qt of 5.7% EC OR mix 1 pt of 10% EC or 11% EC in 100 gal water or mix 30-118 ml of 40% EC in 25 gal of water or apply 1% pour-on as an undiluted spray.	0 D	Spray animal thoroughly. Re-treat as needed but not more often than once every 14 days. To control lice or mites, a second treatment may be needed 10-21 days later.
	<i>phosmet</i> Prolate/Lintox Prolate/Lintox HD	1B	Mix 1 qt in 25-50 gal water (depending on target pest), and spray to run-off.	3 D	Apply as a coarse high pressure spray to thoroughly wet the skin and hair of the animal. Apply up to 1 gal/animal. Do not re-treat within 7 days. Follow label restrictions.
Injectables	<i>eprinomectin</i> 5% LongRange Injectable	6	Ready-to-use when purchased.	48 D	Inject 1 ml of LongRange/110 lb animal weight.
Injectable Pour-on Spot-on	<i>cyfluthrin</i> Cylence 1% pour-on insecticide	3A	Ready-to-use when purchased.	0 D	Apply pour-on along the top of the back and top of the head. For horn fly and face fly control apply 4 ml to animals weighing less than 400 lb, 8 ml to animals weighing 400-800 lb and 12 ml to animals weighing over 800 lb. Do not re-treat within 3 weeks following treatment. Double the dose for biting and sucking lice.
	<i>doramectin</i> 0.5% Dectomax pour-on	6	Ready-to-use when purchased.	45 D	Apply 1 ml/22 lb body weight, along midline of the back between withers and tailhead. Safe for all beef cattle and replacement dairy heifers up to 20 months of age.
	<i>eprinomectin</i> Ivomec Eprinex pour-on for beef cattle. Contains 5 mg. <i>eprinomectin</i> /ml.	6	Ready-to-use when purchased.	0 D	Administer pour-on to cattle 8 weeks of age or older. Apply at the dose of 1 ml/22 lb body weight. Apply pour-on to the top of the animal along the backline from the withers to the tailhead.
	<i>ivermectin</i> Ivomec 1% clear, ready-to-use sterile solution.	6	Ready-to-use when purchased.	35 D	Administer subcutaneously only 1 ml (10 mg <i>ivermectin</i> )/110 lb body weight. Restrain animals and inject under the loose skin in front of or behind the shoulder. A sterile, 16-gauge, 0.5-0.75" needle is suggested. Divide doses greater than 10 ml between 2 injection sites to reduce occasional transitory discomfort or site reaction. <b>Waiting period between application and slaughter: 35 days.</b>
	Ivomec pour-on, ready-to-use. 5 mg <i>ivermectin</i> /ml.		Ready-to-use when purchased.	48 D	Apply 1 ml/22 lb of body weight. Apply along the topline in a narrow strip extending from the withers to the tailhead.
Injectable Pour-on Spot-on	<i>moxidectin</i> Moxidectin 1% injectable Cydectin 10 mg/ml	6	Ready-to-use when purchased.	35 D	Inject 1 mg/10 lb body weight.
	Cydectin Pour-on				Use 22.7 mg/100 lb body weight (mites and lice).
	<i>permethrin</i> Atroban DeLice 1% pour-on	3A	Ready-to-use when purchased.	0 D	Apply 0.5% fl oz (15 cc)/100 lb body weight of animal up to a maximum of 5 fl oz for any 1 animal. Pour correct dose along back and down face.
	Brute Pour-on 10% Ultra-Boss Pour-on 5%				Apply 15 cc (10%) or 30 cc (5%)/1000 lb down mid-line of back. Repeat the application in 10-14 days for mites.

**BEEF CATTLE EXTERNAL PARASITE AND GRUB CONTROL**

**STABLE FLIES**

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS <sup>1,2,3</sup>	
Sprays	<i>dichlorvos</i> Vapona EC	1B	Mix 1 qt 21.8% EC in 6 gal of water. Restricted Use Pesticide.	1 D	Apply 1-2 fl oz as a light mist-spray daily. Spray to cover all parts of the animal. Do not wet the skin. Do not apply more than 2 fl oz/animal each day.	
	<i>permethrin</i> Permethrin EC spray Permethrin II Atroban 11%	3A	Mix 1 qt of 5.7% EC OR mix 1 pt of 10% EC or 11% EC in 100 gal water or mix 30-118 ml of 40% EC in 25 gal of water or apply 1% pour-on as an undiluted spray.	0 D	Spray animal thoroughly. Re-treat as needed but not more often than once every 14 days. To control lice or mites, a second treatment may be needed 10-21 days later.	
	Permethrin EC Spray (low pressure)		Mix 1 qt 11% EC in 5 gal water.			
		Permethrin EC Spray		Mix 1 cup 42.5% EC in 100 gal water or mix 1 pt 40% EC in 100 gal water.		Apply 1-2 oz spray mixture/animal. Spot treat the back, face, legs, and ears.
		Pyrethrins Pyrethrins – synergized		Ready-to-use when purchased.		Apply 1 qt of low concentration spray mixture/animal to control horn flies only. Apply 2 qt of high concentration spray/animal to control all labeled parasites. Repeat treatment as needed but not more than every 14 days.
					Apply 1-2 fl oz daily or as needed. Apply to wet hair not skin.	
Ear-Tags and Dust Bags (Self-Treatment)	<i>diazinon</i> Optimizer 21.4% insecticide ear tag	1B	Ready-to-use when purchased.	0 D	Attach 1 tag to the inside of 1 or both ears of mature animals. Remove tags when control drops off, at the end of fly season, or before slaughter.	
	Patriot 40% insecticide cattle ear tag.					
	Warrior 40% insecticide ear tag 30% <i>diazinon</i> + 10% <i>chlorpyrifos</i>					
	<i>lambda-cyhalothrin</i> Saber 10% insecticide ear tag 10% <i>lambda-cyhalothrin</i> + 13% <i>piperonyl butoxide</i>	3A	Ready-to-use when purchased.	0 D	Apply 1 tag to the inside of each ear on mature cattle or calves. Remove tags when control drops off, at the end of fly season, or before slaughter.	
	Double Barrel/Double Barrel VP 20.8% insecticide ear tag 6.8% <i>lambda-cyhalothrin</i> + 14% <i>pirimiphos methyl</i>	3A	Ready-to-use when purchased.	0 D	Apply 1 tag to the inside of each ear on mature cattle or calves. Remove tags when control drops off, at the end of fly season, or before slaughter.	
	<i>permethrin</i> Permethrin 10% Insecticide ear tag Gard Star Plus	3A	Ready-to-use when purchased.	0 D	Attach 1 tag to the inside of each ear on mature cattle and calves. Remove tags when control drops off, at the end of fly season, or before slaughter.	
	<i>pirimiphos-methyl</i> Dominator 20% insecticide ear tag	3A	Ready-to-use when purchased.	0 D	Attach 1 tag to the inside of each ear on mature cattle. Remove tags when control drops off or in the fall, whichever occurs first.	

## BEEF CATTLE EXTERNAL PARASITE AND GRUB CONTROL

### STABLE FLIES

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS <sup>1,2,3</sup>
Ear-Tags and Dust Bags (Self-Treatment) (continued)	<i>zeta-cypermethrin</i> PYthon Zetagard 10% insecticide ear tag <i>zeta-cypermethrin</i> 10% + <i>piperonyl butoxide</i> 20%	3A	Ready-to-use when purchased.	0 D	Attach 1 tag to the inside of each ear on mature cattle. Remove tags when control drops off, at the end of fly or lice season, or before slaughter. During the horn fly season, 1 tag/animal can be used on cows. Calves can be tagged with 1 tag as needed.
Backrubbers and Facerubbers	<i>permethrin</i> Permethrin Rubbing Mixture	3A	Mix 1 qt 5.7% EC in 10 gal diesel fuel or mix 1 pt 10% or 11% EC in 1 gal of #2 diesel fuel or mineral oil or mix 118 ml 40% EC in 10 gal of diesel oil or suitable mineral oil.	0 D	Keep rubbing device charged. Daily forced use provides best results.
Pour-on Spot-on	<i>lambda-cyhalothrin</i> with <i>piperonyl butoxide</i> Vetcap AIM-L insecticide capsules	2A	Ready-to-use when purchased.		Apply only with a SmartVet Approved Vetcap Application Device according to label directions
	<i>lambda-cyhalothrin</i> Saber 1% pour-on insecticide	2A	Ready-to-use when purchased.	0 D	Apply to beef cattle and calves for lice and horn flies. Apply pour-on down the backline at 10 ml (1/3 fl oz)/animal for cattle weighing less than 600 lb or at a rate of 15 ml (1/2 fl oz)/animal for cattle weighing more than 600 lb. Repeat as needed but not more often than every 2 weeks and not more than 4 applications within a six-month period.
	<i>permethrin</i> Atroban DeLice 1% pour-on	2A	Ready-to-use when purchased.	0 D	Apply 0.5% fl oz (15 cc)/100 lb body weight of animal up to a maximum of 5 fl oz for any 1 animal. Pour correct dose along back and down face.
	Brute Pour-on 10% Ultra-Boss Pour-on 5%				Apply 15 cc (10%) or 30 cc (5%)/1000 lb down mid-line of back. Repeat the application in 10-14 days for mites.
	Clean-up Pour-on Insecticide with IGR <i>permethrin</i> 5% + <i>diflubenzuron</i> 5%	2A/15			Follow label directions.

**BEEF CATTLE EXTERNAL PARASITE AND GRUB CONTROL**

**TICKS**

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS <sup>1,2,3</sup>
Sprays	<i>coumaphos</i> Co-Ral 11.6%	1B	Mix 5 fl oz/4 gal water.		Mix 2.5-5 fl oz in 4 gal water and spray to complete wetting. Wait at least 10 days between treatments.
	<i>permethrin</i> Permethrin EC spray Permethrin II Atroban 11%	3A	Mix 1 qt of 5.7% EC OR mix 1 pt of 10% EC or 11% EC in 100 gal water or mix 30-118 ml of 40% EC in 25 gal of water or apply 1% pour-on as an undiluted spray.	0 D	Spray animal thoroughly. Re-treat as needed but not more often than once every 14 days. To control lice or mites, a second treatment may be needed 10-21 days later.
	Permethrin EC Spray (low pressure)	3A	Mix 1 qt 11% EC in 5 gal water.		Apply 1-2 oz spray mixture/animal. Spot treat the back, face, legs, and ears.
	Permethrin EC Spray		Mix 1 cup 42.5% EC in 100 gal water or mix 1 pt 40% EC in 100 gal water.		Apply 2 qt of high concentration spray/animal to control all labeled parasites. Repeat treatment as needed but not more than every 14 days.
	<i>phosmet</i> Prolate/Lintox Prolate/Lintox HD	1B	Mix 1 qt in 25-50 gal water (depending on target pest), and spray to run-off.	3 D	Apply as a coarse high pressure spray to thoroughly wet the skin and hair of the animal. Apply up to 1 gal/animal. Do not re-treat within 7 days. Follow label restrictions.
	<i>stirofos + dichlorvos</i> Ravap EC spray 0.35% <i>stirofos</i> + 0.1% <i>dichlorvos</i>	1B	Mix 1 pt 28.7% EC in 10 gal water. Restricted Use Pesticide.	0 D	Apply as a coarse spray. Apply 0.5-1 gal spray/animal. Do not repeat application within 10 days.
	Ravap EC spray 0.5% <i>stirofos</i> + 0.1% <i>dichlorvos</i>		Mix 1 pt 28.7% EC in 6 gal of water. Restricted Use Pesticide.		Apply as a coarse spray. Apply 0.5 gal spray/animal. Do not repeat application within 10 days.
	<i>tetrachlorvinphos</i> Rabon WP spray	1B	Mix 1 lb 50% WP in 18 gal of water.	0 D	Apply as a coarse spray. Apply 2 qt-1 gal/animal to obtain complete wetting.
Ear-Tags and Dust Bags (Self-Treatment)	<i>coumaphos</i> Corathon Insecticide Cattle Ear Tag 15% <i>coumaphos</i> + 35% <i>diazinon</i>	1B	Ready-to-use when purchased.		All mature animals in the herd should be tagged. For optimum control of horn flies, Gulf Coast ticks, and spinose ear ticks, and as an aid in the control of face flies, attach 1 tag to each ear (2/animal). Replace as necessary. Calves less than 3 months of age should not be tagged as ear damage may result. Remove tags at end of fly season or prior to slaughter.
	<i>cyfluthrin</i> Beta-cyfluthrin CyLence Ultra Insecticide Cattle Ear Tags 8%	3A	Ready-to-use when purchased.		All mature animals in the herd should be tagged. For optimum control of horn flies, coast ticks, and spinose ear ticks, and as an aid in the control of face flies, attach 1 tag to each ear (2/animal). Replace as necessary. Calves less than 3 months of age should not be tagged as ear damage may result. Remove tags at end of fly season or prior to slaughter.
	<i>diazinon</i> OPTimizer 21.4% insecticide ear tag	1B	Ready-to-use when purchased.	0 D	Attach 1 tag to the inside of each ear on mature cattle. Tags should be removed when control drops off, at the end of the fly season, or before slaughter.

## BEEF CATTLE EXTERNAL PARASITE AND GRUB CONTROL

### TICKS

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS <sup>1,2,3</sup>
Ear-Tags and Dust Bags (Self-Treatment) <i>(continued)</i>	<i>diazinon</i> Patriot 40% insecticide cattle ear tag.	1B	Ready-to-use when purchased.	0 D	Attach 1 tag to the inside of 1 or both ears of mature animals. Remove tags when control drops off, at the end of fly season, or before slaughter.
	Warrior 40% insecticide ear tag 30% <i>diazinon</i> + 10% <i>chlorpyrifos</i>				Attach 1 tag to the inside of 1 or both ears of mature animals. Remove tags when control drops off, at the end of fly or lice season, or before slaughter.
	<i>lambda-cyhalothrin</i> Saber 10% insecticide ear tag 10% <i>lambda-cyhalothrin</i> + 13% <i>piperonyl butoxide</i>	3A	Ready-to-use when purchased.	0 D	Apply 1 tag to the inside of each ear on mature cattle or calves. Remove tags when control drops off, at the end of fly season, or before slaughter.
	<i>permethrin</i> Permethrin 10% Insecticide Ear Tag Gard Star Plus	2A	Ready-to-use when purchased.	0 D	Attach 1 tag to the inside of each ear on mature cattle and calves. Remove tags when control drops off, at the end of fly season, or before slaughter.
	Permethrin 0.25% dust	3A			Use in dust bags or apply up to 2 oz directly to animals. Re-treat 14-21 days later if needed for lice control.
	<i>pirimiphos-methyl</i> Dominador 20% insecticide ear tag 20% <i>pirimiphos methyl</i>	3A	Ready-to-use when purchased.	0 D	Attach 1 tag to the inside of each ear on mature cattle. Remove tags when control drops off or in the fall, whichever occurs first.
	<i>zeta-cypermethrin</i> PYthon Magnum 10% insecticide ear tag <i>zeta-cypermethrin</i> 10% + <i>piperonyl butoxide</i> 20%	3A	Ready-to-use when purchased.	0 D	Attach 1 tag to the inside of each ear on mature cattle. Remove tags when control drops off, at the end of fly or lice season, or before slaughter. During the horn fly season, 1 tag/animal can be used on cows. Calves can be tagged with 1 tag as needed.
Backrubbers and Facerubbers	<i>permethrin</i> Permethrin Rubbing Mixture	3A	Mix 1 qt 5.7% EC in 10 gal diesel fuel or mix 1 pt 10% or 11% EC in 1 gal of #2 diesel fuel or mineral oil or mix 118 ml 40% EC in 10 gal of diesel oil or suitable mineral oil.	0 D	Keep rubbing device charged. Daily forced use provides best results.
	<i>stirofos + dichlorvos</i> Ravap 1% <i>stirofos</i> + 0.25% <i>dichlorvos</i> in oil.	1B	Mix 5 oz 28.7% EC in 1 gal of #2 diesel fuel. Restricted Use Pesticide.	0 D	Pour 1 gal of mixture/20 ft of cable. Keep rubbing device charged.
Pour-on Spot-on	<i>permethrin</i> Atroban DeLice 1% pour on	3A	Ready-to-use when purchased.	0 D	Apply 0.5% fl oz (15 cc)/100 lb body weight of animal up to a maximum of 5 fl oz for any 1 animal. Pour correct dose along back and down face.
	Brute Pour-on 10% Ultra-Boss Pour-on 5%				Apply 15 cc (10%) or 30 cc (5%)/1000 lb down mid-line of back. Repeat the application in 10-14 days for mites.

<sup>1</sup> Waiting periods refer to the time interval between the last application of the insecticide and slaughter of beef animals.

<sup>2</sup> Do not treat calves under 6 months of age with insecticides unless specifically allowed on the insecticide label.

<sup>3</sup> Do not treat Brahman cattle with organophosphate insecticides unless specifically allowed on the insecticide label.

<sup>4</sup> Available from veterinarians.



# DAIRY CATTLE EXTERNAL PARASITE AND CATTLE GRUB CONTROL

Nancy C. Hinkle, Veterinary Entomologist

Annie Rich, Graduate Student

Listed here are products for lactating and non-lactating dairy cattle. Read instructions carefully and determine if the product is suitable for both the target pest and the animal. Be sure to observe all precautions on insecticide labels to prevent injury to animals and humans and to prevent illegal insecticide residues in milk and milk by-products.

## CATTLE GRUBS

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS
Pour-On	<i>doramectin</i> 0.5% Dectomax Pour-on	6	Ready-to-use when purchased.	45 D	Apply 1 ml/22 lb body wt along midline of back between withers and tailhead. Safe for all beef cattle and replacement dairy heifers up to 20 months of age.
	<i>eprinomectin</i> 0.5% Eprinex Pour-on	6	Ready-to-use when purchased.		Apply 1 ml/22 lb body wt along midline of the back between withers and tailback. Safe for all beef and dairy (including lactating) cattle. Applications of macrocyclic lactones will also control blood sucking lice (nymphs and adults). Lice eggs may hatch on untreated cattle may serve as source of reinfestation, requiring re-treatment.
	<i>ivermectin</i> 0.5% Ivomec Pour-on	6	Ready-to-use when purchased.	48 D	Apply 1 ml/22 lb body wt, along midline of the back between withers and tailhead. Safe for all beef cattle; cattle must not be treated within 48 days of slaughter for human consumption. Do not use in female dairy cattle of breeding age.
	<i>moxidectin</i> 0.5% Cydectin Pour-on	6	Ready-to-use when purchased.		Pour weight-determined dose evenly along animal's backline from withers to tailhead (basing dose on label weight table). No pre-slaughter or milk discard interval.

## CATTLE LICE

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS
Sprays	<i>coumaphos</i> Coumaphos Co-Ral 6.15%	1B	Mix 2.5 fl oz/4 gal water		Mix 2.5 fl oz/4 gal water and spray to complete wetting. Do not make treatments fewer than 10 days apart.
	<i>permethrin</i> Permethrin CDS 7.4%	3A	Mix 1 qt in 25 gal water		1-2 qt of coarse spray/animal over whole body surface. Thoroughly wet animal.
	<i>tetrachlorvinphos</i> 23% + <i>dichlorvos</i> 5.3% Ravap E.C.	1B	Dilute 2 oz in 3 gal water. Direct spray to cover thoroughly with up to 0.5 gal/animal. Restricted Use Pesticide		Repeat as necessary. No milk discard is required. Apply at least 20 minutes prior to milking, or spray after milking has been completed.
Dusts	<i>coumaphos</i> 1% Co-Ral Livestock Dust, ProZap Zipcide Dust	1B	Ready-to-use when purchased.		Using shaker can, apply no more than 1 oz/animal as a uniform coat to the head, shoulders, and back. Treat no more than 6 times/year. Wait 10 days between applications. No milk withholding.
	<i>permethrin</i> 0.25% Permethrin Fly & Louse Dust	3A	Ready-to-use when purchased.		Using shaker can, apply no more than 2 oz/animal over the head, neck, shoulders, back, and tailhead. Repeat as necessary.
	<i>zeta-cypermethrin</i> PYthon Dust 0.075%	3A	Ready-to-use when purchased.		Apply with dust bag or shaker.

