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VARROA MITE CONTROL IN SOUTH CAROLINA

INTRODUCTION

The varroa mite, *Varroa jacobsoni*, is considered to be the most serious honey bee pest which now occurs almost worldwide. Many beekeeping operations in South Carolina have lost colonies to this parasite. Normally, unprotected honey bee colonies will die from the effects of varroa within one to two years. So, it is imperative that beekeepers become familiar with and apply the latest varroa mite control recommendations.

Fig. 1 - Adult varroa on honey bee

HISTORY

The varroa mite's natural host is the Asian honey bee, *Apis cerana*, and it seldom reaches a destructive level in this species. Varroa mites were found on specimens of Asian bees collected in 1942 and are stored in Museum Moscow. Varroa mites were first discovered in the same USSR region on European honey bees, *Apis mellifera,* in 1964. A rapid and multidirectional spread of the mite occurred within the USSR. Varroa was first detected in West Germany in 1977. The mite continued to spread and is now found throughout the world within the natural limits of honey bee distribution.

In September 1987, varroa mites were first discovered in North America in honey bee colonies located in Saukville, Wisconsin. Shortly after this initial find, varroa was discovered in Florida. By the end of October 1987, varroa had been found in 19 of Florida's 67 counties. By spring of 1988, the mite had been detected in 12 US states. Varroa mites were first discovered in resident South Carolina honey bee colonies in Saluda county in November 1990 and have now spread throughout the state.

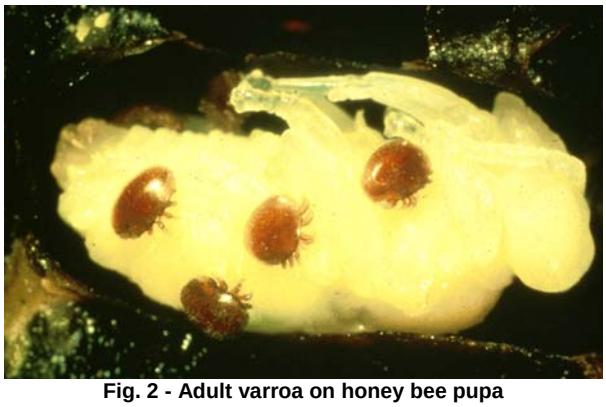

Fig. 2 - Adult varroa on honey bee pupa

BIOLOGY

Varroa mites can be found on adult honey bees, on the brood and in the hive debris. The adult mite has eight legs and is reddish brown, oval and flattened in shape. Their flattened body confirmation allows them to hide between the bees abdominal segments and go unnoticed by the beekeeper. The adult female is about 1.1 mm long and 1.5 mm wide; it can be seen easily with the unaided eye (about the size of the head of a common pin). Male varroa are considerably smaller and are pale to light tan in color.

When brood are present in the hive, an adult female mite will enter an uncapped larval cell (5-5.5 days old). After the cell is sealed, the mite will lay approximately five eggs. Egg to adult stage requires 5-6 days for male mites, and 6-7 days for females. The nymphal stages feed on the developing brood, often causing deformities in the developing bee. The old female and the newly mated female mites exit the cell as the young honey bee emerges from the cell. Adult honey bees serve as an intermediate host and a form of transportation for the newly emerged mites. Male mites and any immature female mites are left behind in the cell to die. Life span of varroa females is reported to be 2-3 months in summer and 6-8 months in winter. Mite populations increase