**DAIRY CATTLE EXTERNAL PARASITE AND CATTLE GRUB CONTROL**

**CATTLE LICE**

<b>WAYS TO APPLY INSECTICIDES</b>	<b>INSECTICIDE</b>	<b>MOA</b>	<b>MIXING INSTRUCTIONS</b>	<b>WITHDRAWAL TIME</b>	<b>APPLICATION INSTRUCTIONS AND RESTRICTIONS</b>
Dust Bags (Self- Treatment)	<i>coumaphos</i> 1% Co-Ral Livestock Dust, ProZap Zipcide Dust	1B	Ready-to-use when purchased.		Place contents in dust bag and suspend in area frequented by cattle to force daily use. For lactating dairy cattle, bags may be suspended in the exit through which cattle leave the milking barn. Suspend so that the bottom of the bag will hang 4-6” below the topline of the cattle. No milk withholding.
	<i>permethrin</i> Permethrin Fly & Louse Dust 0.25%	3A	Ready-to-use when purchased.		Place contents in dust bag and suspend in area frequented by cattle to force daily use. For lactating dairy cattle, bags may be suspended in the exit through which cattle leave the milking barn. Suspend so that the bottom of the bag will hang 4-6” below the topline of the cattle. No milk withholding.
	<i>zeta-cypermethrin</i> PYthon Dust 0.075%	3A	Ready-to-use when purchased.		Apply with dust bag or shaker.
Backrubbers and Facerubbers	<i>coumaphos</i> Co-Ral Fly and Tick Spray 6.15%	1B	Mix 4 qt in 13 gal oil.		Saturate the backrubber with mixture. Place in location to force daily use. Suspend at height to prevent straddling. No milk with holding.
	<i>tetrachlorvinphos</i> 23% + <i>dichlorvos</i> 5.3% Ravap E.C.	1B	Mix 1 gal in 25 gal oil. Restricted Use Pesticide		Can be used on lactating dairy cattle with no withholding. Dilute according to label instructions. Pour 1 gal/20 linear feet of backrubber. Recharge as needed.
Pour-On	<i>doramectin</i> Dectomax 0.5%	6	Ready-to-use when purchased.	45 D	Apply 1 ml/22 lb body wt along midline of back between withers and tailhead. Safe for all beef cattle and replacement dairy heifers to 20 months of age. Lice eggs may hatch or untreated cattle may serve as source of reinfestation, requiring re-treatment.
	<i>eprinomectin</i> Eprinex 0.5%	6	Ready-to-use when purchased.		Apply 1 ml/22 lb body wt along midline of the back between withers and tailback. Safe for all beef and dairy (including lactating) cattle. Lice eggs may hatch or untreated cattle may serve as source of reinfestation, requiring re-treatment.
	<i>ivermectin</i> Ivomec 0.5%	6	Ready-to-use when purchased.	48 D	Apply 1 ml/22 lb body wt, along midline of the back between withers and tailhead. Cattle must not be treated within 48 days of slaughter for human consumption. Do not use in female dairy cattle of breeding age. Lice eggs may hatch or untreated cattle may serve as source of reinfestation, requiring re-treatment.
	<i>moxidectin</i> Cydectin 0.5%	6	Ready-to-use when purchased.		Pour weight-determined dose evenly along animal’s backline from withers to tailhead (basing dose on label weight table). Provides 7 days of activity against horn flies. No pre-slaughter or milk discard interval. Lice eggs may hatch or untreated cattle may serve as source of reinfestation, requiring re-treatment.
	<i>permethrin</i> Synergized DeLice 1% solution	3A	Ready-to-use when purchased.		Apply 0.5 fl oz (15 cc)/100 lb body weight of animal up to a maximum of 5 fl oz for any 1 animal. Pour-On: Pour correct dose along back and down face. Repeat pour-on treatments as needed, but not more than once every 14 days.

DAIRY CATTLE EXTERNAL PARASITE AND CATTLE GRUB CONTROL

FACE FLIES

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS
Sprays	<i>coumaphos</i> Co-Ral 6.15%	1B	Mix 2.5 fl oz/4 gal water		Mix 2.5 fl oz/4 gal water and spray to complete wetting. Do not make treatments fewer than 10 days apart.
	<i>dichlorvos</i> Prozap Beef and Dairy RTU	1B	Apply 1-2 oz/animal		Apply no more than 2 fl oz daily as a light mist-spray to cover all body parts, especially head, back, legs, and sides. Do not wet skin, only hair of animal. Do not apply to animals less than 6 months old.
	Vapona Insecticide Dairy Cattle Spray		Ready-to-use when purchased.		Use according to label; apply less than 2 oz/animal.
	<i>permethrin</i> Synergized DeLice 1% solution	3A	Ready-to-use when purchased.		Apply 0.5 fl oz (15 cc)/100 lb body weight of animal up to a maximum of 5 fl oz for any 1 animal. Ready-to-use spray: Use undiluted in a mist-sprayer to apply correct dose. Apply directly to neck, face, back, legs, and ears. Repeat spray and pour-on treatments as needed, but not more than once every 14 days.
	Mix 1 qt 5.7% EC in 25 gal water.		Mix 1 qt 5.7% EC in 25 gal water.		Apply 1-2 qt diluted spray thoroughly/animal as a high pressure spray. Re-treat as needed but no more than once every 14 days.
	0.5% EC Spray		Mix 1 qt 5.7% EC in 1.5 gal water.		Apply 1-2 oz diluted spray as a low pressure spray to face and shoulders of animal. Re-treat as needed but not more often than every 14 days.
	Permethrin CDS 7.4%		Mix 1 qt in 25 gal water		1-2 qt of coarse spray/animal over whole body surface. Thoroughly wet animal.
	10% Permethrin II Concentrate		Mix 1 qt in 200 gal water OR 8 oz in 50 gal water.		Spray from 0.5-1 gal to cover entire animal. Can be applied to lactating dairy cattle.
	pyrethrins + synergist piperonyl butoxide Oil Solution or EC Spray pyrethrins 0.05-0.1% + synergist 0.5-1% pyrethrins 0.075% + synergist 0.75%	3A	Oil Solution is ready-to-use. EC spray, mix according to label instructions.		Oil Solution or EC Spray: Apply 1-2 fl oz as a fine mist-spray daily to all body parts, especially head and neck, with hand or automatic sprayer. Do not wet skin.
	EC Spray pyrethrins 0.025% + synergist 0.25% pyrethrins 0.05% + synergist 0.5% pyrethrins 0.1% + synergist 1%		Mix according to label instructions.		Apply thoroughly as wetting spray. Repeat after 2-3 weeks if needed. Apply 1-2 qt as wet spray every 3-7 days if needed. Apply 1-2 qt as a wet spray every 2-3 days or apply 1-2 fl oz as a light mist-spray daily with hand or automatic sprayer.
<i>tetrachlorvinphos</i> 23% + <i>dichlorvos</i> 5.3% Ravap E.C.	1B	Dilute 2 oz in 3 gal Direct spray to cover thoroughly with up to 0.5 gal/animal. Restricted Use Pesticide		Repeat as necessary. No milk discard is required. Apply at least 20 minutes prior to milking, or spray after milking has been completed.	
Dusts	<i>coumaphos</i> 1% Co-Ral Livestock Dust, ProZap Zipcide Dust	1B	Ready-to-use when purchased.		Using shaker can, apply no more than 1 oz/animal as a uniform coat to the head, shoulders, and back. Treat no more than 6 times/year. Wait 10 days between applications. No milk withholding.
	<i>permethrin</i> Permethrin 0.25% Dust	3A	Ready-to-use when purchased.		Apply up to 2 oz (5 Tbsp)/animal. Re-treat as needed but not more often than every 14 days.

DAIRY CATTLE EXTERNAL PARASITE AND CATTLE GRUB CONTROL

FACE FLIES

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS
Dusts (continued)	<i>tetrachlorvinphos</i> Rabon 3% Dust	1B	Ready-to-use when purchased.		Apply 2 oz of dust/animal. Rub in lightly or apply in suspended self-treatment dust bags. Repeat as needed.
	<i>zeta-cypermethrin</i> Python Dust 0.075%	3A	Ready-to-use when purchased.		Apply with dust bag or shaker.
Feed Additives	<i>diflubenzuron</i> ClariFly 8%	15	Mix according to label instructions.		Feed at rates stipulated based on cattle weights. Prevents development of fly larvae in manure of treated cattle. Prevents emergence of horn flies, face flies, house flies, and stable flies from manure of treated cattle. Start feeding early in the spring before flies appear and continue until cold weather restricts fly activity. Does not affect adult flies. No withdrawal; no milk withholding.
	<i>methoprene</i> Altosid 0.02% feed mixture or mineral block IGR	7A	Ready-to-use when purchased.		Animals should consume 0.25-0.5 lb/100 lb body weight each month. Feed this oral insect growth regulator as free choice mineral or mixed in supplements for pasture cattle early in the spring before horn flies appear. May be used in lactating dairy animals.
	Altosid IGR 1% Liquid		Feed-through.		Mix in feed to achieve consumption rate of 1.13 mg/100 lb animal body weight/day.
	<i>tetrachlorvinphos</i> Rabon Oral Larvicide Feed Mixture	1B	Mix Rabon 7.76% Oral Larvicide Pre-mix in feed or mineral mixes. Also available in ready-to-use products.		Feed the appropriate larvicidal feed or mineral mix to milking cows to prevent the development of fly larvae in manure. Follow manufacturers' instructions to ensure adequate amounts are consumed.
Dust Bags (Self-Treatment)	<i>coumaphos</i> Co-Ral Livestock Dust, ProZap Zipcide Dust 1%	1B	Ready-to-use when purchased.		Place contents in dust bag and suspend in area frequented by cattle to force daily use. For lactating dairy cattle, bags may be suspended in the exit through which cattle leave the milking barn. Suspend so that the bottom of the bag will hang 4-6" below the topline of the cattle. No milk withholding.
	<i>permethrin</i> Permethrin 0.25% Dust	3A	Ready-to-use when purchased.		Apply 4-10 lb in self-treatment cotton cloth, doubled burlap bags or commercial dust bags. Suspend where animals will treat themselves daily, such as near mineral stations, salt blocks or in milking barn exit. Bags should hang 4-6" below topline of cattle. Protect bags from weather. Do not hang bags over feed, mineral or water troughs.
	<i>stirofos</i> or <i>tetrachlorvinphos</i> Rabon 3% Dust	1B	Ready-to-use when purchased.		Apply 2 oz of dust/animal. Rub in lightly or apply in suspended self-treatment dust bags. Repeat as needed.
	<i>zeta-cypermethrin</i> Python Dust 0.075%	3A	Ready-to-use when purchased.		Apply with dust bag or shaker.
Backrubbers and Facerubbers	<i>coumaphos</i> Co-Ral Fly and Tick Spray 6.15%	1B	Mix 4 qt in 13 gal oil		Saturate the backrubber with mixture. Place in location to force daily use. Suspend at height to prevent straddling. No milk with holding.
	<i>permethrin</i> Synergized DeLice 1% solution	3A	Ready-to-use when purchased.		Back rubber use: Mix 1 pt/gal of #2 diesel fuel or mineral oil. Keep rubbing device charged. Results improved by daily forced use.
	<i>permethrin</i> 10%		Mix 1 pt in 10 gal diesel oil.		Keep rubbing device charged with 1 gal mixture/20 ft of cable. Cattle should be forced to use rubbing device daily.

## DAIRY CATTLE EXTERNAL PARASITE AND CATTLE GRUB CONTROL

### FACE FLIES

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS
Ear Tags	<i>beta-cyfluthrin</i> Cylence Ultra	3A	Ready-to-use when purchased.		Follow label instructions regarding number of tags/head; remove when effectiveness is diminished and at end of season. Can be used on lactating dairy animals.
	<i>permethrin</i> GardStar Plus	3A	Ready-to-use when purchased.		Follow label instructions regarding number of tags/head; remove when effectiveness is diminished and at end of season. Can be used on lactating dairy animals.
	<i>zeta-cypermethrin</i> PYthon, PYthon Magnum	3A	Ready-to-use when purchased.		Follow label instructions regarding number of tags/head; remove when effectiveness is diminished and at end of season. Can be used on lactating dairy animals.

### HORN FLIES

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS
Sprays	<i>coumaphos</i> Coumaphos Co-Ral 6.15%	1B	Mix 2.5 fl oz/4 gal water		Mix 2.5 fl oz/4 gal water and spray to complete wetting. Do not make treatments fewer than 10 days apart.
	<i>dichlorvos</i> Prozap Beef and Dairy RTU	1B	Apply 1-2 oz/animal.		Apply no more than 2 fl oz daily as a light mist-spray to cover all body parts, especially head, back, legs, and sides. Do not wet skin, only hair of animal. Do not apply to animals less than 6 months old.
	1% Vapona Insecticide Dairy Cattle Spray Prozap		Ready-to-use when purchased.		Apply no more than 2 fl oz daily as a light mist-spray to cover all body parts, especially head, back, legs, and sides. Do not wet skin, only hair of animal. Do not apply to animals less than 6 months old.
	<i>permethrin</i> Permethrin EC Spray Permethrin II Atroban 11%	3A	Mix 1 qt of 5.7% EC in 100 gal water OR Mix 1 pt of 10% EC or 11% EC in 100 gal water OR Mix 30-118 ml of 40% EC in 25 gal of water OR Apply 1% pour-on as an undiluted spray.		Spray animal thoroughly with 1 qt of coarse spray per animal.  Re-treat as needed but not more than once every 14 days.  To control lice or mites, a second treatment may be needed 10-21 days later.
	<i>permethrin</i> Synergized DeLice 1% solution	3A	Ready-to-use when purchased.		Ready-to-use spray: Use undiluted in a mist-sprayer to apply correct dose. Apply directly to neck, face, back, legs, and ears. Repeat spray and pour-on treatments as needed, but not more than once every 14 days.
	Permethrin 0.05% EC Spray		Mix 1 qt 5.7% EC in 25 gal water.		Apply 1-2 qt diluted spray thoroughly/animal as a high pressure spray. Re-treat as needed but no more than once every 14 days.
	Permethrin 0.5% EC Spray		Mix 1 qt 5.7% EC in 1.5 gal water.		Apply 1-2 oz diluted spray as a low pressure spray to face and shoulders of animal. Re-treat as needed but not more often than every 14 days.
	Permethrin CDS 7.4%		Mix 1 qt in 25 gal water.		Apply 1-2 qt of coarse spray/animal over whole body surface. Thoroughly wet animal.

DAIRY CATTLE EXTERNAL PARASITE AND CATTLE GRUB CONTROL

HORN FLIES

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS
Sprays (continued)	<i>phosmet</i> Prolate/Lintox (11.75%)	1B	Mix with water according to label directions		<b>For non-lactating dairy only.</b> Spray cattle to control horn flies, lice, scabies mites, and ticks. Repeat no more frequently than every 7-10 days. Do not apply within 28 days of freshening. Cattle may be slaughtered 3 days after spraying.
	<i>pyrethrins + synergist piperonyl butoxide</i>	3A	Ready-to-use		Apply 1-2 fl oz as a fine mist-spray daily to all body parts, especially head and neck, with hand or automatic sprayer. Do not wet skin.
	Oil Solution or EC Spray pyrethrins 0.05-0.1% + synergist 0.5-1% pyrethrins 0.075% + synergist 0.75%		Oil Solution is Ready-to-use when purchased. EC spray, mix according to label instructions.		Apply thoroughly as wetting spray. Repeat after 2-3 weeks if needed.
	EC Spray pyrethrins 0.025% + synergist 0.25% pyrethrins 0.05% + synergist 0.5% pyrethrins 0.1% + synergist 1%		Mix according to label instructions.		Apply 1-2 qt as wet spray every 3-7 days if needed. Apply 1-2 qt as a wet spray every 2-3 days or apply 1-2 fl oz as a light mist-spray daily with hand or automatic sprayer.
	<i>tetrachlorvinphos</i> 23% + <i>dichlorvos</i> 5.3% Ravap EC	1B	Dilute 2 oz in 3 gal. Direct spray to cover thoroughly with up to 0.5 gal/animal.  Restricted Use Pesticide		Repeat as necessary. No milk discard is required. Apply at least 20 minutes prior to milking, or spray after milking has been completed.
Dusts	<i>coumaphos</i> 1% Co-Ral Livestock Dust, ProZap Zipcide Dust	1B	Ready-to-use when purchased.		Using shaker can, apply no more than 1 oz/animal as a uniform coat to the head, shoulders, and back. Treat no more than 6 times/year. Wait 10 days between applications. No milk withholding.
	<i>permethrin</i> Permethrin 0.25% Dust	3A	Ready-to-use when purchased.		Apply up to 2 oz (5 Tbsp)/animal. Re-treat as needed but not more often than every 14 days.
	<i>tetrachlorvinphos</i> Rabon 3% Dust	1B	Ready-to-use when purchased.		Apply 2 oz of dust/animal. Rub in lightly or apply in suspended self-treatment dust bags. Repeat as needed.
	<i>zeta-cypermethrin</i> Python Dust 0.075%	3A	Ready-to-use when purchased.		Apply with dust bag or shaker.
Feed Additives	<i>diflubenzuron</i> ClariFly 8%	15	Mix according to label instructions.		Feed at rates stipulated based on cattle weights. Prevents development of fly larvae in manure of treated cattle. Prevents emergence of horn flies, face flies, house flies, and stable flies from manure of treated cattle. Start feeding early in the spring before flies appear and continue until cold weather restricts fly activity. Does not affect adult flies. No withdrawal; no milk withholding.
	<i>methoprene</i> Methoprene Altosid 0.02% feed mixture or mineral block IGR	7A	Ready-to-use when purchased.		Animals should consume 0.25-0.5 lb/100 lb body weight each month. Feed this oral insect growth regulator as free choice mineral or mixed in supplements for pasture cattle early in the spring before horn flies appear. May be used in lactating dairy animals.
	Altosid IGR 1% Liquid		Feed-through.		Altosid IGR: Mix in feed to achieve consumption rate of 1.13 mg/100 lb animal body weight/day.

**DAIRY CATTLE EXTERNAL PARASITE AND CATTLE GRUB CONTROL**

**HORN FLIES**

<b>WAYS TO APPLY INSECTICIDES</b>	<b>INSECTICIDE</b>	<b>MOA</b>	<b>MIXING INSTRUCTIONS</b>	<b>WITHDRAWAL TIME</b>	<b>APPLICATION INSTRUCTIONS AND RESTRICTIONS</b>
Feed Additives ( <i>continued</i> )	<i>tetrachlorvinphos</i> Rabon Oral Larvicide Feed Mixture	1B	Mix Rabon 7.76% Oral Larvicide Pre-mix in feed or mineral mixes. It is also available in ready-to-use products.		Feed the appropriate larvicidal feed or mineral mix to milking cows to prevent the development of fly larvae in manure. Follow manufacturers' instructions to ensure adequate amounts are consumed.
Dust Bags (Self-Treatment)	<i>coumaphos</i> 1% Co-Ral Livestock Dust, ProZap Zipicide Dust	1B	Ready-to-use when purchased.		Place contents in dust bag and suspend in area frequented by cattle to force daily use. For lactating dairy cattle, bags may be suspended in the exit through which cattle leave the milking barn. Suspend so that the bottom of the bag will hang 4-6" below the topline of the cattle. No milk withholding.
	<i>permethrin</i> Permethrin 0.25% Dust	3A	Ready-to-use when purchased.		Apply 4-10 lb in self-treatment cotton cloth, doubled burlap bags, or commercial dust bags. Suspend where animals will treat themselves daily, such as near mineral stations, salt blocks or in milking barn exit. Bags should hang 4-6" below topline of cattle. Protect bags from weather. Do not hang bags over feed, mineral, or water troughs.
	<i>tetrachlorvinphos</i> Rabon 3% Dust	1B	Ready-to-use when purchased.		Apply 2 oz of dust/animal. Rub in lightly or apply in suspended self-treatment dust bags. Repeat as needed.
Backrubbers and Facerubbers	<i>coumaphos</i> Co-Ral Fly and Tick Spray 6.15%	1B	Mix 4 qt in 13 gal oil.		Saturate the backrubber with mixture. Place in location to force daily use. Suspend at height to prevent straddling. No milk withholding.
	<i>permethrin</i> Synergized DeLice 1% solution	3A			Back rubber use: Keep rubbing device charged. Results improved by daily forced use.
	<i>Permethrin</i> 10% PY, ME		Mix 1 pt in 10 gal diesel oil		Keep rubbing device charged with 1 gal mixture/20 ft of cable. Cattle should be forced to use rubbing device daily.
	<i>tetrachlorvinphos</i> 23% + <i>dichlorvos</i> 5.3% Ravap E.C.	1B	Mix 1 gal in 25 gal oil Restricted Use Pesticide		Can be used on lactating dairy cattle with no withholding. Dilute according to label instructions. Pour 1 gal/20 linear ft of backrubber. Recharge as needed.
Ear Tags	<i>beta-cyfluthrin</i> Cylence Ultra	3A	Ready-to-use when purchased.		Follow label instructions regarding number of tags/head; remove when effectiveness is diminished and at end of season. Can be used on lactating dairy animals.
	<i>diazinon</i> Cattle ear tags Optimizer, Patriot	1B	Ready-to-use when purchased.		Follow label instructions regarding number of tags/head; remove when effectiveness is diminished and at end of season. Beef and non-lactating animals only.
	<i>permethrin</i> GardStar Plus	3A	Ready-to-use when purchased.		Follow label instructions regarding number of tags/head; remove when effectiveness is diminished and at end of season. Can be used on lactating dairy animals
	<i>zeta-cypermethrin</i> PYthon, PYthon Magnum Zeta Gard	3A	Ready-to-use when purchased.		Follow label instructions regarding number of tags/head; remove when effectiveness is diminished and at end of season. Can be used on lactating dairy animals.

**DAIRY CATTLE EXTERNAL PARASITE AND CATTLE GRUB CONTROL**

**HORN FLIES**

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS
Pour-On	<i>doramectin</i> Dectomax Pour-on 0.5%	6	Ready-to-use when purchased.	45 D	Apply 1 ml/22 lb body wt along midline of back between withers and tailhead. Safe for all beef cattle and replacement dairy heifers to 20 months of age. Applications of macrocyclic lactones will also control blood sucking lice (nymphs and adults). Lice eggs may hatch or untreated cattle may serve as source of reinfestation, requiring re-treatment.
	<i>eprinomectin</i> Eprinex Pour-on 0.5%	6	Ready-to-use when purchased.		Apply 1 ml/22 lb body wt along midline of the back between withers and tailback. Safe for all beef and dairy (including lactating) cattle. Applications of macrocyclic lactones will also control blood sucking lice (nymphs and adults). Lice eggs may hatch or untreated cattle may serve as source of reinfestation, requiring re-treatment.
	<i>moxidectin</i> Cydectin Pour-on 0.5%	6	Ready-to-use when purchased.		Pour weight-determined dose evenly along animal's backline from withers to tailhead (basing dose on label weight table). Provides 7 days of activity against horn flies. No pre-slaughter or milk discard interval. Applications of macrocyclic lactones will also control blood sucking lice (nymphs and adults). Lice eggs may hatch or untreated cattle may serve as source of reinfestation, requiring re-treatment.
	<i>permethrin</i> Synergized DeLice 1% solution	3A	Ready-to-use when purchased.		Apply 0.5 fl oz (15 cc)/100 lb body weight of animal up to a maximum of 5 fl oz for any 1 animal. Pour-On: Pour correct dose a long back and down face. Repeat pour-on treatments as needed, but not more than once every 14 days.
Ultra Boss 5%	Apply 3 ml/100 lb body weight up to a maximum of 30 ml/animal. Pour along back and down face.				

**HORSE FLIES**

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS
Sprays	<i>dichlorvos</i> Prozap Beef and Dairy RTU	1B	Apply 1-2 oz/animal. Ready-to-use when purchased.		Apply no more than 2 fl oz daily as a light mist-spray to cover all body parts, especially head, back, legs and sides. Do not wet skin, only hair of animal. Do not apply to animals less than 6 months old.
	<i>permethrin</i> Synergized DeLice 1.0% solution	3A	Ready-to-use when purchased.		Apply 0.5 fl oz (15 cc)/100 lb body weight of animal up to a maximum of 5 fl oz for any 1 animal. Ready-to-use spray: Use undiluted in a mist-sprayer to apply correct dose. Apply directly to neck, face, back, legs, and ears. Repeat spray and pour-on treatments as needed, but not more than once every 14 days.
	Permethrin CDS 7.4% <i>Permethrin</i>		Ready-to-use for spot treatment or premise spray.		Can be used as spot treatment on cattle or as premise spray.



**DAIRY CATTLE EXTERNAL PARASITE AND CATTLE GRUB CONTROL**

**HORSE FLIES**

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS
Sprays (continued)	<i>permethrin + synergist piperonyl butoxide</i>  Oil Solution or EC Spray permethrin 0.05-0.1% + synergist 0.5-1% permethrin 0.075% + synergist 0.75%	3A	Oil Solution is ready-to-use when purchased. EC spray, mix according to label instructions.		Apply 1-2 fl oz as a fine mist-spray daily to all body parts, especially head and neck, with hand or automatic sprayer. Do not wet skin.
	EC Spray permethrin 0.025% + synergist 0.25% permethrin 0.05% + synergist 0.5% permethrin 0.1% + synergist 1%		Mix according to label instructions.		Apply thoroughly as wetting spray. Repeat after 2-3 weeks if needed. Apply 1-2 qt as wet spray every 3-7 days if needed. Apply 1-2 qt as a wet spray every 2-3 days or apply 1-2 fl oz as a light mist-spray daily with hand or automatic sprayer.
Backrubbers and Facerubbers	<i>permethrin</i> Synergized DeLice 1.0% solution	3A	Ready-to-use when purchased.		Back rubber use: Mix 1 pt/gal of #2 diesel fuel or mineral oil. Keep rubbing device charged. Results improved by daily forced use.
	Permethrin 1% Backrubber and Facerubber Oil Mixture		Mix 1 pt/gal #2 diesel or mineral oil.		Keep rubbing device charged with 1 gal mixture/20 ft of cable. Cattle should be forced to use rubbing device daily.

**HOUSE FLIES**

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS
Sprays	<i>dichlorvos</i> Prozap Beef and Dairy RTU	1B	Apply 1-2 oz/animal.		Apply no more than 2 fl oz daily as a light mist-spray to cover all body parts, especially head, back, legs and sides. Do not wet skin, only hair of animal. Do not apply to animals less than 6 months old.
	<i>permethrin</i> Synergized DeLice 1% solution	3A	Ready-to-use when purchased.		Ready-to-use spray: Use undiluted in a mist-sprayer to apply correct dose. Apply directly to neck, face, back, legs and ears. Repeat spray and pour-on treatments as needed, but not more than once every 14 days.
	Permethrin CDS 7.4% <i>Permethrin</i>		Ready-to-use for spot treatment or premise spray		Can be used as spot treatment on cattle or as premise spray.
		pyrethrins + synergist piperonyl butoxide  Oil Solution or EC Spray pyrethrins 0.05-0.1% + synergist 0.5-1% pyrethrins 0.075% + synergist 0.75%	3A	Oil Solution is Ready-to-use when purchased. EC spray, mix according to label instructions.	
EC Spray pyrethrins 0.025% + synergist 0.25% pyrethrins 0.05% + synergist 0.5% pyrethrins 0.1% + synergist 1%		Mix according to label instructions.		Apply thoroughly as wetting spray. Repeat after 2-3 weeks if needed. Apply 1-2 qt as wet spray every 3-7 days if needed. Apply 1-2 qt as a wet spray every 2-3 days or apply 1-2 fl oz as a light mist-spray daily with hand or automatic sprayer.	

**DAIRY CATTLE EXTERNAL PARASITE AND CATTLE GRUB CONTROL**

**HOUSE FLIES**

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS
Sprays	<i>tetrachlorvinphos</i> + <i>dichlorvos</i> Ravap E.C. Livestock, Poultry & Premise Insecticide Spray	1B	1 gal in 200 gal water for lactating dairy cattle. Restricted Use Pesticide		Can be used on lactating dairy cattle, with no withholding. Dilute according to label instructions.
Feed Additives	<i>diflubenzuron</i> ClariFly 8%	15	Mix according to label instructions.		Feed at rates stipulated based on cattle weights. Prevents development of fly larvae in manure of treated cattle. Prevents emergence of horn flies, face flies, house flies, and stable flies from manure of treated cattle. Start feeding early in the spring before flies appear and continue until cold weather restricts fly activity. Does not affect adult flies. No withdrawal; no milk withholding.
	<i>tetrachlorvinphos</i> Rabon Oral Larvicide Feed Mixture	1B	Mix Rabon 7.76% Oral Larvicide Pre-mix in feed or mineral mixes. It is also available in ready-to-use products.		Feed the appropriate larvicidal feed or mineral mix to milking cows to prevent the development of fly larvae in manure. Follow manufacturers' instructions to ensure adequate amounts are consumed.
Backrubbers and Facerubbers	<i>permethrin</i> Synergized DeLice 1% solution	3A	Ready-to-use when purchased.		Back rubber use: Mix 1 pint/gal of #2 diesel fuel or mineral oil. Keep rubbing device charged. Results improved by daily forced use.
	----- Permethrin 10%		Mix 1 pt in 10 gal diesel oil.		Keep rubbing device charged with 1 gal mixture/20 ft of cable. Cattle should be forced to use rubbing device daily.
Ear Tags	<i>zeta-cypermethrin</i> PYthon Magnum Insecticide Cattle Ear Tag	3A	Ready-to-use when purchased.		Apply 1 tag/head to the front or back of 1 ear on each animal to control most strains of horn flies and to aid in the control of face flies, stable flies, and house flies for up to 4 months.

**MOSQUITOES**

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS
Sprays	<i>dichlorvos</i> Prozap Beef and Dairy RTU	1B	Apply 1-2 oz/animal.		Apply no more than 2 fl oz daily as a light mist-spray to cover all body parts, especially head, back, legs, and sides. Do not wet skin, only hair of animal. Do not apply to animals less than 6 months old.
	Vapona Insecticide Dairy Cattle Spray		Ready-to-use when purchased.		
	<i>permethrin</i> Synergized DeLice 1% solution	3A	Ready-to-use when purchased.		
	----- Permethrin CDS 7.4% <i>Permethrin</i>		Ready-to-use for spot treatment or premise spray.		
	<i>permethrin</i> + synergist piperonyl butoxide Oil Solution or EC Spray <i>permethrin</i> 0.05-0.1% + synergist 0.5-1% <i>permethrin</i> 0.075% + synergist 0.75%	3A	Oil Solution is ready-to-use when purchased. EC spray, mix according to label instructions.		Apply 1-2 fl oz as a fine mist-spray daily to all body parts, especially head and neck, with hand or automatic sprayer. Do not wet skin.

**DAIRY CATTLE EXTERNAL PARASITE AND CATTLE GRUB CONTROL**

**MOSQUITOES**

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS
Sprays (continued)	EC Spray permethrin 0.025% + synergist 0.25% permethrin 0.05% + synergist 0.5% permethrin 0.1% + synergist 1%	3A	Mix according to label instructions.		Apply thoroughly as wetting spray. Repeat after 2-3 weeks if needed. Apply 1-2 qt as wet spray every 3-7 days if needed. Apply 1-2 qt as a wet spray every 2-3 days or apply 1-2 fl oz as a light mist-spray daily with hand or automatic sprayer.
	tetrachlorvinphos + dichlorvos Ravap E.C. Livestock, Poultry & Premise Insecticide Spray	1B	1 gal in 200 gal water for lactating dairy cattle. Restricted Use Pesticide		Can be used on lactating dairy cattle, with no withholding. Dilute according to label instructions.
Dusts	permethrin Permethrin 0.25% Dust	3A	Ready-to-use when purchased.		Apply up to 2 oz (5 Tbsp)/animal. For lice, a second treatment may be needed 14-21 days later. Re-treat as needed but not more often than every 14 days.
Dust Bags (Self- Treatment)	permethrin Permethrin 0.25% Dust	3A	Ready-to-use when purchased.		Apply 4-10 lb in self-treatment cotton cloth, doubled burlap bags or commercial dust bags. Suspend where animals will treat themselves daily, such as near mineral stations, salt blocks or in milking barn exit. Bags should hang 4-6" below topline of cattle. Protect bags from weather. Do not hang bags over feed, mineral or water troughs.
Backrubbers and Facerubbers	permethrin Synergized DeLice 1% solution	3A	Ready-to-use when purchased.		Back rubber use: Mix 1 pt/gal of #2 diesel fuel or mineral oil. Keep rubbing device charged. Results improved by daily forced use.
	Permethylin 10%		Mix 1 pt 10 gal diesel oil.		Keep rubbing device charged with 1 gal mixture/20 ft of cable. Cattle should be forced to use rubbing device daily.
	tetrachlorvinphos + dichlorvos Ravap E.C. Livestock, Poultry & Premise Insecticide Spray	1B	Diluted in oil for backrubber. Restricted Use Pesticide		Can be used on lactating dairy cattle, with no withholding. Dilute according to label instructions.
Pour-On	permethrin Synergized DeLice 1% solution	3A	Ready-to-use when purchased.		Apply 0.5 fl oz (15 cc)/100 lb body weight of animal up to a maximum of 5 fl oz for any 1 animal. Pour-On: Pour correct dose along back and down face. Repeat pour-on treatments as needed, but not more than once every 14 days.

**MITES (Chorioptic)**

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS
Pour-On	doramectin Dectomax 0.5%	6	Ready-to-use when purchased.		Apply 1 ml/22 lb body wt along midline of back between withers and tailhead. Safe for all beef cattle, and replacement dairy heifers to 20 months of age.
	eprinomectin Eprinex 0.5%	6	Ready-to-use when purchased.		Apply 1 ml/22 lb body wt along midline of the back between withers and tailback. Safe for all beef and dairy (including lactating) cattle.
	ivermectin Ivomec 0.5%	6	Ready-to-use when purchased.		Apply 1 ml/22 lb body wt, along midline of the back between withers and tailhead. Safe for all beef cattle; cattle must not be treated within 48 days of slaughter for human consumption. Do not use in female dairy cattle of breeding age.
	moxidectin Cydectin 0.5%	6	Ready-to-use when purchased.		Pour weight-determined dose evenly along animal's backline from withers to tailhead (basing dose on label weight table). No pre-slaughter or milk discard interval.

DAIRY CATTLE EXTERNAL PARASITE AND CATTLE GRUB CONTROL

STABLE FLIES

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS
Sprays	<i>dichlorvos</i> Prozap Beef and Dairy RTU	1B	Apply 1-2 oz/animal.		Apply no more than 2 fl oz daily as a light mist-spray to cover all body parts, especially head, back, legs, and sides. Do not wet skin, only hair of animal. Do not apply to animals less than 6 months old.
	Vapona Insecticide Dairy Cattle Spray		Ready-to-use when purchased.		Apply no more than 2 fl ozs daily as a light mist-spray to cover all body parts, especially head, back, legs, and sides. Do not wet skin, only hair of animal. Do not apply to animals less than 6 months old.
	<i>permethrin</i> Synergized DeLice 1% solution	3A	Ready-to-use when purchased.		Use undiluted in a mist-sprayer to apply correct dose. Apply directly to neck, face, back, legs, and ears. Repeat spray treatments as needed, but not more than once every 14 days.
	EC Spray 11%		Mix 1 pt 11% EC in 25 gal water.		Apply 1-2 qt diluted spray thoroughly/animal as a high pressure spray. Re-treat as needed but no more than once every 14 days.
	Permethrin CDS 7.4% Permethrin		Ready-to-use for spot treatment or premise spray.		Can be used as spot treatment on cattle or as premise spray.
	<i>permethrin + synergist piperonyl butoxide</i> Oil Solution or EC Spray permethrin 0.05-0.1% + synergist 0.5-1% permethrin 0.075% + synergist 0.75%	3A	Oil Solution is ready-to-use when purchased. EC spray, mix according to label instructions.		Apply 1-2 fl oz as a fine mist-spray daily to all body parts, especially head and neck, with hand or automatic sprayer. Do not wet skin.
	EC Spray permethrin 0.025% + synergist 0.25% permethrin 0.05% + synergist 0.5% permethrin 0.1% + synergist 1%		Mix according to label instructions.		Apply thoroughly as wetting spray. Repeat after 2-3 weeks if needed. Apply 1-2 qt as wet spray every 3-7 days if needed. Apply 1-2 qt as a wet spray every 2-3 days or apply 1-2 fl oz as a light mist-spray daily with hand or automatic sprayer.
<i>tetrachlorvinphos + dichlorvos</i> Ravap E.C. Livestock, Poultry & Premise Insecticide Spray	1B	1 gal in 200 gal water for lactating dairy Restricted Use Pesticide		Can be used on lactating dairy cattle, with no withholding. Dilute according to label instructions.	
Dusts	<i>zeta-cypermethrin</i> PYthon Dust 0.075%	3A	Ready-to-use when purchased.		Apply with dust bag or shaker.
Feed Additives	<i>tetrachlorvinphos</i> Rabon Oral Larvicide Feed Mixture	1B	Mix Rabon 7.76% Oral Larvicide Pre-mix in feed or mineral mixes. It is also available in ready-to-use products.		Feed the appropriate larvicidal feed or mineral mix to milking cows to prevent the development of fly larvae in manure. Follow manufacturers' instructions to ensure adequate amounts are consumed.
Dust Bags (Self- Treatment)	<i>zeta-cypermethrin</i> PYthon Dust 0.075%	3A	Ready-to-use when purchased.		Apply with dust bag or shaker.

DAIRY CATTLE EXTERNAL PARASITE AND CATTLE GRUB CONTROL

STABLE FLIES

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS
Backrubbers and Facerubbers	<i>permethrin</i> Synergized DeLice 1% solution	3A	Ready-to-use when purchased.		Back rubber use: Mix 1 pt/gal of #2 diesel fuel or mineral oil. Keep rubbing device charged. Results improved by daily forced use.
	<i>permethrin</i> 10% PY, ME		Mix 1 pt in 10 gal diesel oil.		Keep rubbing device charged with 1 gal mixture/20 ft of cable. Cattle should be forced to use rubbing device daily.
Ear Tags	<i>beta-cyfluthrin</i> Cylence Ultra	3A	Ready-to-use when purchased.		Follow label instructions regarding number of tags/head; remove when effectiveness is diminished and at end of season. Can be used on lactating dairy animals.
	<i>permethrin</i> GardStar Plus				
	<i>zeta-cypermethrin</i> PYthon, PYthon Magnum				

TICKS

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS
Sprays	<i>coumaphos</i> Coumaphos Co-Ral 11.6%	1B	Mix 2.5 fl oz/4 gal water.		Mix 1.25 fl oz/4 gal water and spray to complete wetting. Make treatments no fewer than 10 days apart.
	<i>permethrin</i> EC Spray 0.05%	3A	Mix 1 qt 5.7% EC in 25 gal water.		Apply 1-2 qt diluted spray thoroughly/animal as a high pressure spray. Re-treat as needed but no more than once every 14 days.
	Permethrin CDS 7.4%		Mix 1 qt in 25 gal water.		1-2 qt of coarse spray/animal over whole body surface. Thoroughly wet animal.
	<i>tetrachlorvinphos</i> 23% + <i>dichlorvos</i> 5.3% Ravap E.C.	1B	Dilute 2 oz in 3 gal Direct spray to cover thoroughly with up to 0.5 gal/animal.  Restricted Use Pesticide		Repeat as necessary. No milk discard is required. Apply at least 20 minutes prior to milking or spray after milking has been completed.