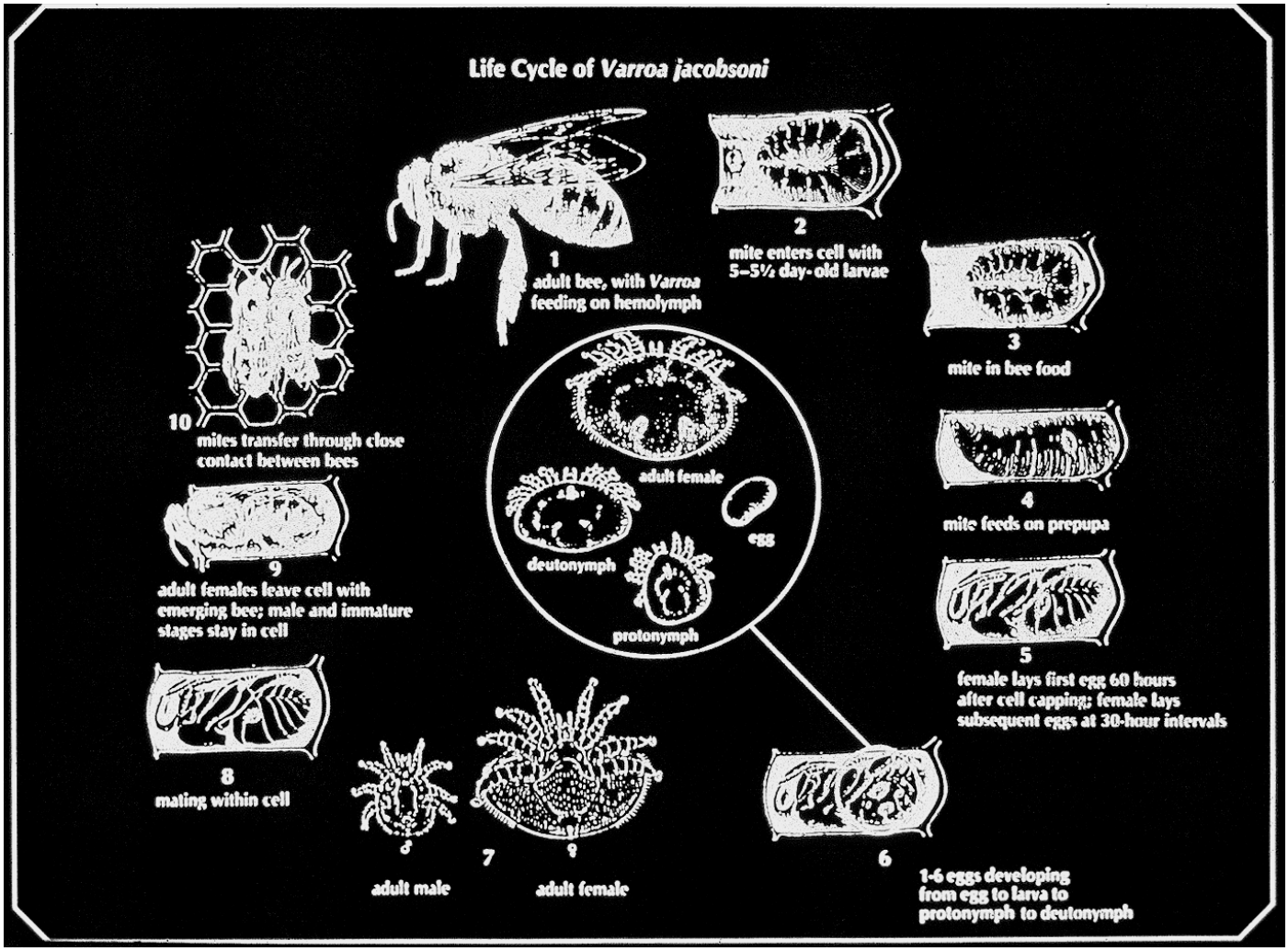

Fig. 3 - Life cycle of *Varroa jacobsoni* (Courtesy of Roger A. Morse)

rapidly during the heavy brood rearing season. Drone brood are parasitized more than worker brood. In South Carolina, bee colonies usually die from varroa parasitism in mid-summer to fall. This late-season die-off period (including unmanaged wild colonies) may lead to infestation of nearby colonies through robbing or drifting bees that abscond from the collapsing colonies.

Varroa infested colonies may die with full supers of honey left behind that are subject to destruction by wax moths. Beekeepers can safely extract uncontaminated honey from dead colonies prior to ant or wax moth infestation.

Varroa mites have piercing and sucking mouthparts and feed on blood of honey bee adults, larvae and pupae. In heavy infestations, pupae may not develop into normal adult bees and several mites per cell (five mites or more per pupa) may result in death. Adult bees that emerge may have misshapen wings, deformed legs, shortened abdomens, and may weigh less than mite-free raised honey bees. These heavily infested bees may be found in front of the hive, unable to fly. Other symptoms of heavy mite infestation include spotty brood pattern and the appearance of a weak colony with low morale. Low mite infestations are difficult to detect without a thorough survey.