DAIRY CATTLE EXTERNAL PARASITE AND CATTLE GRUB CONTROL

TICKS

WAYS TO APPLY INSECTICIDES	INSECTICIDE	MOA	MIXING INSTRUCTIONS	WITHDRAWAL TIME	APPLICATION INSTRUCTIONS AND RESTRICTIONS
Dusts	<i>coumaphos</i> Co-Ral Livestock Dust, ProZap Zipcide Dust 1%	1B	Ready-to-use when purchased.		Using shaker can, apply no more than 1 oz/animal as a uniform coat to the head, shoulders, and back. Treat no more than 6 times/year. Wait 10 days between applications. No milk withholding.
	<i>zeta-cypermethrin</i> PYthon Dust 0.075% <i>zeta-cypermethrin</i>	3A	Ready-to-use when purchased.		Apply with dust bag or shaker.
Dust Bags Self-Treatment	<i>zeta-cypermethrin</i> PYthon Dust 0.075%	3A	Ready-to-use when purchased.		Apply with dust bag or shaker.
Backrubber and Facerubbers	<i>coumaphos</i> 6.15% Co-Ral Fly and Tick Spray	1B	Mix 4 qt in 13 gal oil.		Saturate the backrubber with mixture. Place in location to force daily use. Suspend at height to prevent straddling. No milk with holding.
	<i>tetrachlorvinphos</i> 23% + <i>dichlorvos</i> 5.3% Ravap E.C.	1B	Mix 1 gal in 25 gal oil. Restricted Use Pesticide		Can be used on lactating dairy cattle with no withholding. Dilute according to label instructions. Pour 1 gal/20 linear feet of backrubber. Recharge as needed.
Ear Tags	<i>beta-cyfluthrin</i> Cylence Ultra	3A	Ready-to-use when purchased.		Follow label instructions regarding number of tags/head; remove when effectiveness is diminished and at end of season. Can be used on lactating dairy animals.
	<i>permethrin</i> GardStar Plus		Ready-to-use when purchased.		
	<i>zeta-cypermethrin</i> PYthon, PYthon Magnum		Ready-to-use when purchased.		
Pour-On	<i>permethrin</i> Synergized DeLice 1.0% solution	3A	Ready-to-use when purchased.		Apply 0.5 fl oz (15 cc)/100 lb body weight of animal up to a maximum of 5 fl oz for any 1 animal.  Pour-On: Pour correct dose along back and down face. Repeat pour-on treatments as needed, but not more than once every 14 days.

## CATTLE EAR TAGS

Nancy C. Hinkle, Veterinary Entomologist

Annie Rich, Graduate Student

TAG NAME	ACTIVE INGREDIENT	CHEMICAL CLASS	BEEF	LACTATING DAIRY
Co-Ral Plus	<i>Diazinon + Coumaphos</i>	Organophosphate	YES	NO
Corathon	<i>Coumaphos+Diazinon</i>	Organophosphate	YES	YES
CyGuard	<i>Beta-cyfluthrin</i>	Pyrethroid	YES	YES
Cylence Ultra	<i>Beta-cyfluthrin</i>	Pyrethroid	YES	YES
Dominator	<i>Pirimiphos methyl</i>	Organophosphate	YES	NO
Double Barrel VP	<i>Lambda-cyhalothrin + Pirimiphosmethyl</i>	Pyrethroid + Organophosphate	YES	NO
GardStar Plus	<i>Permethrin</i>	Pyrethroid	YES	YES
OPTimizer	<i>Diazinon</i>	Organophosphate	YES	NO
Patriot	<i>Diazinon</i>	Organophosphate	YES	NO
PYthon	<i>Zeta-cypermethrin</i>	Pyrethroid	YES	YES
PYthon Magnum	<i>Zeta-cypermethrin</i>	Pyrethroid	YES	YES
Saber Extra	<i>Lambda-cyhalothrin</i>	Pyrethroid	YES	NO
Warrior	<i>Diazinon + Chlorpyrifos</i>	Organophosphate	YES	NO
XP820	<i>Abamectin</i>	Macrocyclic lactone	YES	NO
X-Terminator	<i>Diazinon</i>	Organophosphate	YES	NO
ZetaGard	<i>Zeta-cypermethrin</i>	Pyrethroid	YES	YES

Ear tags are generally effective against horn flies; they aid in control of face flies, stable flies, house flies, and ear ticks. Remove tags when control declines, at the end of fly season, or before slaughter.

# SWINE: EXTERNAL PARASITE CONTROL<sup>1</sup>

Nancy C. Hinkle, Veterinary Entomologist

## HOG LICE CONTROL<sup>1</sup>

INSECTICIDE	FORMULATION	FINAL STRENGTH IN WATER	MIXING INSTRUCTIONS	AMOUNT PER MATURE ANIMAL	DAYS FROM LAST APPLICATION UNTIL SLAUGHTER	APPLICATION <sup>2,3</sup> INSTRUCTIONS & RESTRICTIONS
<b>SPRAYS<sup>4,5</sup></b>						
<i>coumaphos</i> Co-Ral	6.15%	0.06%	Mix 2 qt/50 gal water (or 5 oz/4 gal water)	Wet to point of runoff. Treat no more than 6 times/year. Do not make applications less than 10 days apart.	0	Do not treat sick, convalescent, or stressed animals. Do not spray animals for 10 days before or after shipping or weaning, or after exposure to contagious or infectious diseases. Do not spray in a confined, non-ventilated area. Do not apply in conjunction with oral drenches or other internal medications, or with pyrethrins or their synergists, or with other organophosphates or cholinesterase inhibiting drugs, pesticides, or chemicals.
Co-Ral Emulsifiable Livestock Insecticide (Restricted Use)	11.6%	0.06%	Mix 1 qt/50 gal water (or 2.5 oz/4 gal water)			
<i>permethrin</i>	42.5% EC	0.108%	Mix 8 oz of 42.5% EC in 25 gal water.	Spray animals thoroughly (approximately 1 pt/animal).	5	Spray entire animal thoroughly. Pay special attention to ears and hard to spray areas. Make a second application 14 days later if needed.
GardStar 40% EC			60-118 ml-25 gal water (treats 50-100).			
Atroban, Ectiban, Gardstar, Permethrin SP, ME	5.7% EC 10% EC 11% EC 40% EC 42.5% EC	0.025- 0.054%	Mix 1 pt of 11% EC OR mix 1 qt of 5.7% EC OR mix 1 cup 10% EC OR mix 60-118 ml of 40% EC OR mix 4 oz of 42.5% EC in 25 gal water.	Wet thoroughly. (approximately 1 pt/animal).		Spray entire animal thoroughly. Pay special attention to ears and hard-to-spray areas. Make a second application 14 days later if needed.
Swine Guard	10%		Ready-to-use.			
<i>phosmet</i> Prolate/Lintox-HD	11.75% EC	0.06%	Mix 1 qt of 11.6% EC in 25 gal water.	Wet to point of runoff. Wet thoroughly to skin.	1	Single application should be effective. Should a second application be needed, it may be made 14 days following the first treatment. Do not treat suckling pigs.
<i>tetrachlorvinphos</i> Rabon	50% WP	0.5%	Mix 4 lb of 50% WP in 50 gal water.	1-2 qt. Wet animal thoroughly.	0	Apply as a coarse spray. Repeat in 2 weeks, if needed.



**SWINE: EXTERNAL PARASITE CONTROL**

**HOG LICE CONTROL<sup>1</sup>**

<b>INSECTICIDE</b>	<b>FORMULATION</b>	<b>FINAL STRENGTH IN WATER</b>	<b>MIXING INSTRUCTIONS</b>	<b>AMOUNT PER MATURE ANIMAL</b>	<b>DAYS FROM LAST APPLICATION UNTIL SLAUGHTER</b>	<b>APPLICATION<sup>2,3</sup> INSTRUCTIONS &amp; RESTRICTIONS</b>
<b>LARVICIDE SPRAYS</b>						
<i>cyromazine</i> Neporex 2SG			Mix 1 lb/gal of water.			Spray manure where fly larvae are found.
<i>diflubenzuron</i> Dimilin 2L			Mix 5 fl oz in 10 gal water.			Apply as a directed spray in spot treatments at a volume of 1 qt of spray solution to 10 sq ft of surface area where maggots are developing.
<i>pyriproxyfen</i> Archer Nylar Insect Growth Regulator 1.3%			Mix 1 fl oz in 1 gal water.			Wet surfaces where larvae are found; may repeat 14 days afterward.
NyGuard IGR 10%			Mix 4 ml in sufficient water to cover 1500 sq ft.			Apply to maggot habitats at rate of 4 ml/1,500 sq ft.
Pyri-Shield EC 1.3%			Mix 1 fl oz in 1 gal water.			Apply to 1500 sq ft of surface area.
<b>DIPS<sup>5</sup></b>						
<i>permethrin</i>	40% EC	0.025-0.05%	Mix 60-118 ml in 25 gal water.	Immerse entire animal.	5	Dip animals including ears. Spray pen floors, sides, and bedding. Repeat at 14 days.
<b>DUSTS<sup>5</sup></b>						
<i>permethrin</i> Ectiban Insectrin	0.25% D	Ready-to-use	No mixing required.	Dust thoroughly.	5	Apply up to 1 oz (2 1/2 Tbsp)/animal. Pay particular attention to ears and other hard-to-reach areas. Re-treat 14 days later if needed.
<i>coumaphos</i> Co-Ral 11.6%						Do not treat sick, convalescent, or stressed animals. Do not spray animals for 10 days before or after shipping or weaning, or after exposure to contagious or infectious diseases. Do not spray in a confined, non-ventilated area. Do not apply in conjunction with oral drenches or other internal medications, or with pyrethrins or their synergists, or with other organophosphates or cholinesterase inhibiting drugs, pesticides, or chemicals.
<i>phosmet</i> Prolate	1% D	Ready-to-use	No mixing required.	Dust thoroughly. Apply 0.5-1 oz of dust/animal to backline and lightly rub in. Repeat in 10-14 days or as needed.	1	Dust animals thoroughly. Do not treat sick, convalescent, or stressed animals. Do not spray animals for 10 days before or after shipping or weaning, or after exposure to contagious or infectious diseases. Do not spray in a confined, non-ventilated area. Do not apply in conjunction with oral drenches or other internal medications.

**SWINE: EXTERNAL PARASITE CONTROL**

**HOG LICE CONTROL<sup>1</sup>**

INSECTICIDE	FORMULATION	FINAL STRENGTH IN WATER	MIXING INSTRUCTIONS	AMOUNT PER MATURE ANIMAL	DAYS FROM LAST APPLICATION UNTIL SLAUGHTER	APPLICATION <sup>2,3</sup> INSTRUCTIONS & RESTRICTIONS
<b>INJECTABLE<sup>5</sup></b>						
<i>doramectin</i> Decto Max injectable	1%		Ready-to-use when purchased.	Inject 1 ml/75 lb	24	Intramuscular injection.
<i>ivermectin</i> Ivomec	1%	Ready-to-use when purchased.	No mixing required	1 ml/75 lb body weight. (300 mcg of <i>ivermectin</i> /kilogram of body weight)	18	Inject subcutaneously. Follow label instructions.

**CONTROL OF HOG MANGE MITES**

INSECTICIDE	FORMULATION	FINAL STRENGTH IN WATER	MIXING INSTRUCTIONS	AMOUNT PER MATURE ANIMAL	DAYS FROM LAST APPLICATION UNTIL SLAUGHTER	APPLICATION <sup>2,3</sup> INSTRUCTIONS & RESTRICTIONS
<b>POUR-ON<sup>5</sup></b>						
<i>permethrin</i> 10% pour on	To control mange mites, lice and fleas. Apply 3 ml/100 lb body weight.					
<i>phosmet</i> Prolate	1% D	Ready-to-use when purchased.	No mixing required.	Dust thoroughly. Apply 0.5-1 oz of dust/animal to backline and lightly rub in. Repeat in 10-14 days or as needed.	1	Dust animals thoroughly. Do not treat sick, convalescent, or stressed animals. Do not spray animals for 10 days before or after shipping or weaning, or after exposure to contagious or infectious diseases. Do not spray in a confined, non-ventilated area. Do not apply in conjunction with oral drenches or other internal medications.

**CONTROL OF BLOWFLIES, MOSQUITOES, FLEAS AND TICKS<sup>4,5</sup>**

INSECTICIDE	FORMULATION	FINAL STRENGTH IN WATER	MIXING INSTRUCTIONS	AMOUNT PER MATURE ANIMAL	DAYS FROM LAST APPLICATION UNTIL SLAUGHTER	APPLICATION <sup>2,3</sup> INSTRUCTIONS & RESTRICTIONS
<i>permethrin</i> Permethrin II	10% EC	0.025%	Mix 1 qt of 10% EC in 25 gal of water.	Spray, paint or dip to apply 1 pt/hog, especially around ears.	5	

**SWINE: EXTERNAL PARASITE CONTROL**

**CONTROL OF TICKS<sup>4,5</sup>**

<b>INSECTICIDE</b>	<b>FORMULATION</b>	<b>FINAL STRENGTH IN WATER</b>	<b>MIXING INSTRUCTIONS</b>	<b>AMOUNT PER MATURE ANIMAL</b>	<b>DAYS FROM LAST APPLICATION UNTIL SLAUGHTER</b>	<b>APPLICATION<sup>2,3</sup> INSTRUCTIONS &amp; RESTRICTIONS</b>
<i>coumaphos</i> Co-Ral	6.15%	0.06%	Mix 2 qt/50 gal water (or 5 oz/4 gal water).	Wet to point of runoff. Treat no more than 6 times/year. Do not make applications less than 10 days apart.	0	Do not treat sick, convalescent, or stressed animals. Do not spray animals for 10 days before or after shipping or weaning, or after exposure to contagious or infectious diseases. Do not spray in a confined, non-ventilated area. Do not apply in conjunction with oral drenches or other internal medications, or with pyrethrins or their synergists, or with other organophosphates or cholinesterase inhibiting drugs, pesticides, or chemicals.
Emulsifiable Livestock Insecticide	11.6%		Mix 1 qt/50 gal water (or 2.5 oz/4 gal water)			
Co-Ral	25% WP	0.24%	Mix 8 lb of 25% WP in 100 gal of water.	Thoroughly treat wound and surrounding area with light but thorough coverage.		Do not treat sick, convalescent, or stressed animals. Do not spray animals for 10 days before or after shipping or weaning, or after exposure to contagious or infectious diseases. Do not spray in a confined, non-ventilated area. Do not apply in conjunction with oral drenches or other internal medications, or with pyrethrins or their synergists, or with other organophosphates or cholinesterase inhibiting drugs, pesticides, or chemicals. Repeat as needed but not more often than every 14 days.
<i>phosmet</i> Prolate	1% D	Ready-to-use when purchased.	No mixing required.	Dust thoroughly. Apply 0.5-1 oz of dust/animal to backline and lightly rub in. Repeat in 10-14 days or as needed.	1	Dust animals thoroughly. Do not treat sick, convalescent, or stressed animals. Do not spray animals for 10 days before or after shipping or weaning, or after exposure to contagious or infectious diseases. Do not spray in a confined, non-ventilated area. Do not apply in conjunction with oral drenches or other internal medications.

- <sup>1</sup> Insecticides recommended for hog lice control will aid in the control of ticks, mange mites, and flies on swine.
- <sup>2</sup> When applying insecticides, do not contaminate feed or drinking water.
- <sup>3</sup> Do not treat animals less than 3 months old with insecticides unless specifically allowed on the insecticide label.
- <sup>4</sup> Limit spray applications in winter to warm, calm days when temperatures are above freezing.
- <sup>5</sup> Do not treat sick, convalescent, or stressed animals.

## HORSES: EXTERNAL PARASITE CONTROL

Nancy C. Hinkle, Veterinary Entomologist

Insecticide preparations that contain a combination of ingredients are available for use on horses. Included in the insecticide preparation may be insecticides, synergists, repellants, and carriers.

EXTERNAL PARASITES	INSECTICIDE <sup>1</sup>	MIXING INSTRUCTIONS	APPLICATION INSTRUCTIONS & USE RESTRICTIONS
<b>Flies:</b> biting midges, black flies, deer flies, face flies, gnats, horn flies, horse flies, lice, mosquitoes, punkies, ticks, wound-infesting larvae (screwworms)	<i>coumaphos</i> Co-Ral 11.6%	Fly control: Mix 2.5 fl oz in 4 gal water and spray to complete wetting.	Do not use on horses intended for slaughter. Apply specified dosage in 4 gallons of water for complete wetting. Repeat as necessary.
	<i>cypermethrin</i> Bite Free, Tri-Tec 14, 0.15%	Fly control: Ready-to-use when purchased.	<b>Mist-spray or wipe-on:</b> Apply mist-spray to horses as needed every 5-14 days. Not for use on horses intended for human consumption.
	<i>permethrin</i> EC Insectrin 5.7%	Fly, mange, tick, and lice control: Mix 1 pt of 5.7 % EC in 12.5 gal of water.  Lice control: Mix 1 pt of 5.7% EC in 25 gal of water.  Fly and ear tick control: Mix 1 pt of 5.7% EC in 1.25 gal of water.	<b>Spray</b> 1-2 qt/animal over whole body surface. For mange, lice, and scabies control, thoroughly soak animal and apply a second treatment 14 days later.  <b>Spray</b> until animal is thoroughly treated. A second application is recommended 14 days later.  <b>Spray mist:</b> Apply 1-2 oz/animal. Spot treat back, face, legs, and ears. Do not use on horses intended for human consumption.
	EC Atroban, Permethrin II 10-11%	Fly and lice control: Mix 1 pt of EC in 25 or 50 gal water (1 oz in 6 qt of water).	<b>Spray:</b> Use high concentrations for stable flies and face flies. Apply directly to animals at 1-2 qt/animal. Light rates are for horn fly control only. Repeat as needed but not more often than once every 2 weeks. Do not contaminate feed or water.
	Buzz Off II, Hard Hitter, 0.4-1% ready-to-use spray or wipe-on	Fly, lice, and tick control: Ready-to-use when purchased. No mixing required.	<b>Spray or wipe-on:</b> Apply as needed. Do not soak hair or skin. Pay particular attention to legs, shoulders and neck. Do not get in animal's eyes. Do not treat horses intended for human consumption.
	Poridon Insecticide Pour-on 1.84%	Aids in fly control: Ready-to-use when purchased. No mixing required.	<b>Pour-on:</b> Apply 2-4 oz/animal. Start by pouring a line from the poll, along the neck, and continue posteriorly down the back parallel with the spinal column or apply as a wipe-on.
	Permethrin 25% WP	Fly, lice, tick, and mite control: Mix 6 oz (21 level Tbsp) of 25% WP in 19 gal water.	<b>Spray:</b> Spray to run off or use 1 gal spray mix/head. Do not spray feed or water.
	GardStar SP, ME 40% EC	Fly, mite, tick, and lice control: Mix 7.5 ml in 1 pt of water (0.64%).  Fly, mite, tick, and lice control: Mix 5-12.5 ml in 2 gal water (0.026-0.067%).	<b>Spray:</b> Apply as a low pressure spray. Apply 1-2 fl oz (30-60 ml) spray/animal. Spot treat back, face, legs, tail, and ears.  <b>Dip wash:</b> Thoroughly wet animal to skin with sponge or rag. Let drip dry. Do not wet the animal's face.
	Brute 10%		<b>Pour-on or wipe:</b> Apply 3-6 ml/200 lb body weight, up to 30 ml max. Do not treat foals under 12 weeks of age.
	Ultra Boss Pour-on 5%	Ready-to-use when purchased.	Apply 3 ml/100 lb body weight of animal up to a maximum of 30 ml/animal. Pour along back and down face. Do not saddle animal for 6 hours after application.
Clean-up Pour-on Insecticide with IGR <i>permethrin</i> 5% + <i>diflubenzuron</i> 5%	Ready-to-use when purchased for fly and lice control.	Ready-to-use for fly and lice control. Follow label directions as wipe-on or undiluted RTU spray.	