Varroa mites can live only a few days without a blood meal from an immature or adult bee. Equipment that has been stored free of brood and adult bees for two weeks or more may be reused without fear of mite survivability.

Varroa mites are spread from colony to colony by drifting bees, especially drones. Other means of mite spread are bee colony movement for pollination or honey production. Mites can also be spread with package bees, queens, and swarms.

Fig. 4 - Honey bees showing degenerative conditions caused by varroa

ECONOMIC IMPORTANCE

Thousands of managed honey bee colonies in South Carolina have been affected or lost as a result of varroa since 1990. The value of the feral and managed honey bee colonies lost to this pest, and the resulting damage caused by decreased honey production and the loss of marginal beekeepers, is only a fraction of the losses caused by inadequate pollination of vegetable, fruit crops, and wildlife food plants. Fruit and vegetable growers (apple, cucumber, melon, etc.) have experienced increased honey bee colony rental costs to insure adequate pollination. South Carolina beekeepers have experienced increased management costs due to colony replacement and mite control.

DETECTION

Unless special measures are taken to survey for varroa mite levels, the beekeeper may treat colonies unnecessarily or may delay treatment too long. Infested colonies may appear to be apparently healthy up to a certain mite level, but will suffer a population crash at a certain mite threshold, depending on local conditions and other factors. A beekeeper should choose an effective method of mite detection and periodically survey for pest level.

When sampling for varroa, remember that the number and location of mites in a colony vary according to time of year. The number of mites is lowest in spring, increase during the summer, and is highest in the fall. During spring and summer, most varroa are found on the brood. In late fall and winter, most mites are attached to adult worker honey bees. To get a reliable estimate of the varroa density in an apiary, beekeepers should survey at least 50 percent of the colonies. There are several varroa mite survey methods available to the beekeeper.

Brood Examination - Varroa mites spend most of their life cycle inside sealed bee brood cells. Uncapping and checking brood (pupae) for mites is a reliable detection method. The adult mites can be easily seen against the white surface of worker or drone pupae after they are removed from the cells. It is suggested that at least 100 pupae per colony be examined for an adequate survey. An individual pupa can be removed from its cell with forceps or groups of pupae removed from their cells by inserting a capping scratcher at an angle through the cappings and lifting the brood and cappings upward.

Fig. 5 - Pupa removal

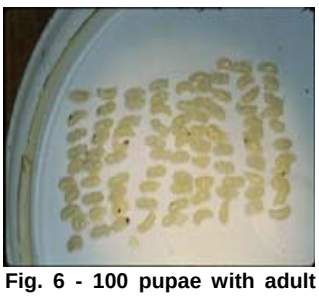

Fig. 6 - 100 pupae with adult varroa

Ether Roll - This technique gives a reliable estimate of the varroa population at moderate to high levels, but is less sensitive when surveying for low level mite infestations. The best time to use this method of mite detection is in late summer or fall. At least 300 adult bees from the brood nest should be collected in a quart jar and anesthetized with ether delivered from an aerosol can (this product is sold in auto-parts stores as an aid to start engines). A 1-2 second burst of ether spray is adequate; cap the jar, roll and shake it for 30 seconds. Most of the mites will dislodge from the bees and will adhere to the inside sticky surface of the jar. The mites will appear as brown oval objects and can be easily counted. WARNING: the aerosol ether product is highly flammable and should be used with extreme caution around bee smokers or other forms of heat.

Fig.7 - Two short bursts of ether in jar of 300 bees

Fig. 8 - Roll and shake vigorously for 30 sec.

Fig. 9 - Remove bees & count varroa

Fig.10 - Wash 300 bees thoroughly to remove varroa

Bee Washes - Collect about 300 adult bees from the brood nest into a jar filled with detergent-water or alcohol. Place a lid on the jar and shake vigorously for about a minute; then pour the bees and solution through a double screen or sieve. The upper screen should filter out the bees while the lower screen will catch the mites. A white drip coffee pot filter used on the second screen to catch varroa mites works fine. Repeat the solution wash for a

thorough survey. The beekeeper may then count the bees and mites and estimate a mite to bee ratio for the colony.