## HORSES: EXTERNAL PARASITE CONTROL

EXTERNAL PARASITES	INSECTICIDE <sup>1</sup>	MOA	MIXING INSTRUCTIONS	APPLICATION INSTRUCTIONS & USE RESTRICTIONS
<b>Flies:</b> biting midges, black flies, deer flies, face flies, gnats, horn flies, horse flies, lice, mosquitoes, punkies, ticks, wound-infesting larvae (screwworms)  (continued)	<i>pyrethrins + synergist</i> Spray and wipe-on.	3A	Fly control: 0.05%-0.2% plus synergist mist-spray. Ready-to-use when purchased. No mixing required.	<b>Spray or wipe-on:</b> Apply mist-spray or wipe-on to wet the ends of the hair but not enough to wet the hide (1-4 fl oz/animal). Direct application will kill ticks. Repeat as needed.
	Repel-X EC <i>pyrethrins 0.4% + synergist</i>		Fly and tick control: Mix 1 pt of 0.4% EC in enough water to make 1 gal of mixture. For horse flies, deer flies (Tabanids), stable flies, and ticks, mix 1 pt of 0.4% EC in 2 qt of water.	<b>Spray or sponge-on:</b> Apply heavily to wet animal every 3-4 days or as needed to control flies and ticks. Do not use on animals intended for human consumption. Avoid getting into animal's eyes.
	Swat <i>pyrethrins 0.36% + synergist spray</i>		Fly, lice, tick and flea control: Ready-to-use when purchased. No mixing required.	<b>Spray or wipe-on:</b> Apply to wet hair but not skin of animal. Remove excess dirt and dust before treating. Repeat as needed. Do not treat horses intended for human consumption
	Repel-X <i>pyrethrins 0.05% + synergist 0.5% + permethrin 0.1% to 0.5%</i>			
	Wipe II <i>pyrethrins 0.1% + synergist</i>		Fly, gnat and mosquito control: Ready-to-use when purchased. No mixing required.	<b>Spray or wipe-on:</b> Apply to wet hair but not the skin. Remove excess dirt and dust before treating. Repeat as needed.
	<i>pyrethrins 0.2% + synergist</i> Wipe-on Swat ointment		Fly, gnat and mosquito control: Ready-to-use when purchased. No mixing required.	<b>Wipe-on:</b> Apply as a wipe-on to wet hair but not the skin. Remove excess dust and dirt before treating. Repeat as needed.  <b>Ointment:</b> To treat superficial wounds, abrasions, sores, and scratches, apply enough ointment to cover the wound. Apply directly to the wound and use daily.
	<i>resmethrin 0.5% + butoxypropylene glycol 10.0%</i> Super Shield II	3A	Fly control: Ready-to-use when purchased. No mixing required.	<b>Spray or wipe-on:</b> Apply to wet hair but not the skin of animal. For maximum protection apply 4-6 oz to animal and repeat every 2-3 days if needed. Do not use on horses intended for slaughter.
	<i>resmethrin 0.554% + butoxypropylene glycol 11.0%</i> Fly Repellent	3A	Fly and tick control: Apply by spray or wipe-on. Mix 4 oz of concentrate in 28 oz of water to make 1 qt.	<b>As a wipe-on:</b> Dampen a soft cloth and rub over hair after cleaning debris from animal.  <b>Apply spray</b> mist to horse's coat. Pay particular attention to legs, shoulders, and neck while avoiding eyes. Do not use on horses intended for slaughter.
<i>zeta-cypermethrin</i> PYthon Dust 0.075%	3A	Ready-to-use when purchased.	Can be applied by shaker can, dusting glove, or mechanical dust applicator. Apply up to 2 oz (6 Tbsp) evenly into hair. Repeat as needed, but not more than once every 3 days.	
<b>Flies:</b> face flies, horn flies	<i>tetrachlorvinphos 0.475-2.468%</i> Horse Feed Supplement Rabon, Equitrol, Vita-Plus with Equitrol, Drive with Equitrol	1B	Manure breeding flies: Ready-to-use feed supplement. Each horse must consume 70 mg <i>tetrachlorvinphos</i> /100 lb of body weight daily.	<b>Feed additive:</b> Follow feeding instructions on the label. Each horse must consume sufficient quantities if adequate control is to be achieved. Do not feed to horses intended for slaughter. This product must be supplemented with other fly control products.
	<i>diflubenzuron</i> SimpliFly 0.24%	15	Manure breeding flies: Ready-to-use feed supplement. Each horse must consume 6.8 mg <i>diflubenzuron</i> /100 lb. body weight daily.	<b>Feed additive:</b> Follow feeding instructions on the label. Each horse must consume sufficient quantities if adequate control is to be achieved. Do not feed to horses intended for slaughter. This product must be supplemented with other fly control products.
	Dimilin 2L		Mix 5 fl oz in 10 gal water.	Apply as a directed spray in spot treatments at a volume of 1 qt of spray solution to 10 sq ft of surface area where maggots are developing.

## HORSES: EXTERNAL PARASITE CONTROL

EXTERNAL PARASITES	INSECTICIDE <sup>1</sup>	MOA	MIXING INSTRUCTIONS	APPLICATION INSTRUCTIONS & USE RESTRICTIONS
<b>Flies:</b> face flies, horn flies  (continued)	<i>cyromazine</i> Solitude IGR 2.12%	17	1 scoop 300 mg/horse/day.	<b>Feed additive:</b> Follow feeding instructions on the label. Each horse must consume sufficient quantities if adequate control is to be achieved. Do not feed to horses intended for slaughter.
	Neporex 2SG		Ready-to-use granular.	Scatter 1 lb/200 sq ft to wet areas where maggots develop.
	<i>pyriproxyfen</i> Archer Nylar Insect Growth Regulator 1.3%	7C	Mix 1 fl oz in 1 gal water.	Wet surfaces where larvae are found; may repeat 14 days afterward.
	NyGuard IGR 10%		Mix 4 ml in sufficient water to cover 1,500 sq ft.	Apply to maggot habitats at rate of 4 ml/1,500 sq ft.
	Pyri-Shied EC 1.3%		Mix 1 fl oz in 1 gal water.	Apply to 1,500 sq ft of surface area.
Mange	<i>permethrin</i> Purina Hard Hitter, Stable Spray, Insectrin 5.7% EC	3A	Mix 1 pt of 5.7% EC in 12.5 gal water.	<b>Fly, mange, tick, and lice control:</b> Spray 1-2 qt/animal over whole body surface. For mange, lice, and scabies control, thoroughly soak animal and apply a second treatment 14 days later. No waiting period between application and slaughter.
Bots	<i>ivermectin</i> Eqvalan, Zimectrin	6	1.87% oral paste. Ready-to-use when purchased. No mixing required.	Follow directions on pre-filled syringe. Do not treat horses less than 4 months of age. Do not treat horses intended for food purposes.
	<i>moxidectin</i> 2%	6	Ready-to-use when purchased.	Follow directions on pre-filled syringe. Do not treat horses less than 6 months of age or those intended for food purposes.

## FLY CONTROL IN HORSE FACILITIES: RESIDUAL (CONTACT) SPRAYS<sup>1</sup> AND BAITS

INSECTICIDE	MOA	MIXING INSTRUCTIONS	METHODS OF APPLICATION AND SAFETY REGULATIONS
<i>cyantraniliprole</i> Zyrox Fly Granular bait	28	Ready-to-use when purchased.	Apply in bait station, inaccessible to children, pets, and food animals. Use 2 lb bait/1000 sq ft/yr.
<i>cyfluthrin</i> Countdown 24.3% EC, 20% WP	3A	Mix 9.5 grams or 19 grams of 20% WP OR mix 16 ml of 24.3% EC in sufficient water to cover 1000 sq ft.	Direct as a coarse, wetting spray to surfaces in horse operations where flies congregate, including ceilings, walls, fences, posts and manure. Apply to point of runoff (1 gal/500-1000 sq ft). Do not contaminate feed or drinking water. Do not apply as a space spray. Do not apply directly to animals. Repeat as needed. For baited solutions add 1 lb of sugar/gal of spray. Remove animals before spraying and return them when spray dries.
<i>beta-cyfluthrin</i> Tempo 11.8% SC, 24.3% EC, 20% WP	3A	Mix 8-16 milliliters of 11.8% Tempo SC Ultra Premise Spray in sufficient water to cover 1000 sq ft.	
<i>deltamethrin</i> Annihilator Insecticide Premise Spray 0.02%	3A	Ready-to-use when purchased.	Apply thoroughly to surfaces until wet. Repeat as necessary, but not more than once/week. Do not spray animals or humans, or apply to animal feed or watering equipment.
<i>gamma-cyhalothrin</i> StandGuard 5.9%	3A	Mix 0.16 fl oz (5 ml)/gal of water.	Spray 1 gal of diluted spray to treat 500-1000 sq ft of fly resting surfaces.
<i>imidacloprid</i> QuickBayt Spot Spray 10%	4A	Mixed at the rate of 1 lb/gal water to treat 1000 sq ft of fly resting areas.	Product can be sprayed on virtually any surface (out of reach of animals) where flies rest or congregate, indoors, or outdoors. Examples include posts, beams, ceilings, railings, door frames, windows, and stable walls. Residual activity of up to 6 weeks indoors and 2 weeks outdoors.
<i>lambda-cyhalothrin</i> Grenade ER Insecticide 9.7% Demand CS 9.7%	3A	Mix 0.2-0.4 oz (6-12 ml)/gal water.	Make a directed application to fly-resting surfaces and allow to dry before reintroduction of animals. Do not apply when animals are present
<i>permethrin</i> Atroban Ectiban Insectrin Overkill Permethrin 5.7% EC, 11% EC or 25% WP	3A	5.7% EC is ready-to-use as a mist-spray OR mix 1 qt 5.7% EC in 12.5 gal of water OR mix 6 oz 25% WP in 11 gal of water OR mix 1 pt 11% EC in 10 gal water.	Apply as a residual surface spray to fly resting areas. Do not spray manure or litter. Do not apply directly to horses. Apply 5.7% EC un diluted at 4 oz/1000 sq ft of surface area or apply diluted WP and EC mixtures at 1 gal/750 sq ft. Do not apply more often than once every 2 weeks.
<i>tetrachlorvinphos</i> Rabon 2 lb ai/gal 23% + dichlorvos Vapona 0.5 lb ai/gal  Ravap 5.7% EC3A	1B	1.25-2.5% spray.  Mix 1 gal or 2 gal EC in 25 gal.	Direct a coarse, wetting spray to surfaces when flies congregate, to include ceilings, walls, fences, posts, and floor. Apply to point of runoff (1 gal/500-1000 sq ft) Do not contaminate feed or drinking water. Do not apply as a space spray. Repeat as permitted by label. Do not apply directly to animals. Remove animals before spraying and return them after spray dries.

<sup>1</sup> Residual sprays can be applied as spot sprays to control maggots in manure accumulations.

## FLY CONTROL IN HORSE FACILITIES: RESIDUAL (CONTACT) SPRAYS<sup>1</sup> AND BAITS<sup>1</sup>

INSECTICIDE	MOA	MIXING INSTRUCTION	METHODS OF APPLICATION AND SAFETY REGULATIONS
<b>SPACE SPRAYS<sup>1</sup>; FOGS OR MISTS</b>			
<i>esfenvalerate</i> 35% Endure 35WP	3A	Mix 1 or 2 scoops with 1 gal water and spray 1 gal/1000 sq ft	Do not apply when feed is present.
<i>permethrin</i> 5.7% EC	3A	Mix 1 pt 5.7% EC in 6.25 gal diesel or mineral oil	Apply fog at 4 fl oz/1000 cu ft of air space in confined facility. Repeat as needed.
<i>permethrin</i> 0.5% + <i>tetramethrin</i> 0.2% Indoor Fogger	3A	Ready-to-use when purchased.	Remove animals from area. Turn off all ignition sources (flames, pilot lights, etc). 1 fogger treats 6000 cu ft.
<i>pyrethrins</i> 0.1-0.75% + <i>synergist</i> 0.5-3.75%	3A	Ready-to-use when purchased.	Apply fogs or spray mists at 1 fl oz/1000 cu ft as fine atomized spray. Repeat as needed.
<i>spinosad</i> 44.2% Elector PSP	5	Mix 2 fl oz (60 ml) in 10 gal water to treat 5000-10000 sq ft. Use sufficient water in a directed spray to contact flies and their resting surfaces.	
<b>BAITS</b>			
<i>cyantraniliprole</i> Zyrox Fly Granular bait	28	Ready-to-use when purchased.	Apply in bait station, inaccessible to children, pets, and food animals. Use 2 lb bait/1000 sq ft/year.
<i>dinotefuran</i> QuickStrike Scatter Bait 0.5%	4A	Ready-to-use when purchased.	Use as a scatter bait outdoors around animal agricultural facilities; do not place in areas where bait might be accessible to children or animals. Use in bait stations inside poultry and livestock facilities, placing bait stations so they will be inaccessible to children and animals. Bait is effective only against adult house flies. Follow label directions.
<i>imidacloprid</i> QuickBait 0.5%	4A	Ready-to-use when purchased.	Scatter bait directly from container onto dry level surfaces so individual granules lie near each other without forming piles. Or place in any commercial bait station. Or mix 1.5 oz bait with 1 fl oz warm water and stir to create a paste; apply with brush to surfaces where flies rest. Bait should be inaccessible to food-producing animals, children, and pets.
QuickBait Fly Strip			Use in buildings where animals are kept and where flies are a nuisance.
<i>methomyl</i> Blue Streak, Golden Malrin 1% Fly Bait	1A	Ready-to-use when purchased.	Scatter on floors, walkways, etc. throughout operation but away from animals. Apply lightly (about 1/4 lb/500-1000 sq ft) until flies are suppressed. Wear rubber gloves when applying baits. Do not allow workers on treated floors without shoes. Do not allow animals to come in contact with baits.
<i>nithiazine</i> 1% QuickStrike Fly Abatement Strip	4	Ready-to-use when purchased.	Place in areas where flies congregate and feed. Do not expose to sunlight or moisture. Follow label directions.
<i>spinosyn</i> 0.5% spinosad	5	Ready-to-use when purchased.	Follow label directions for scatter bait, station/tray bait, or paint/spray bait use. Locate where inaccessible to animals and children.
<i>thiamethoxam</i> Agita 10 WG	4A	Dissolve 8 oz in 60 fl oz water	Follow label directions for spraying adult fly resting sites.

<sup>1</sup> Space sprays are designed to kill adult flies that are present when the fog or mist is applied. There is little or no residual insecticide deposit remaining after the application unless synthetic pyrethroids are applied. Fogs or mists must come in contact with the fly. These materials are especially effective in enclosed areas where air movement is minimal. Heavy mists can offer some adult house fly kill in open areas.



# SHEEP AND GOATS: EXTERNAL PARASITE CONTROL<sup>1</sup>

Nancy C. Hinkle, Veterinary Entomologist

INSECTICIDE	FORMULATION	FINAL STRENGTH IN WATER	MIXING INSTRUCTIONS	AMOUNT PER MATURE ANIMAL	DAYS FROM LAST APPLICATION UNTIL SLAUGHTER	APPLICATION INSTRUCTIONS & RESTRICTIONS
<b>NASAL BOTS</b>						
<i>ivermectin</i> Ivomec Sheep Drench	0.08% <i>Ivermectin</i>			Administer orally at a dose of 3 ml/26 lb body wt. Delivers 0.2 mg <i>ivermectin</i> /1 kg body wt.	11	For nasal bots: Ready-to-use solution is specifically formulated for use in sheep only. May cause severe reactions in other animals. Do not treat sheep within 11 days of slaughter.
<b>LICE, KEDS, TICKS, HORN FLIES, HOUSE FLIES AND STABLE FLIES</b>						
<i>permethrin</i> Permethrin Prozap Pour-on Xtra	1% <i>permethrin</i>					Pour along back, applying 0.25 fl oz/50 lb body weight of animal, up to maximum of 3 fl oz/animal. For optimal control, all animals in flock should be treated after shearing.
<i>permethrin</i> * Gardstar	40% EC	0.013-0.05% high pressure spray	Mix 30-118 ml in 25 gal of water.	Apply 1-2 qt of coarse spray/animal over the entire body.	0	Repeat application in 10-14 days for mites and lice. Do not apply to milk goats.
		0.5% low pressure spray (hand pump sprayer)	Mix 118 ml in 2.5 gal of water.	Apply 1.5 fl oz of spray to midline from face to tailhead to point of runoff, but do not let runoff occur.		Repeat application in 10-14 days for mites and lice. Do not apply to milk goats.
Atroban 11%, Permethrin II 10%	10% EC 11% EC	0.05% spray	Mix 1 pt of 11% EC in 25 gal water OR mix 8 oz of 10% EC in 25 gal water.	Apply 1-2 qt of coarse spray/animal to thoroughly wet the animal.		Repeat the application in 10-14 days for mites. Do not apply to milk goats.
Atroban 42.5% EC	42.5% EC	0.054% spray	Mix 1 pt of 42.5% EC in 100 gal of water.	Apply sufficient spray (Approximately 2 qt/animal) to thoroughly wet animals to ensure complete coverage.		Repeat the application as needed but not more often than once every 2 weeks. Do not apply to milk goats.
Atroban DeLice, Permethrin, Synergized DeLice	1% Solution	No mixing required. Ready-to-use when purchased.	Pour along back. Apply 0.25 fl oz (7.5 cc)/50 lb body weight of animal, up to a maximum of 3 fl oz for any 1 animal.			Do not treat goats. For optimum control, all animals in the flock should be treated after shearing. Repeat treatment as needed, but not more often than once every 14 days. For optimum control, 2 treatments at a 14 day interval are recommended. Do not apply to milk goats.

**SHEEP AND GOATS: EXTERNAL PARASITE CONTROL<sup>1</sup>**

<b>INSECTICIDE</b>	<b>FORMULATION</b>	<b>FINAL STRENGTH IN WATER</b>	<b>MIXING INSTRUCTIONS</b>	<b>AMOUNT PER MATURE ANIMAL</b>	<b>DAYS FROM LAST APPLICATION UNTIL SLAUGHTER</b>	<b>APPLICATION INSTRUCTIONS &amp; RESTRICTIONS</b>
<b>LICE, KEDS, TICKS, HORN FLIES, HOUSE FLIES AND STABLE FLIES</b>						
<i>permethrin</i> Boss	5% Pour-On Solution	No mixing required. Ready-to-use when purchased.	Pour-On. No mixing required.	Pour along the back. Apply 1.5 ml/50 lb of body weight of animal up to a maximum of 18 ml for any 1 animal.	0	Repeat treatment as needed, but not more often than once every 2 weeks. For optimum lice control, 2 treatments at 14 day intervals are recommended. Do not apply to milk goats.
Ultra Boss 5.0%	Pour-on RTU			Apply 1.5 ml/50 lb body weight of animal up to a maximum of 18 ml/animal. Pour along back and down face.		
Permethrin	Spray			Follow label instructions.		
<i>zeta-cypermethrin</i> PYthon Dust 0.075%				Apply up to 2 oz (6 Tbsp) of dust/animal.		For control of keds, lice, ticks, and flies. Repeat as necessary, but not more often than once in 3 days.