Fig. 11 - Count varroa

Mite Fall Examination - This technique requires a piece of sticky white construction paper be placed on the hive floor. The paper surface may be made sticky by applying petroleum jelly, cooking oil spray or Tangle Foot. The mites will naturally fall from the bees in the hive and be trapped in the adhesive material. A screen of 1/8 inch hardware cloth must be placed 1/4 inch above the sticky paper to prevent bees from becoming en-tangled on the trap or allowing bees to remove mites from the trap. Commercially produced frames to exclude bees, the Varroa Trap and the Beltsville Screen Insert, are available through bee supply stores or a beekeeper may con-struct a similar frame. The sticky paper is removed after 2-3 days and can be easily examined for trapped mites. A magnifying glass or dissecting microscope may be helpful in counting mites if heavy debris is present on the trap. This is a very sensitive method of mite survey when the colony is broodless. Mite fall counts can be increased using an approved acaricide treatment during the survey.


Fig. 12 - Loading varroa detector board

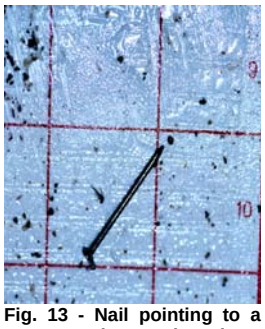
Fig. 13 - Nail pointing to a varroa on detector board

Fig. 14 - Several hundred varroa on detector board

Laboratory Confirmation - Beekeepers may mail bee samples (100 adult bees) to the USDA Bioenvironmental Bee Lab, Building 476, BARC-E, Beltsville, Maryland, 20705 to test for the presence of mites. The mite level will not be estimated. The bees should be placed in a small sealed container with enough alcohol to cover the bees. The container should be mailed in a cardboard box with adequate packing to prevent breakage or accidental leakage. Any sample of brood in comb should be wrapped with paper and shipped dry in a cardboard box. When shipping samples always indicate the owners name, address, county, apiary location and collection date.

CONTROL METHODS

Beekeepers must accept the fact that varroa mite eradication is not possible. We must aim at avoiding pest damage levels using highly effective means of control. Beekeepers are urged to attend local, state and regional beekeeper meetings to stay abreast of the latest varroa mite control recommendations. Beekeeping journals are another good source of current information on how to control varroa. There are many varroa mite control methods available to the beekeeper. Some have been shown to be only moderately effective. An integrated approach to varroa mite control that includes cultural, chemical, and use of resistant lines of bees is best.

Cultural Control - The removal and destruction of infested bee brood, especially drone brood, having mites has proven to reduce varroa problems, but this method is labor intensive and reduces colony strength. Confining the queen to a cage inside the hive and creating a broodless period may break the varroa life cycle, but this method will also stress the colony. The use of the Beltsville Screen Insert which is a bottom board modification with screen slows the growth rate of varroa, but it does not control the mites without the use of other control measures.

Chemical Control - Beekeepers should use only pesticides which are registered for use in South Carolina by EPA for varroa mite control. A pyrethroid, fluvalinate, is fully registered under the name Apistan™ in the US and an organic phosphate, coumaphos, under the name of Bayer Bee Strip or Check Mite+ ™ is registered in SC under an emergency use label only. Both products are available only in plastic strips impregnated with chemical that kills varroa by contact. The strips are hung vertically between hive frames so that the bees and mites


Fig.15 - Apistan™


Fig.16 - Bayer Bee Strip or Check Mite+™

come in contact with the chemical. The strips have enough active ingredient to kill the small mites, but do not affect the larger sized bees. Beekeepers should follow label instructions exactly on these products and remove strips in a timely manner to avoid mite resistance to the product and honey contamination. These products should not be used during a nectar flow and never use both products in a hive at the same time. Treatment effects of these products used simultaneously may be detrimental to the colony. A formic acid gel product should be available for varroa mite control in Fall 1999.

Fig. 17 - Never use these two products in a hive at the same time

Varroa mites have shown resistance to fluvalinate in some European countries and a few US commercial and sideline beekeeping operations. There has been no reports of mite resistance to fluvalinate in SC. Possible reasons for the resistance problem are the long term use of a single product to kill varroa mites, beekeeper failure to remove pesticide strips in a timely manner, and misuse of pesticide products not labeled for varroa control.

Resistant Bee Lines - The use of selected lines of bees that show mite resistance is a preferred method of control. Only a moderate level of varroa resistance has been reported. Varroa resistance may come in the form of bees that show a grooming behavior, hygienic behavior, or shortened brood period that disrupts the life cycle of mites.

Organic Oils - The use of botanical or essential oils such as thymol, neem, and canola may reduce varroa mite numbers. Most require an integrated approach along with other control measures to maintain healthy bee colonies. Some applications of these naturally occurring oils may be detrimental to the colony, causing queen failure or significant loss of worker bees. Additional research is needed to develop application methods of botanical oils for mite control to prevent negative effects on bee colonies.

TREATMENT THRESHOLDS

Chemical acaricides have been used in most successful varroa mite control programs. In an integrated approach to varroa mite control, the goal should be to not treat at low tolerable levels, but to treat only when high pest levels are reached. The crucial problem in a successful mite management program is the proper timing of acaricide treatments. A more judicious system of properly timed treatments may have prolonged the useful life of fluvalinate in areas where resistance to the acaricide has been reported. The resistance problem has led to a vicious cycle where all the spinoffs are negative such as:

- increased use of illegal, unregistered chemicals for varroa control
- increased danger to the honey bees from chemical overexposure
- increased danger to the beekeeper while experimenting with other chemicals
- increased chance of honey contamination
- increased management cost for chemicals and labor
- increased chemical use which may cause residue buildup in comb
- increased chance of chemical cross-resistance

The magnitude of these spinoffs is difficult to estimate and the additional costs to the beekeepers as a result of acaricide resistance are unknown.

Optimal use of acaricides is highly recommended to protect the effectiveness of products over a long period of time. On the other hand, beekeepers must avoid delaying treatment to the "colony collapse level" which can be defined as the lowest varroa mite density which causes colony mortality regardless of treatment. This mite level can vary from region to region depending on climate and other factors that affect bee colony health. The mite damage to the colony below this level is tolerable, but beekeepers should treat well below the colony collapse level to maintain productive colonies.

The key to this pest management dilemma is the development of suitable guidelines for treatment recommendations commonly referred to as treatment thresholds. Treatment threshold here is defined as "the varroa mite density at which control measures should be applied to prevent an increasing pest population from reaching the colony collapse level." The treatment threshold always represents a varroa mite level lower than the colony collapse level. This allows the beekeeper to take action before the varroa density reaches the colony collapse level. By delaying treatment beyond the treatment threshold, the beekeeper risks increased bee mortality, brood pathology and colony mortality. On the other hand, if a beekeeper treats far below the treatment threshold as an "insurance treatment," he/she has increased management costs unnecessarily along with other possible negative side effects as mentioned earlier.
The goal is to identify the level of varroa mites that should be treated to maintain productive colonies and

thus to minimize treatments based on adequate and reliable sampling data. Treatment thresholds should be re-validated periodically in a given region to prevent treatment at lower mite densities than necessary.

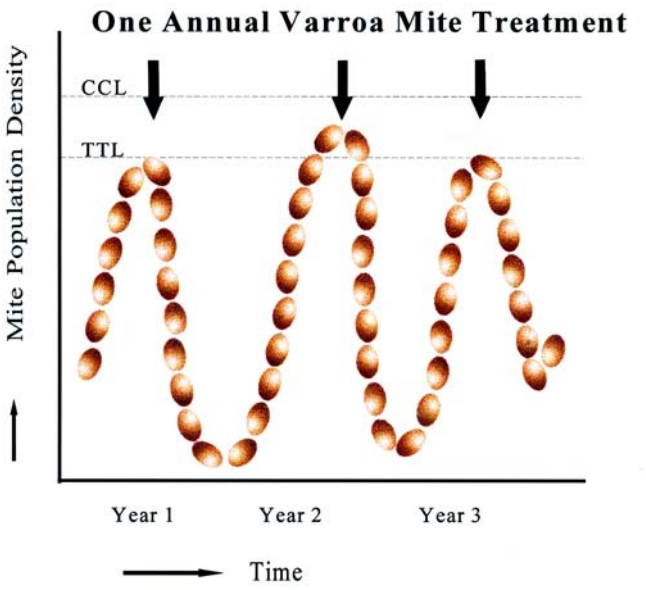

Fig. 18 - Honey bee colony collapse level and varroa mite treatment threshold level. CCL, colony collaspe level; TTL, treatment threshold level. Arrows indicate acaricide treatment.