<sup>1</sup> Do not treat sick, convalescent or stressed animals. Do not spray in a confined, non-ventilated area.

OP - organophosphate, PY - pyrethroid.

# POULTRY: FLY CONTROL

Nancy C. Hinkle, Veterinary Entomologist

**IMPORTANT:** Effective, economical fly control depends on producer management. Check fly-breeding areas (manure, around feed bins, etc.) weekly and maintain an integrated pest management program (IPM) to ensure long term fly control.

INSECTICIDE	MOA	MIXING INSTRUCTIONS	APPLICATION METHODS & SAFETY RESTRICTIONS <sup>1</sup>
<b>RESIDUAL AND BAIT SPRAYS</b>			
Residual and bait sprays are used when a residual insecticide deposit is needed for adult fly control. Apply to surfaces in poultry operations where flies rest and feed. <b>NOTE:</b> Use of residual sprays promotes insecticide resistance. Use of synthetic pyrethroid (SP) insecticides virtually eliminates the implementation of a dump fly ( <i>Hydrotaea aenescens</i> ) biological control program.			
<i>cyantraniliprole</i> Zyrox Fly Granular bait	28	Ready-to-use when purchased.	Apply in bait station, inaccessible to children, pets, and food animals. Use 0.2-0.4 lb bait/1000 sq ft/yr.
<i>esfenvalerate</i> 35%	3A	Apply according to label directions.	Do not apply when feed is present.
<i>permethrin</i> Atroban, Ectiban, Insectrin, Permethrin 5.7% EC, 10% EC or 25% WP	3A	5.7% EC is ready-to-use as a mist-spray OR mix 1 qt 5.7% EC in 12 1/2 gal of water OR mix 6 oz 25% WP in 11 gal of water OR mix 1 qt 10% EC in 25 gal of water.	Apply as a residual surface spray to fly resting areas (walls, ceilings, etc.). Do not spray manure or litter. Do not apply directly to poultry. Do not apply in egg storage areas. Apply 5.7% EC undiluted at 4 oz/1000 sq ft of surface area or apply diluted WP and EC mixtures at 1 gal/750 sq ft. Don't apply more than once every 2 weeks.
<i>Beauveria bassiana</i> HF 23 balEnce 1.12% ES (5.6x10 <sup>9</sup> cfu/ml)		Follow label instructions for dilution instructions.	Apply at a rate of 1.5-2 fl oz/5000 sq ft of floor area. Apply to floors, walls, posts, and manure areas where the greatest number of pests are located. Equipment must not be used with a filter or screen smaller than 50 microns. Re-treat every 2-7 days while pests persist.
<i>beta-cyfluthrin</i> Tempo 11.8% SC, 24.3% EC, 20% WP	3A	Mix 8-16 milliliters of 11.8% Tempo SC Ultra Premise Spray in sufficient water to cover 1000 sq ft.	
<i>bifenthrin</i> Actishield	3A	Mix 0.33-1 oz with 1 gal water; apply/1000 sq ft	For adult fly control in and around animal facilities, spray application should target areas where flies will rest.
<i>chlorpyrifos</i> Durashield, Duratrol	1B	Restricted use pesticide for use by certified applicators	Apply according to label directions to adult fly resting sites
<i>cyfluthrin</i> Optashield CS	3A	Mix 1-2 fl oz with 1 gal water	Apply 1 gal/1000 sq ft.
<i>deltamethrin</i> Deltagard 2%	3A	Follow label instructions for dilution recommendations.	Product intended for use with handheld, backpack, portable and truck mounted ULV or mist-sprayers. Apply in areas where flies congregate. Cover all feed and water sources. Follow application rate chart for flow rate recommendations.
<i>dichlorvos</i> Vapona	1B	Ready-to-use	Apply as coarse spray, 1 pt/1000 sq ft of surface.
<i>gamma-cyhalothrin</i> StandGuard 5.9%	3A	Mix 0.16 fl oz (5 ml)/gal of water.	Spray 1 gal of diluted spray to treat 500-1000 sq ft of fly resting surfaces.
<i>imidacloprid</i> QuickBayt Spot Spray 10%	4A	Mix at the rate of 1 lb/gal of water to treat 1000 sq ft of fly resting areas.	Product can be sprayed on virtually any surface (out of reach of animals) where flies rest or congregate, indoors or outdoors. Examples include posts, beams, ceilings, railings, door frames, windows, and walls. Residual activity of up to 6 weeks indoors and 2 weeks outdoors.
<i>lambda-cyhalothrin</i> 9.7% Grenade ER Insecticide Demand CS	3A	Mix 0.2-0.4 oz (6-12 ml)/gal water.	Make a directed application to fly-resting surfaces and allow to dry before reintroduction of animals. Do not apply when animals are present

## POULTRY: FLY CONTROL

INSECTICIDE	MOA	MIXING INSTRUCTIONS	APPLICATION METHODS & SAFETY RESTRICTIONS <sup>1</sup>
<b>RESIDUAL AND BAIT SPRAYS (continued)</b>			
Residual and bait sprays are used when a residual insecticide deposit is needed for adult fly control. Apply to surfaces in poultry operations where flies rest and feed. <b>NOTE:</b> Use of residual sprays promotes insecticide resistance. Use of synthetic pyrethroid (SP) insecticides virtually eliminates the implementation of a dump fly ( <i>Hydrotaea aenescens</i> ) biological control program.			
Ravap Rabon 2 lb ai/gal 23% + Vapona 0.5 lb ai/gal 5.7% EC	1B	1% spray. Mix 1 gal EC in 25 gal of water (12 Tbsp/gal).	Direct spray to inside and outside surfaces of poultry buildings where flies congregate and feed to include floors, manure, walls, ceilings, grass, etc. Apply thoroughly to point of runoff (about 1 gal/500-1000 sq ft). To make bait spray, add 1 cup sugar or syrup/gal of spray. Do not contaminate eggs, feed or water. Keep spray away from birds.
<i>spinosad</i> Elector 2.46% spinosyn	5	Dilute 10 oz in 5 gal water to give 0.04% <i>spinosad</i> .	Remove all animals from facility. Spray fly-resting surfaces to point of runoff, using approx. 1 gal/500-1000 sq ft. Repeat as needed, but not more often than once/week. Spray in early morning when flies are resting. Do not use in poultry facilities when animals are present; allow surfaces to dry completely before readmitting animals.
<i>spinosad</i> Elector PSP 44.2% spinosyn	5	Mix 2 fl oz (60 ml) in 10 gal of water to treat 5000-10000 sq ft.	Use sufficient water in a directed spray to contact flies and their resting surfaces. Do not apply where birds are present. Follow label directions.
<i>tetrachlorvinphos</i> Rabon 50 WP	1B	Mix 0.5 lb in 1.5 gal water.	Spray 1 gal/500 sq ft.
<i>tetrachlorvinphos</i> + <i>vapona</i> Ravap EC	1B	Mix 5 oz/gal water.	Apply 1 gal spray/500-1000 sq ft, treating fly resting sites.
<b>CONTACT SPRAYS</b>			
These sprays are also called space sprays and are only effective for very short periods. They kill flies directly contacted by the spray. Several types of mist, aerosol, and ULV (ultra-low volume) equipment are sold for applying these sprays. Be sure that insecticides bear full label instructions for use in poultry houses to avoid violation of federal and state laws.			
<i>dichlorvos</i> Vapona or DDVP 1%	1B	Ready-to-use when purchased.	Remove animals before fogging; dispense 1 pt/8000 cu ft. Apply as a light mist-spray when adult flies are present. Direct space spray throughout fly infested area. Do not apply directly to birds. Do not contaminate eggs, feed, or water.
<i>pyrethrins</i> Clear Zone	3A	Ready-to-use when purchased.	Apply 1-3 sec/1000 cu ft.
<i>pyrethrins</i> 0.3-5% + <i>piperonyl butoxide</i> 1.5-25% NP, ME	3A	Ready-to-use when purchased, dilute oil sprays. Aerosols, ULV concentrates, and concentrates for dilution are available.	Apply fog or mist-sprays when adult flies are present to obtain temporary adult fly suppression. Advantage is safety when used around animals and food products. Pyrethrin knockdown sprays are essential for emergency fly control. Aerosol, dilute mist, or ULV cold fog equipment should be available for use when needed.

**POULTRY: FLY CONTROL**

INSECTICIDE	MOA	MIXING INSTRUCTIONS	APPLICATION METHODS & SAFETY RESTRICTIONS <sup>1</sup>
<b>LARVICIDE (MAGGOT) SPRAYS AND FEED THROUGH LARVICIDES</b>			
Another way to control flies is to destroy the immature fly (maggot). Heavy use of a given insecticide could result in flies developing resistance to the insecticide. To kill adult flies, use fly traps and apply baits, residual sprays, bait sprays, and contact sprays either alone or in combination.			
<i>Beauveria bassiana</i> balEnce Biological Fly Spray	Biological	15 oz container diluted in 6-8 gal water. Treats up to 50000 sq ft.	Apply spray to manure. Repeat treatment as recommended on label.
<i>cyromazine</i> Larvadex 1% Premix, HE	17	5 parts/million in total diet of commercial layers or hatching egg layers. Mix 1 lb of 1% premix/2000 lb of feed.	Administer treated feed as daily ration as needed to control house flies. Treated feed must not be fed to layers for a minimum of 3 days (72 hours) before slaughter for food.
Flyzine 1% Premix			Blend into poultry ration for layer and breeder operations at the rate of 1 lb/ton of feed.
Neporex 2SG		Ready-to-use when purchased.	Scatter directly and evenly on wet fly larval development sites (manure). Wear gloves. To spray, mix 1 lb in 1 gal of water and spray 200 sq ft. Do not apply directly to birds or feed. Do not use in conjunction with other <i>cyromazine</i> products.
Larvadex 2SL		Mix 32 fl oz/5 gal water.	Apply 1 gal/100 sq ft of maggot breeding area.
<i>diflubenzuron</i> Dimilin 2L	15	Mix 5 fl oz in 10 gal water.	Apply spray in spot treatments to maggot developmental sites in manure
<i>novaluron</i> Tekko 10 IGR 9.3%	15	Mix 2-3 oz in 1 gal water	Apply as a coarse spot, crack, or crevice spray at a rate of 1.5-3 oz/1000 sq ft. Product is stable, not volatile and may be used while facility is in operation so long as exposed feed and water sources are covered. Do not spray into the air or over water sources. Allow at least 1 day between application and slaughter of animals.
<i>pyriproxyfen</i> Archer Nylar Insect Growth Regulator 1.3%	7C	Mix 1 fl oz in 1 gal water.	Wet surfaces where larvae are found; may repeat 14 days afterward.
NyGuard IGR 10%		Mix 4 ml in sufficient water to cover 1000 sq ft.	Apply to litter at rate of 4 ml/1000 sq ft.
Pyri-Shield EC 1.3%		Mix 1 fl oz in 1 gal water.	Apply to 1500 sq ft of surface area.
Ravap	1B	1% spray. Mix 1 gal EC in 25 gal of water.	Under cages, broadcast treatment as a coarse low-pressure spray at a rate of 1 gal/100 sq ft of manure.
Rabon 2 lb ai/gal 23% and Vapona 0.5 lb ai/gal 5.7% EC			Apply at 7-10 day intervals along with an intensive adult house fly control program until manure begins to dry or cone up. Spot spraying of manure and continued use of adult house fly control will maintain control. Do not contaminate eggs, feed, or water. Keep spray away from birds.
Vapona or DDVP <i>dichlorvos</i> 2 lb ai/gal 21.8% EC	1B	0.5% spray. Mix 3 1/3 cups EC in 10 gal of water.	Apply enough spray to penetrate manure (until thoroughly wet). Since Vapona has such a short residual, heavy treatment is required for larval kill. Once control is established, Vapona is an economical spot spray. Observe same methods of application and safety restrictions as for Ravap above.

**POULTRY: FLY CONTROL**

INSECTICIDE	MOA	MIXING INSTRUCTIONS	APPLICATION METHODS & SAFETY RESTRICTIONS <sup>1</sup>
<b>BAITS</b>			
In some operations, baits can be used to control adult house flies. These materials can be bought ready-to-use.			
<i>cyantraniliprole</i> Zyrox Fly Granular bait	28	Ready-to-use when purchased.	Apply in bait station, inaccessible to children, pets, and food animals. Use 2 lb bait/1000 sq ft/year. Apply using granular spreader at a rate of 3.2-6.4 oz/1000 sq ft. Reapply every 7 days. Do not apply where children or pets are present, or when it is raining. Keep out of reach of food-producing animals. Do not apply more than 2 lb/1000 sq ft/calendar year when using outdoors as a broadcast spreader.
<i>Beauveria bassiana</i> balEnce Biological Fly Bait	Biological		Use in bait stations at least 4 ft above ground at the rate of 0.25 lb/50 sq ft. Do not use within reach of children or animals. Replace every 5-7 days.
<i>dinotefuran</i> QuikStrike Scatter Bait 0.50%	4A	Ready-to-use when purchased.	Use as a scatter bait outdoors around animal agricultural facilities; do not place in areas where bait might be accessible to children or animals. Use in bait stations inside poultry and livestock facilities, placing bait stations so they will be inaccessible to children and animals. Bait is effective only against adult house flies. Follow label directions.
<i>imidacloprid</i> QuickBayt 0.5%	4A	Ready-to-use when purchased.	Scatter bait directly from container onto dry level surfaces so individual granules lie near each other without forming piles. Or place in any commercial bait station. Or mix 1.5 oz bait with 1 fl oz warm water and stir to create a paste; apply with brush to surfaces where flies rest. Bait should be inaccessible to food-producing animals, children, and pets.
QuickBayt Fly Strip		Ready-to-use when purchased.	Use in buildings where animals are kept and where flies are a nuisance.
QuickBayt Spot Spray		Mix 16 oz in 1 gal water.	Treat 1000 sq ft of adult fly resting surface in areas inaccessible to food animals.
<i>methomyl</i> Apache Golden Malrin Improved Golden Malrin Blue Streak 1% bait	1A	Ready-to-use bait.	Scatter on floors, walkways, etc., throughout house. Apply heavy (about 1/2-2 lb/1000 sq ft) until flies are suppressed. Wear rubber gloves when applying baits. Do not allow workers on treated floors without shoes. Keep pets out of house. Do not contaminate eggs, feed, or water. Keep baits away from birds.
<i>nithiazine</i> QuikStrike 1.0% fly abatement strips	4	Ready-to-use strip.	Hang 1 strip/100 sq ft or 300 sq ft depending on fly population in enclosed areas that are protected from rain.
<i>spinosad</i> Elector Bait 0.5% spinosyn	5	Ready-to-use bait.	Apply at rate of 12-16 oz of bait/2,000 sq ft of building. Follow label directions.
<i>thiamethoxam</i> Agita 10 WG	4A	Mix 8 oz per/60 fl oz water.	Treat adult fly resting sites; keep out of reach of animals and children. Follow label directions.

## POULTRY EXTERNAL PARASITE CONTROL

Nancy C. Hinkle, Veterinary Entomologist

### BEDBUGS, CHICKEN LICE, FLEAS, FOWL TICKS, AND MITES FOR DIRECT TREATMENT TO BIRDS OR POULTRY FACILITY

INSECTICIDE	MOA	MIXING INSTRUCTIONS	APPLICATION METHODS & SAFETY RESTRICTIONS <sup>1</sup>
<b>DUSTS<sup>2</sup></b>			
<i>permethrin</i> Ectiban, Insectrin, Permethrin 0.25% Dust	3A	Ready-to-use dust.	Apply 1 lb/100 birds. Ensure thorough treatment of vent for northern fowl mite control.
Sulfur Yellow Jacket Wettable Dusting Sulfur II	Inorganic	Ready-to-use dust.	Dust liberally on birds and rub into plumage, concentrating on area around vent
<b>SPRAYS<sup>3</sup></b>			
<i>permethrin</i> Ectiban, Permethrin 5.7% EC	3A	Mix 1 qt 5.7% EC <b>OR</b> 1 pt 11% EC in 25 gal water.	Apply 1 gal diluted spray to 100 hens using high pressure. Apply to vent area for best results. A second application may be needed 4 weeks later.
23% <i>stirofos</i> + 5.7% <i>dichlorvos</i> Ravap 28.7% EC	1B	Mix 2 qt EC in 24 gal water.	Apply 1 gal/100 birds. Apply directly to birds. Spray vent and fluff areas from below using high pressure (100 psi and up) sprays. Wet feathers around vent area for effective control. Do not spray birds more often than once every 14 days. For floor birds, apply 1-2 gal of spray/1000 sq ft of litter. Spray birds lightly.
<i>spinosad</i> Elector PSP 44.2% <i>spinosad</i>	5	Mix 3 fl oz Elector PSP in 10 gal water.	Apply 100 gal of coarse spray/100 Elector PSP to birds to ensure adequate coverage, directed toward the vent area.
<i>sulfur</i> Yellow Jacket Wettable Dusting Sulfur II	Inorganic	Mix 25-50 lb/100 gal water.	Spray 200-250 lb/20000 sq ft to all interior services, forcing into cracks and crevices. Do not spray birds.

### BEDBUGS, CHICKEN MITES, FLEAS AND FOWL MITES FOR TREATMENT OF POULTRY FACILITY ONLY (Not For Direct Application To Birds)

INSECTICIDE	MOA	MIXING INSTRUCTIONS	APPLICATION METHODS & SAFETY RESTRICTIONS <sup>1</sup>
<i>pyrethrins 1-2% + piperonyl butoxide</i> + 3% <i>bicycloheptane dicarboximide</i> Surekill SK 100	3A	Concentrate designed for undiluted use in mechanical sprayers that give particles of aerosol size.	Apply at a rate of 3 fl oz/1000 cu ft undiluted, using a ULV spraying device. Remove feed, water, and live animals before application. Apply to all areas where insects take shelter. Allow product to thoroughly dry before re-entry.
<i>sulfur</i> Yellow Jacket Flowable Sulfur	Inorganic	Mix 1-2 gal/100 gal water; apply 20 gal/20,000 sq ft.	Remove poultry before spraying.
<i>tetrachlorvinphos</i> + (5.7%) <i>dichlorvos</i> 28.7% Ravap (23%)	1B	1.25% or 2.5% spray or 1.25% roost paint. Mix 1 gal EC in 12.5 gal of water to make 2.5% mixture or mix 1 gal EC in 25 gal of water to make 1.25% mixture.	Apply roost paint at the rate of 1 pt of finished mixture/100 ft of roost area with brush or spray OR apply 1 gal of spray/100-150 sq ft for fowl ticks or 1 gal of spray/500-1000 sq ft for other parasites.

<sup>1</sup> Do not contaminate feed, water, or feeding and watering equipment.

<sup>2</sup> Dust birds thoroughly, especially under the wings and around the vent. Provide thorough ventilation while dusting.

<sup>3</sup> Penetration of feathers around vent is essential for northern fowl mite control. Apply directed sprays using 100-125 psi. Provide thorough ventilation while spraying. Force sprays into cracks and crevices when treating for chicken red mites, bedbugs, fleas, and fowl ticks.