The primary objective of a treatment threshold system is to reduce the number of acaricide applications and still maintain strong, productive colonies. This may result in an immediate cost savings to the beekeeper. A timely application of a highly efficient varroa mite control product is recommended to lengthen the interval between applications. On the other hand, non-chemical methods of varroa control may be used in rotation with acaricides to maintain low mite levels.

A treatment threshold system should identify, for a given region, the mite level and time of year at which acaricide treatments give satisfactory results relative to some future date. This permits a beekeeper to 1) anticipate at what time of year treatment may be necessary and 2) make an informed treatment decision if sampled mite levels at that time meet or exceed an established threshold.

A research based varroa treatment threshold was developed for newly installed (in April) package bees for the piedmont region of Georgia and South Carolina (Delaplane & Hood 1997). A late-season acaricide treatment in the first year colonies was justified at about 15 varroa mites collected with a 300-bee ether roll and overnight adhesive bottom board insert mite level of about 117 mites in mid-August. Using this information, a beekeeper in the piedmont region of South Carolina should take the following actions:

(1) if the mite level detected in mid-August is close to the treatment threshold, then treatment with an acaracide is highly recommended to prevent the mite population from reaching the colony collapse level. Treated colonies should winter well with adequate number of bees and a tolerable number of varroa mites.

(2) If the mite level is well below the treatment threshold in mid-August, the beekeeper should delay treatment until perhaps the next February.

(3) If the mite level is much greater than the treatment threshold or above the colony collapse level in mid-August, the beekeeper may treat but expect to lose the colony.

Other treatment threshold research (Delaplane & Hood 1999) conducted in the piedmont region of Georgia and South Carolina with overwintered colonies yielded very similar thresholds. An ether roll of 15-38 mites and overnight bottom board insert of 59-187 were the varroa treatment threshold levels developed for August.

Treatment Threshold Limitations - Treatment thresholds should not be generally accepted outside of the region from which they were developed. Differences in brood rearing levels and possibly unknown genetic differences in bee and mite populations may alter conditions for adoption of treatment threshold guidelines. Treatment thresholds are not valid when used outside the parameters which they were developed, such as time of year (month). Extreme colony conditions, such as swarming or a period following a pesticide kill, may result in erroneous conclusions.

A research based treatment threshold system is not a long term prescription for good bee health without adequate disease and pests management practices by the beekeeper. Periodic re-validation of thresholds is necessary to maintain the reliability of recommendations.

Conclusions - Several factors have contributed to the argument for use of a treatment threshold systems These include the news of varroa mites developing resistance to a pesticide in some parts of the world, the increased cost to beekeepers in managing mites, the increased cost of discovering and developing new pesticides, and the continued fear of honey and comb contamination have all.

The varroa mite treatment threshold system is based on the principal that pesticides should be used only when the mite population reaches a certain level to prevent colony collapse. The rotation of different chemical class pesticides is recommended to prolong the useful life of acaricides. Nonchemical methods of varroa control that have been proven to be effective are also recommended. Widespread adoption and use of

treatment thresholds in a region will further enhance the effectiveness and prolong the useful life of an acaricide.

PRECAUTIONARY STATEMENT

In order to protect people and the environment, pesticides should be used safely. This is the responsibility of everyone, especially the user. Read and follow label directions carefully before you buy, mix, apply, store, or dispose of a pesticide. It is a violation of State and Federal Laws to use pesticides in a manner inconsistent with its label.

DISCLAIMER STATEMENT

Pesticides recommended in this publication were registered for the prescribed uses when printed. Pesticide registrations are continuously being reviewed and may be revoked for proper justification. Should registration of a recommended pesticide be canceled it would no longer be recommended by Clemson University.

Use of trade names in this publication is for clarity and information; it does not imply approval of the product to the exclusion of others which may be of similar, suitable composition, nor does it guarantee or warrant the standard of the product.

Resources:

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