# POULTRY HOUSE PEST CONTROL

Nancy C. Hinkle, Veterinary Entomologist

## LITTER BEETLES – Darkling Beetles (black bugs, black poultry bugs, lesser mealworms) and Hide Beetles

INSECTICIDE <sup>1</sup>	MOA	MIXING INSTRUCTIONS	APPLICATION INSTRUCTIONS AND SAFETY RESTRICTIONS <sup>2</sup>
<i>Beauveria bassiana</i> HF 23 FBP23 ES 0.46% (1.1x10 <sup>10</sup> cfu/ml)		Apply at a rate of 1.5-2 fl oz to treat 5000 sq ft.	Do not use equipment with a filter or screen smaller than 50 microns. Apply treatment to walls, floors and posts where the greatest number of pests are located. Re-treat between flocks as needed. No restriction on maximum amount that can be applied within a 1-year period.
FBP23 LBT Bait 0.137% (6.5.1x10 <sup>9</sup> cfu/ml)		Apply at a rate of 1 oz/sq ft using a drop spreader or hand shaker.	Apply before birds are placed in houses. Cover or remove water sources. If beetle numbers are high at flock start, re-treatment may be done in 4-week intervals. Only apply to poultry or livestock manure that is to be composted. Avoid using in areas where foraging honey bees are present.
<i>bifenthrin</i> Actishield 7.9% Talstar Professional Insecticide 7.9% Nemesis 7.9%	3A	Apply at rate of 0.33-1 fl oz/1000 sq ft.	Apply to litter surface when birds not present.
<i>chlorpyrifos</i> Duratrol Darkling Beetle Spray Restricted use pesticide	1B	Restricted use only	Follow label directions.
<i>clothianidin</i> Darlex	4A	Mix 80 oz in 10-40 gal to treat 20,000 sq ft.	For whole-house broadcast spray or band application under feeders along water lines, and along walls.
<i>cyfluthrin</i> Optashield CS 6% Tempo SC Ultra 11.8% WP, SP Tempo 1% Dust Tempo 20 WP Insecticide	3A	Apply at rate of 1-2 oz/1000 sq ft. Mix 16 ml in 1 gal water. Ready-to-use when purchased. Add 9.5 g (1 scoopful) Tempo 20 WP to adequate water to cover 1000 sq ft. (based on label chart)	Remove all animals from facility. Do not apply to feedstuffs or watering equipment. Apply as a general surface and/or a crack and crevice spray. Do not make applications when birds are present. Do not make applications to feed, water and feeding and watering equipment. Remove all animals from facility. Apply dust using hand or power dusters or other suitable equipment. Apply uniformly at 0.5-1 lb/1000 sq ft. Do not apply to feedstuffs or watering equipment. Repeat treatment as necessary. Remove all animals from facility. Based on label chart, spray adequate material to adequately cover area but not allow dripping or run-off to occur. Do not apply to feedstuffs or watering equipment. Do not re-apply more frequently than every 10 days.
<i>deltamethrin</i> Annihilator PolyZone	3A	0.75 oz per gal water/1000 sq ft	Spray under feed and water lines, and along walls. Do not apply when birds are present.
<i>esfenvalerate</i> Clear Zone Farm Residual Concentrate 9.36%	3A	Mix 0.8 oz product in 1 gal water.	Apply 1 gal of mixture to treat 1000 sq ft.
<i>gamma-cyhalothrin</i> 5.9% StandGuard	3A	Mix 0.65 fl oz. (20 mi)/gal of water. Spray 1 gal of diluted spray to treat 500-1000 sq ft.	Apply to floor area, with particular attention to areas under feed and water lines. Do not apply when birds are present.
<i>imidacloprid</i> Credo SC 42.8% Dominion 4L Adonis 4F 40.4% Imidashot DF	4A	Apply at rate of 3 fl oz/1000 sq ft. Mix 3 fl oz/0.5-2 gal water and apply to 1000 sq ft of litter. Mix 3 fl oz/2 gal water; treat 1000 sq ft. 2.25 oz/1000 sq ft	Do not apply when birds are present. Cover or remove exposed feed and water. Allow to dry before restocking birds. Apply between flocks following sanitation procedures; do not apply when birds are present. Apply to floor area, with particular attention to areas under feed and water lines. Do not apply when birds are present
<i>lambda-cyhalothrin</i> 9.7% Grenade ER Insecticide Demand CS OxyFly 9.7%	3A	Mix 0.8 oz (24 ml)/gallon water.	Apply to walls and floors at cleanout, before reintroduction of animals. Pay attention to areas where beetles frequently occur (under feed lines, along walls). Do not apply when birds are present.



## POULTRY HOUSE PEST CONTROL

### LITTER BEETLES – Darkling Beetles (black bugs, black poultry bugs, lesser mealworms) and Hide Beetles

INSECTICIDE <sup>1</sup>	MOA	MIXING INSTRUCTIONS	APPLICATION INSTRUCTIONS AND SAFETY RESTRICTIONS <sup>2</sup>
<i>orthoboric acid</i> Safecide Brand IC 99% Borid 99% BorActin 99% Safecide Brand IC	8D	Ready-to-use when purchased.	Remove birds. Apply dust uniformly to floor of poultry house or old litter with a fertilizer or seed spreader, at the rate of 1-2 lb/100 sq ft in bands along feeder lines. Cover with fresh shavings.
<i>permethrin</i> Tengard SFR 36.8%	2A	Apply at rate of 4 fl oz in 12.5 gal water. Spray 1 gal/750 sq ft.	Do not apply when birds are present.
<i>pyrethrins</i> Riptide ULV 5%	3A	Ready-to-use when purchased.	Apply undiluted at 0.25-1 fl oz/1000 cu ft for knockdown of accessible insects; provides no residual.
<i>pyriproxyfen</i> Archer Insect Growth Regulator 1.3%	7C	Mix 1 fl oz in 1 gal water.	Wet surfaces where larvae are found; water volume may be increased to enhance litter penetration.
NyGuard IGR 10%		Mix 4 ml in sufficient water to wet surface being treated.	Wet area where larvae are found.
Pyri-Shield EC 1.3%		Mix 1 oz in 1 gal.	Apply 1 gal/1000 sq ft where larvae are found.
<i>spinosad</i> 44.2% Electro PSP	5	Mix 2 fl oz (60 ml) in 10 gal of water to treat 5000 sq ft.	Use sufficient water to ensure thorough coverage, treating litter along feed and water lines, walls, and support beams. Reapply after each grow-out.
Extinosad PSP 44.2%		Mix 2 oz with 10 gal water.	Apply 1 gal/500 sq ft.
<i>tetrachlorvinphos</i> Rabon Beetle Shield 3% dust	1B	Ready-to-use when purchased.	Use 4-8 oz/100 sq ft, applied using plunger or rotary type duster
Rabon 50WP			Use rotary, mechanical or electrostatic duster to apply 3/4 oz/100 sq ft of surface.
<i>tetrachlorvinphos + dichlorvos</i> Ravap E.C. 23% <i>tetrachlorvinphos</i> + 5.3% <i>dichlorvos</i>	1B	1 gal in 25 gal water (for extreme infestations dilute 1 gal in 12.5 gal water)	Apply 1 gal of spray/500-1000 sq ft to cover walls, floors, and other sites where beetles congregate.
Rabon 50WP	1B	Mix 8 lb with 100 gal water.	Apply 1-2 gal/100 sq ft.
<i>thiamethoxam</i> Agita 10 WG	4A	Mix 2 oz in 32 fl oz water.	Apply 2 fl oz to shavings under each feeder (do not broadcast).
<i>zeta-cypermethrin</i> ZetaGard LBT	3A	RTU dust	Use a drop spreader to make band applications under feedlines and along walls; 50 lb/20,000 sq ft broiler house.

### MOTHS IN FEED (webbing clogging auger and feed lines)

INSECTICIDE <sup>1</sup>	MOA	MIXING INSTRUCTIONS	APPLICATION INSTRUCTIONS AND SAFETY RESTRICTIONS <sup>2</sup>
Diatomaceous earth DE	Inorganic	Ready-to-use when purchased.	Mix 4-6 lb of DE/ton of feed and run through lines monthly to prevent caterpillars from spinning webbing. Existing webbing must be removed by hand; DE does not affect silk webbing.

<sup>1</sup> Abbreviations used: CR - carbamate; NP - natural pyrethrum; OP - organophosphate; INO - inorganic; SP - synthetic pyrethroid.

<sup>2</sup> Do not contaminate feed, water or feeding and watering equipment.

# HONEY BEE DISEASE AND PEST CONTROL

Keith S. Delaplane, Extension Entomologist

PEST	MATERIAL AND FORMULATION	RATE	REMARKS AND PRECAUTIONS
American foulbrood (AFB)	<i>oxytetracycline</i> , <i>tylosin</i> , <i>lincomycin</i> Effective 1 Jan 2017, the antibiotics <i>oxytetracycline</i> , (Terramycin), <i>tylosin</i> , (Tylan) and <i>lincomycin</i> , (Lincomix) are available for treating symptoms of AFB, but only under a Veterinary Feed Directive (VFD) prescribed by a licensed veterinarian.	Allowable rates and dosages are by veterinary prescription or by written Veterinary Feed Directive (VFD) instructions obtained from a licensed veterinarian.	Antibiotics are not effective against this disease and serve only to mask symptoms. If symptoms are restricted to one comb, it may be possible to eliminate the disease by removing, burning, and burying the affected comb and requeening the colony with stock genetically selected for AFB-resistant hygienic behavior. If symptoms recur (very probable), then the colony must be burned. Kill the colony by wrapping it completely in a large plastic trash sack and allowing it to suffocate in the heat of the day. Dig a pit and burn all bees, combs, and frames. Bottom boards, supers, and lids can be salvaged by scorching their interiors with a torch. As a general practice, do not feed bees honey from unknown sources and exercise caution when purchasing used equipment. The disease is highly communicable by contact, whether by contaminated food, equipment, or drifting bees.
European foulbrood (EFB)	Same as for American foulbrood.	Same as for American foulbrood.	These drugs are for preventing and treating disease. Treat in February and September and never within 4 weeks of a marketable nectar flow. Help infected colonies by adding unsealed brood and feeding 1:1 sugar syrup. Use hygienic-selected bee stick.
Chalkbrood	None		Keep hives well-ventilated. Prop lid slightly to exhaust warm, damp air. Lean hive forward to drain rain water from interior. Use bee stock selected for hygienic behavior.
Nosema	<i>fumagilin B</i>	Dissolve 1 teaspoon of fumagilin B in 1.1 gal of sugar syrup.	Feed medicated syrup in spring and fall and never immediately before a marketable nectar flow. Keep hives well-ventilated. Prop lid slightly to exhaust warm, damp air. Lean hive forward to drain rain water from interior.
Small hive beetles	<b>For treatment inside colonies:</b> Adult beetles can be trapped and drowned in vegetable oil with any of the numerous in-hive adult beetle traps available by bee suppliers. Some beekeepers report success at trapping adults with sheets of micro-fiber cloth laid on top of brood combs. These cloths are widely used in the automobile detailing industry. Beetles – and a small number of bees – get entangled and die in the fibers. In-hive trapping should be done in conjunction with soil nematodes to optimize beetle control.		
	<i>permethrin</i> GardStar 40% EC	<b>For treatment outside colonies:</b> Mix 5 millimeters GardStar concentrate with 1 gallon water. Thoroughly wet ground in an area 18-24 in wide in front of each hive (1 gal/6 hives).	Product is designed to kill immature beetles when they leave hive in order to pupate in the soil. Product is highly toxic to bees. Avoid direct spray onto hive surfaces. Apply in late evening after bees become inactive. For pre-placement cleanup of new apiary site, apply thoroughly to ground surface 24-48 hours prior to hive placement.
	<i>Heterohabditis indica</i> predatory soil nematodes (Southeastern Insectaries, Perry, GA)	<b>For treatment outside colonies:</b> Mix 1 million infective juveniles in 2 gallons water per colony. Strain out gelatin globules and trickle solution on ground in front of hive. Treat ground under hive if screen bottoms are used.	<b>Management:</b> Predatory nematodes have been shown to effectively kill SHB pupae in soil in front of hives.

HONEY BEE DISEASE AND PEST CONTROL

PEST	MATERIAL AND FORMULATION	RATE	REMARKS AND PRECAUTIONS
Tracheal mites (This mite is now rarely seen in Georgia)	menthol	one 1.8 oz packet per colony	Do not use on hives containing marketable honey. Enclose 1.8 oz menthol in a 7-inch square plastic (or other porous) screen packet. Treat colonies in fall and early spring and only when daytime highs range from 60-90° F. If daytime high is > 80° F, place packet on bottom board. If daytime high is 60-79° F, place packet on top bars. Replace menthol as needed. Remove all menthol 10-12 weeks after first treatment and at least 1 month before nectar flows. Vegetable oil in the medicated extender patty described below helps control AFB, EFB and tracheal mites.
	oil patties	Mix patties with 2 parts sugar and 1 part vegetable cooking shortening. Each patty should be 0.5 lb.	Place oil patty on top bars of brood frames. Treatments applied February through April are most effective.
Varroa mites	Population growth of mites can be limited by use of genetically-selected mite resistant stock, screened bottom boards, and spring-time drone brood trapping. For the latter, a drawn comb of drone cells is inserted in the hive in early spring. Bees fill it with drone pupae, and once the brood is capped, the beekeeper removes the frame, freezes it (killing mites along with the brood), then returns it to the hive so the bees can eat the brood and recover some of their nutrient investment. Because mites significantly prefer drone brood, a large fraction of the mite population will be removed and killed with this procedure. Any of the mite treatments below will be more effective at times of year when brood area is naturally low. It is especially important to treat in late summer/early autumn in order to protect the bees destined to form the overwintering cluster.		
	<i>fluvalinate</i> Apistan (This product is now largely ineffective due to evolved mite resistance)	1 strip for each 5 combs of bees in each brood chamber	Do not use on hives containing marketable honey. Hang one strip between frames 3 and 4, and another strip between frames 7 and 8. Leave strips in hive for 42-56 days. Apistan treatments are usually most effective when used in early fall.
	<i>coumaphos</i> CheckMite+ Strip (This product is now widely ineffective due to evolved mite resistance)	1 strip for each 5 combs of bees in each brood chamber	Remove honey supers before application of CheckMite+ Strips and do not replace until 14 days after the strips are removed. Hang the strips within two combs of the edge of the bee cluster. If two deep supers are used for the brood nest, hang CheckMite+ Strips in alternate corners of the cluster, in the top and bottom super. Treat all infested colonies within yard. The treatment is most effective when brood rearing is lowest. Do not treat when surplus honey is being produced. Leave the strips in the hive for at least 42 days (six weeks), but do not leave strips in hive for more than 45 days. Do not treat more than twice a year for varroa mites.
	<i>thymol</i> Apiguard	1 tray per colony, repeated after 2 weeks	Open the hive. Peel back the foil lid of the Apiguard tray leaving one corner of the lid attached to the tray. Place the open tray centrally on top of the brood frames, gel side up. Ensure that there is a free space of at least 0.5-inch between the top of the tray and the hive cover board, for example, by placing an empty super on top of the brood box. Close the hive. After two weeks replace the first tray with a new one, according to the same instruction. Leave the product in the colony until the tray is empty. Remove the product when installing the supers on the colony.  The efficacy of Apiguard is maximized if the product is used in late summer after the honey harvest (when the amount of the brood present is diminishing). However, in the case of severe infestations, Apiguard can also be used during springtime, when temperatures are above 60° F. Efficacy will vary between colonies due to the nature of the application. Therefore, Apiguard should be used as one treatment among others within an Integrated Pest Management program, and mite fall regularly monitored. If further significant mite fall is observed during the following winter or spring, use an additional secondary winter or spring treatment for varroa.

HONEY BEE DISEASE AND PEST CONTROL

PEST	MATERIAL AND FORMULATION	RATE	REMARKS AND PRECAUTIONS
<p>Varroa mites (continued)</p>	<p><i>thymol</i> ApiLife VAR</p>	<p>1 treatment consists of 3 wafers over 2-32 days</p>	<p>Applications can be made in any season (spring, summer, fall, winter) in which all applicable restrictions, precautions and directions for use can be followed. Do not use when surplus honey supers are in place. Use when average daily temperatures are between 59-69° F. Do not use ApiLife VAR at temperatures above 90° F.</p> <p>Two treatments per year may be made. A treatment (3 tablets) consists of the following:</p> <p>Take one tablet and break into four equal pieces. Place pieces on the top corners of the hive body. Avoid placing pieces directly above the brood nest. After 7-10 days, replace with a fresh tablet broken in to pieces as above. Repeat procedure again 7-10 days later and leave last tablet for 12 days. After 12 days, remove residuals from the colony.</p> <p>To prevent the bees from gnawing the tablet either enclose each piece of tablet in an envelope of screen wire (8 mesh/inch) or place the uncovered pieces above a sheet of metal screen that prevents bees from contacting it.</p> <p>Remove ApiLife VAR tablets from hive at least 1 month (30 days) prior to harvesting the honey.</p>
	<p><i>formic acid</i> Mite-Away Quick Strips</p>	<p>2 strips</p>	<p>Optimal treatment season is spring or fall corresponding to optimal temperature windows described below. Outside daytime temperature highs should be between 50-92° F. Temperatures &gt; 95° F during the first three days of treatment can cause excessive brood mortality and absconding. Remove strips from pouch. For hives with single brood chambers lay two strips across the top bars of the frames of the brood chambers, staggering them so they lay flat and across the full width of the hive body, with approximately 2 inches between strips and 4 inches between the ends of the brood chamber and the outer edges of the strips. For hives with two brood chambers place the strips as described above on the frame top bars of the lower hive body, so the strips are in-between the brood chambers. Put on honey supers if a honey flow is anticipated. The active ingredient dissipates after 3 days; however, do not disturb the colony for 7 days to allow it to recover from manipulation. Spent strips need not be removed after use.</p>
<p>Wax moths</p>	<p>PDB crystals</p>	<p>Stack stored supers, cover stack and make air-tight with newspaper or duct tape. At intervals equal to the height of 5 deep supers or 10 shallow supers, insert 6 tablespoons of PDB. Put crystals on a small piece of cardboard placed on top bars of frames. Replace crystals as they evaporate. Air-out supers before using on live bee hives.</p>	<p>Wax moths are secondary scavengers. Wax moths in living colonies indicate an underlying problem. Check for queenlessness, disease, or mites. Protect stored combs by: (1) storing them on top of strong colonies, (2) freezing combs and supers, then stacking them and taping shut all cracks to exclude moths, (3) stacking combs so they are constantly exposed to air and daylight, (4) operating an electronic “bug zapper” in the super storage room to kill adult moths, (5) using PDB crystals.</p>

# Stable Fly (Dog Fly) Control<sup>1</sup>

P. E. Kaufman and E. N. I. Weeks<sup>2</sup>

## Introduction

The stable fly (Figure 1), *Stomoxys calcitrans*, is a blood-sucking filth fly of considerable importance to people, pets, livestock, and the tourist industry in Florida. Filth flies, including stable flies, exploit habitats and food sources created by human activities, such as farming. “Stable fly” is just one of the many common names used to refer to this pest. Stable flies are also known as “dog flies” because the fly often bites and irritates dogs. Other names are the “biting house fly” and “lawn mower fly,” because the larvae are often found in the cut grass on the undersides of lawn mowers. Stable flies will bite people in the absence of a preferred animal host for obtaining a blood meal.

In its normal environment the stable fly is not considered a pest to humans. However, certain regions of the United States have considerable problems with large numbers of stable flies attacking people. The coastal part of New Jersey, the shores of Lake Superior and Lake Michigan, some Tennessee Valley Authority lakes, and most importantly due to the significance of the tourism industry in these areas, west Florida and along the Gulf coast to Louisiana are areas that historically have stable fly problems. Although west Florida has the most severe stable fly problems, the flies are numerous throughout the state.



Figure 1. Stable fly, *Stomoxys calcitrans*. Note the mouthparts projecting forward.

Credits: Lyle Buss, UF/IFAS

## Biology

Stable flies breed in soggy hay, grasses, or feed; piles of moist, fermenting weed or grass cuttings; spilled green chop; peanut litter; seaweed deposits along beaches; soiled straw bedding; and sometimes in hay ring feeding sites when the temperatures warm in the spring. The female, when depositing eggs, will often crawl into loose material. Each female fly may lay 500–600 eggs in four separate batches. Eggs are small, white, and sausage-shaped. Eggs hatch in 2–5 days into larvae, which feed and mature in 14–26 days. Larvae are typical maggots and transform to small, reddish-brown, capsule-like pupae from which the

1. This document is ENY267, one of a series of the Department of Entomology and Nematology, UF/IFAS Extension. Original publication date December 1997. Revised July 2006, August 2012, September 2015, and January 2019. Visit the EDIS website at <https://edis.ifas.ufl.edu> for the currently supported version of this publication.
2. P. E. Kaufman, professor/Extension entomologist; and E. N. I. Weeks, assistant research scientist; Department of Entomology and Nematology; UF/IFAS Extension, Gainesville, FL 32611. First published in 1997 by P. G. Koehler, professor/Extension entomologist, Department of Entomology and Nematology.

The Institute of Food and Agricultural Sciences (IFAS) is an Equal Opportunity Institution authorized to provide research, educational information and other services only to individuals and institutions that function with non-discrimination with respect to race, creed, color, religion, age, disability, sex, sexual orientation, marital status, national origin, political opinions or affiliations. For more information on obtaining other UF/IFAS Extension publications, contact your county's UF/IFAS Extension office.

U.S. Department of Agriculture, UF/IFAS Extension Service, University of Florida, IFAS, Florida A & M University Cooperative Extension Program, and Boards of County Commissioners Cooperating. Nick T. Place, dean for UF/IFAS Extension.

adult flies emerge (Figure 2). The average life cycle is 28 days, ranging from 22–58 days depending on the weather conditions. In Florida, during years with wet summers, the stable fly breeds throughout the year, although peak populations occur from October through January.



Figure 2. Stable fly maggot or larva presented with three stable fly pupae.

Credits: Lyle Buss, UF/IFAS

The stable fly adult is similar to the house fly in size and color. Adult stable flies are typically 5–7 mm in length, and unlike the house fly, which has an unpatterned abdomen, stable fly abdomens have seven circular spots (Figure 3). Stable flies also have long, bayonet-like mouthparts for sucking blood (Figure 1). Unlike many other blood feeding fly species, both male and female stable flies feed on blood. Stable flies feed mainly on the legs of cattle and horses.



Figure 3. Stable fly adult abdomen, showing the characteristic spots.

Credits: Lyle Buss, UF/IFAS

Stable flies are competent fliers and have been shown to disperse far from their larval development sites to feed. Recent studies in Florida have shown that the majority of stable flies collected at equine facilities were travelling between 0.8 and 1.5 km from cattle farms, following a

blood meal, to breed in equine farms. One study even recorded stable flies travelling distances of up to 70 miles from their development sites. They are inactive at night, resting on fences, buildings, trees, and bushes.

## Scope of the Problem in Florida

Stable flies attack people, pets, and agricultural animals throughout Florida. Stable fly bites are extremely painful to people and other animals. When hungry, stable flies are quite persistent and will continue to pursue a blood meal even after being swatted several times. Although the bite is painful, there is little irritation after the bite, and few people exhibit allergic reactions.

The tourist industry is severely affected by large numbers of stable flies, especially in west Florida, from Wakulla County to Escambia County. Because stable flies are active during the daylight hours, the flies have a big impact on Florida's beach tourism. When stable flies are numerous, tourists leave and are unlikely to return if their vacation was spoiled.

Stable flies congregate on beaches because they are sensitive to the wind. When a northerly wind blows toward the beach from inland, the flies are carried to the beach and take shelter from the wind on the leeward side of the dunes. Some individuals even fly to boats and are taken off shore, where they continue to bite. The flies normally do not concentrate in residential areas, but they may bite an occasional human and often bite dogs as they pass through the dunes on the way to the beach. Stable flies are usually on the beach during the morning hours, when the wind is from the north. Frequently, during the middle of the day, the thermal currents on land pull the winds in from the Gulf and the flies suddenly leave. They may then move inland 10–15 miles from the Gulf of Mexico.

The animal industries of Florida are severely affected by the stable fly. Because the fly takes blood meals, animals are weakened from blood loss and continual irritation. Animals such as swine, cattle, and horses show reduced weight gains. As a result of stable fly annoyance, animals stamp nervously, switch, become irritable and have been known to stand in water, with only their necks and heads exposed, to escape the biting flies during heavy outbreaks. Stable flies also are known to transmit the pathogens that cause diseases such as anthrax, equine infectious anemia (EIA), and anaplasmosis to animals. In addition, bite wounds can be sites for secondary infection.

## Monitoring Stable Fly Abundance

Because these pests leave an animal immediately after feeding, they may go unnoticed unless heavy outbreaks occur. Monitoring is important for early detection of a potential outbreak situation and is usually done by counting flies on lower legs of cattle and horses (Figure 4). Counts should be done on all four legs of at least 15 animals. Greater than 10 flies per animal is considered economically damaging. High numbers of stable flies on animals suggests a productive local larval development site. However, it is important to note that the absence of a local development site does not necessarily mean that the animals are not being bothered by stable flies. Because stable flies will disperse from their larval development sites and travel great distances to obtain a blood meal, development sites may be over 1 kilometer away. Consequently, a stable fly larval development site on your property may have an influence on the people and animals for miles around. A study of equine facilities in Florida found that only 24.3% of the flies captured on horse farms had fed on horses; 64.6% had travelled up to 1.5 km from cattle farms to reach the horse farms, with 9.5% of these flies having fed on humans.



Figure 4. Stable flies feed mainly on the legs of cattle and horses.  
Credits: UF/IFAS

While one stable fly does not cause significant damage, 50–100 of these blood-sucking pests occurring together with 500 horn flies can cause a substantial daily loss of blood. The defensive behavior that these flies cause in the animals reduces time spent feeding or grazing and so less feed conversion to protein. The stress of constant attack by biting flies results in elevated levels of the stress hormone,

cortisol, in the blood of dairy cows. This common livestock pest situation can result in a loss of 10–20% in milk production and up to 40 pounds of beef gain eliminated per animal each year—an economic loss of millions of dollars per year to Florida cattlemen. Estimates in 2012 gave a total impact to the US cattle industry of \$2.211 billion per year, with \$360 million for dairy, \$358 million for calf-cattle herds, \$1.268 billion for pastured cattle, and \$226 million for cattle on feed.

Reducing fly abundance on animals through effective management has been shown to reduce these defensive behaviors, decrease stress, and increase grazing. In the short term these changes are critical for animal health and welfare, and in the long term these improvements will increase production and decrease impacts on the economy.

## Control at Breeding/Larval Development Sites

The most practical and economical method for reducing stable fly populations is the elimination or appropriate management of larval food sources. It is important to remember that flies cannot develop in dry materials. Furthermore, due to the dispersal capability of stable flies, larval development sites on your property may be causing problems for other animals that may be miles away or in residential areas where the flies feed on humans and pets. Management of potential development sites should be completed for the health and safety of your animals, your neighbors' animals, and the local community. Most of the following methods also will reduce the presence of other localized fly problems through improved sanitation and hygiene.

Stable flies breed in the following types of material:

1. Green chop or silage—Stable fly maggots thrive in decaying plant material, such as old silage in and around feed troughs and trench silos. Silage probably has a greater potential for producing stable flies than almost any other material found on today's farms. More than 3,000 stable fly maggots per cubic foot of silage have been found in mid-January on some west Florida farms, which can increase fivefold by late summer.
2. Crop residues—Unwanted crop residues, such as peanut vines discarded in piles during harvest, are frequently important sources of fly nutrition for development. To avoid creating a larval development site, this material should be spread thinly for quick drying.

3. Hay and grain—Hay allowed to accumulate where animals are fed in fields decays rapidly when exposed to the elements and may produce flies in tremendous numbers. To reduce the impact of this fly larval development site, feed cattle at a different place in the field each time so that accumulations of old hay do not occur. Likewise, spilled grain around feed troughs or storage bins may provide the stable fly with a moist, favorable larval growth medium and should be cleaned up immediately.
4. Animal manures—When handled properly, manure will not provide a development site for stable flies. Manure should not be allowed to accumulate for more than a week before it is spread thinly on fields, where quick drying eliminates stable fly development.
5. Stables—The popularity of recreational horses creates a staggering number of fly sources. However, proper care and management of waste feed and manure can greatly reduce or eliminate fly populations in these areas. Stalls should be cleaned of droppings daily and the manure spread thinly (not more than 1–2 inches deep). The choice of bedding is very important. Hay or straw absorbs urine and decomposes rapidly, and unless it is changed every few days, it will produce thousands of flies. A far better material is wood shavings, which, when cleaned of manure daily and changed approximately every two weeks, will not normally permit fly development.
6. Other sources—Any pile of moist, decaying organic matter should be considered a potential source of stable flies that could cause serious harm to livestock.

There may be instances where sanitation of larval development sites is not enough to control stable fly numbers below the threshold. Biological control using natural enemies of stable flies also can be implemented. Parasitoid wasps that target stable fly pupae are available commercially and can be used to increase the natural parasitism level. Alternative control measures include the use of traps (e.g. Alsynite traps, Knight stick traps), the use of insecticide treated targets, and insecticide treatment of stable fly resting sites or cattle. See the Livestock Pest Management Guides for specific control mechanisms for beef, dairy, horses etc. [https://edis.ifas.ufl.edu/topic\\_livestock\\_pests\\_by\\_animal](https://edis.ifas.ufl.edu/topic_livestock_pests_by_animal).

## Keys to Pesticide Safety

1. Before using any pesticide, stop and read the precautions.
2. Read the label on each pesticide container before each use. Heed all warnings and precautions.

3. Store all pesticides in their original containers away from food or feed.
4. Keep pesticides out of the reach of children, pets, and livestock.
5. Apply pesticides only as directed.
6. Dispose of empty containers promptly and safely.

Recommendations in this document are guidelines only. The user must insure that the pesticide is applied in strict compliance with label directions.

The Food and Drug Administration has established residue tolerances for several insecticides in the meat of certain animals. When these and other approved insecticides are applied according to recommendations, the pests should be effectively controlled, and the animals' products will be safe for consumption.

The improper use of insecticides may result in residues in milk or meat. Such products must not be delivered to processing plants. To avoid excessive residues, use the insecticides recommended at the time recommended and in the amounts recommended.

For more information on pesticide safety, please consult the EDIS document *Pesticide Safety Around Animals*.

## Locating an Approved Pesticide

In 2014, a group of livestock entomologists, as a part of Multistate Hatch Project S-1060, developed an online system for obtaining the names of registered pesticides appropriate for use with livestock and pets. This is a state-specific database (only certain states are represented, and Florida is one of these); if you are in another state, you must be certain that your state is represented in the drop-down list.

This database is easily searchable by the type of animal or site that you want to treat (such as a barn), as well as the targeted pest. From these two selections, you can then choose the "Method of Application" and the "Formulation Type." To use this system, please visit the following website: <https://www.veterinaryentomology.org/vetpestx>.

Although we continuously strive to keep this database current, it is ultimately your responsibility to ensure that the product that you choose is registered in Florida (and the application is made in Florida) and that you use the product in accordance with the label requirements and



local laws and ordinances. Remember, “the label is the law” for pesticide use, and the uses indicated on the label, including the site of application and targeted pest(s) must be on the label.

If you have any challenges with this system, please contact your local UF/IFAS Extension office (<http://sfyl.ifas.ufl.edu/find-your-local-office/>) or for additional assistance contact Dr. Phillip Kaufman, [pkaufman@ufl.edu](mailto:pkaufman@ufl.edu).

## Improving Control

Great progress has been made in control of stable flies in recent years, but a number of actions must be taken if the present level of control is to be improved significantly.

These are:

1. The public and those responsible for stable fly control must be made aware of the extent of the problem and must realize that it cannot be controlled by small-scale, isolated efforts.
2. There must be realistic funding for trained personnel and equipment to combat the pest. Because of its long flight range, the stable fly is not a problem just at the county level; it is a state-wide issue. Therefore, even if the developmental sites of this pest are managed in an area, there still might be a stable fly problem in that area if the fly is not controlled in other neighboring regions.
3. Man-made sources of flies in agricultural and industrial areas and on private premises must be eliminated or greatly reduced. In most instances this can be accomplished by proper handling and disposal of animal and plant wastes.
4. Each coastal county must operate an effective stable fly surveillance and control program on beaches seven days a week in late summer and fall.

## References

Broce, A. B. 1988. “An improved Alsynite trap for stable flies *Stomoxys calcitrans* (Diptera: Muscidae).” *J. Med. Entomol.* 25: 406–409.

Campbell, J. B., S. R. Skoda, D. R. Berkebile, D. J. Boxler, G. D. Thomas, D. C. Adams, and R. Davis. 2001. “Effects of stable flies (Diptera: Muscidae) on weight gains of grazing yearling cattle.” *J. Econ. Entomol.* 94: 780–783.

Catangui, M. A., J. B. Campbell, G. D. Thomas, and D. J. Boxler. 1995. “Average daily gains of Brahman-crossbred

and English x exotic feeder heifers during long-term exposure to stable flies (Diptera: Muscidae).” *J. Econ. Entomol.* 88: 1349–1352.

Catangui, M. A., J. B. Campbell, G. D. Thomas, and D. J. Boxler. 1997. “Calculating economic injury levels for stable flies (Diptera: Muscidae) on feeder heifers.” *J. Econ. Entomol.* 90: 6–10.

Cilek, J. E. 2002. “Attractiveness of beach ball decoys to adult *Stomoxys calcitrans* (Diptera: Muscidae).” *J. Med. Entomol.* 39: 127–129.

Gerry A. C. (updated 8/17/2018). VetPestX: Database of pesticides for control of insect pests of animals. Retrieved from <https://www.veterinaryentomology.org/vetpestx>

Hogsette, J. A., and J. P. Ruff. 1985. “Stable fly (Diptera: Muscidae) migration in northwest Florida.” *Environ. Entomol.* 14: 170–175.

Hogsette, J. A. 1990. “Comparative attraction of four different fiberglass traps to various age and sex classes of stable fly (Diptera: Muscidae) adults.” *J. Econ. Entomol.* 83: 883–886.

Hogsette J. A., and G. A. Ose. 2017. “Improved capture of stable flies (Diptera: Muscidae) by placement of knight stick sticky traps protected by electric fence inside animal exhibit yards at the Smithsonian’s National Zoological Park.” *Zoo Bio.* 36: 382–386.

Hogsette J. A., and L. D. Foil. 2018. “Blue and black cloth targets: Effects of size, shape and color on stable fly (Diptera: Muscidae).” *J. Econ. Entomol.* 111: 974–979.

Jones, C. J., J. A. Hogsette, R. S. Patterson, D. E. Milne, G. D. Propp, J. F. Milio, L. G. Rickard, and J. P. Ruff. 1991. “Origin of stable flies (Diptera: Muscidae) on west Florida beaches: Electrophoretic analysis of dispersal.” *J. Med. Entomol.* 28: 787–795.

Kaufman, P. E., and E. N. I. Weeks. (2015). *Pesticide Safety Around Animals*. ENY-272/IG-128. Gainesville: University of Florida Institute of Food and Agricultural Sciences. Available at <http://edis.ifas.ufl.edu/ig128> (last accessed 7 Jan 2019).

Machtinger, E. T., N. C. Leppla, and J. A. Hogsette. 2016. “House and stable fly seasonal abundance, larval development substrates, and natural parasitism on small equine farms in Florida.” *Neotrop. Entomol.* 45: 433–440.

Marcon, P. C. R. G., G. D. Thomas, B. D. Siegfried, and J. B. Campbell. 1997. "Susceptibility of stable flies (Diptera: Muscidae) from southeastern Nebraska beef cattle feedlots to selected insecticides and comparison of 3 bioassay techniques." *J. Econ. Entomol.* 90: 293–298.

Moon, R. D. 2002. Muscoid flies (Muscidae), pp. 45–65. *In* G. R. Mullen and L. A. Durden (eds.), *Medical and Veterinary Entomology*, vol. 2. Elsevier, San Diego, CA.

Pickens, L. G., E. T. Schmidtman, and R. W. Miller. 1994. How to control house and stable flies without using pesticides, pp. 1–14. USDA, Washington, DC.

Pitzer, J. B., P. E. Kaufman, S. H. TenBroeck, and J. E. Maruniak. 2011. "Host blood meal identification by multiplex polymerase chain reaction for dispersal evidence of stable flies (Diptera: Muscidae) between livestock facilities." *J. Med. Entomol.* 48: 53–60.

Rochon, K., T. J. Lysyk, and L. B. Selinger. 2004. "Persistence of *Escherichia coli* in immature house fly and stable fly (Diptera: Muscidae) in relation to larval growth and survival." *J. Med. Entomol.* 41: 1082–1089.

Taylor, D. B., R. D. Moon, and D. R. Mark. 2012. "Economic impact of stable flies (Diptera: Muscidae) on dairy and beef cattle production." *J. Med. Entomol.* 49: 198–209.

Vitela-Mendoza, I., C. Cruz-Vazquez, J. Solano-Vergara, and A. Orihuela-Trujillo. 2016. "Short communication: Relationship between serum cortisol concentration and defensive behavioral responses of dairy cows exposed to natural infestation by stable flies." *J. Dairy Sci.* 99: 9912–9916.

Woolley, C. E., S. Lachance, T. J. DeVries, and R. Bergeron. 2018. "Behavioral and physiological responses to pest flies in pastured dairy cows treated with a natural repellent." *Appl. Anim. Behav. Sci.* 207: 1–7.

Wright, R. E. 1985. Arthropod pests of beef cattle on pastures and range land, pp. 191–206. *In* R. E. Williams, R. D. Hall, A. B. Broce and P. J. Scholl (eds.), *Livestock Entomology*. Wiley, New York.

## **Alachua County**

Dr. Cindy Sanders  
County Extension Director - Livestock  
[Sanders1@ufl.edu](mailto:Sanders1@ufl.edu)  
(352) 955-2402

Dr. Kevin Korus  
Agriculture / Natural Resources  
[kkorus@ufl.edu](mailto:kkorus@ufl.edu)  
(352) 955-2402

## **Baker County**

Alicia Halbritter  
Livestock / Forages  
[aliciah1221@ufl.edu](mailto:aliciah1221@ufl.edu)  
(904) 259-3520

## **Bradford County**

Laura Bertelli Canal  
Livestock / Forages  
[bertellicanall@ufl.edu](mailto:bertellicanall@ufl.edu)  
(904) 966-6224

## **Citrus County**

Clay Cooper  
Agriculture / Natural Resources  
[coop1632@ufl.edu](mailto:coop1632@ufl.edu)  
(352) 527-5700

## **Clay County**

Vacant

## **Columbia County**

Paulette Tomlinson  
Livestock / Natural Resources  
[apt@ufl.edu](mailto:apt@ufl.edu)  
(386) 752-5384

## **Duval County**

Jane Cant  
Livestock / Forages  
[jane.griffin@ufl.edu](mailto:jane.griffin@ufl.edu)  
(386) 362-2771

## **Hamilton County**

Keith Wynn  
Agriculture / Livestock  
[kwynn@ufl.edu](mailto:kwynn@ufl.edu)  
(386) 792-1276

## **Levy County**

Ed Jennings  
County Extension Director- Livestock  
[edjennin@ufl.edu](mailto:edjennin@ufl.edu)  
(352) 486-5131

## **Madison County**

Dan Fenneman  
Agriculture / Livestock  
[dfenneman@ufl.edu](mailto:dfenneman@ufl.edu)  
(850) 973-4138

## **Nassau County**

Justina Dacey  
Agriculture / Natural Resources  
[jdacey@ufl.edu](mailto:jdacey@ufl.edu)  
(904) 879-1019

## **Suwanee County**

Vacant

## **Union County**

Luke Harlow  
Agriculture / Natural Resources  
Interim County Extension Director  
[harlow1231@ufl.edu](mailto:harlow1231@ufl.edu)  
(386) 496-2321