The Sugarcane Aphid: Management Guidelines for Grain and Forage Sorghum in Texas.

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Introduction. The sugarcane aphid (SCA) has recently become one of the most important insect pests of grain and forage sorghum in Texas and the southern US. The sugarcane aphid originally fed only on sugarcane in the US. In 2013, it was found feeding on sorghum near Beaumont, TX. This sorghum-feeding biotype of the sugarcane aphid resulted from either a genetic change in the existing US population or a new introduction into the US. In 2013, the sugarcane aphid infested sorghum in the Rio Grande Valley, Texas Gulf Coast and in north Texas and in southern Oklahoma, Louisiana and Mississippi. Sugarcane aphids survived the 2013-2014 winter in south Texas and during the spring and summer of 2014, dispersed throughout much of Texas and 12 southern states. In 2015, the sugarcane aphid again dispersed through Texas into Oklahoma and Kansas and the south eastern US, eventually infesting 17 states representing 90% of the US sorghum acreage.

This pest can be economically controlled, but growers must frequently assess infestations to properly time an insecticide, if needed, to prevent crop loss and harvest difficulties due to honeydew accumulation. Sorghum hybrids with resistance to sugarcane aphid are being developed and will play an important part in managing sugarcane aphid. Resistant hybrids, along with selective insecticides and biological control provided by beneficial insects, are important components of an integrated pest management program for sugarcane aphid.

Identification. Sugarcane aphids are pale yellow, gray or tan. The cornicles or "tailpipes", feet and antennae are black. The SCA feeds on the underside of sorghum leaves. Initial colonies consist of only a few aphids but can increase such that aphid colonies cover much of the lower leaf surface. Once the sorghum head emerges, SCA can also be found in the grain head. They do not feed on the upper leaf surface. They are often found in compact colonies during initial infestation, but large populations can develop within a few weeks covering much of the leaf surface. Sugarcane aphids produce large amounts of honeydew which collect on leaves, leaving them sticky and shiny. When first looking for aphids, the shiny reflection of honeydew on leaves can help detect small colonies

The greenbug is another common aphid that feeds on the underside of sorghum leaves. It has a dark green stripe down its back, unlike the sugarcane aphid. The corn leaf aphid is also found in sorghum but it is a dark green color, feeds in the whorl of the sorghum plant and is rarely a pest. The yellow sugarcane aphid also feeds on sorghum. It is bright yellow with rows of dark spots and short cornicles, but it does not produce honeydew. See Figure 1.

Life Cycle. All SCA are females and give birth to live young. Immature aphids mature to adults in about five days and live for about 4 weeks. Aphid numbers can increase very rapidly during the summer. At Corpus Christi, an infestation of 50 SCA per leaf increased to 500 per leaf in 2 weeks. For this reason, once SCA are found in a field, it should be monitored 1-2 times a week to determine if infestations exceed the treatment threshold at which time an insecticide application should be considered to prevent crop loss. Under warm dry conditions that are optimal for aphid reproduction, twice a week field scouting is highly advisable.

Sugarcane aphids need living sorghum or Johnsongrass, plants to survive the winter. Small colonies of SCA can be found on Johnsongrass and volunteer sorghum which remain green throughout the winter in

the Rio Grande Valley and Gulf Coast of Texas and in northern Mexico. Little is known about the ability of SCA to overwinter in northern areas of TX. In 2015, small colonies were found on Johnsongrass in early April near Waco and Hillsboro, suggesting that SCA can overwinter as far north as central Texas in some years. As SCA colonies become crowded and/or food quality declines, adults with wings begin to appear. Although weak fliers, winged aphids can be carried on the wind across long distances. It is believed that each spring winged SCA aphids are carried by winds from overwintering sites in Mexico and south Texas to northern areas of Texas and then from field to field during the growing season..

Host Plants. Sugarcane aphids are known to feed and reproduce well on grain and forage sorghum (Sudan grass, sorghum/Sudan hybrids, forage sorghum, shattercane) and Johnsongrass. All of these hosts are in the genus *Sorghum*. Laboratory tests show that SCA does not survive on wheat, oats, or on seedling foxtail millet or proso millet. Hybrid pearl millet is not a species of Sorghum. However, small colonies of SCA are sometimes present but little damage results, thus hybrid pearl millet is considered a poor host of SCA. Winged SCA aphids may be found on other crops, such as corn, but they either fail to establish colonies or only small colonies develop which soon die out without crop damage. The sugarcane aphid also feeds on sugarcane in the Rio Grande Valley, but populations usually do not increase to the large numbers observed in sorghum.

Damage. Sugarcane aphids feed by sucking plant sap, but there is no evidence of it injecting a toxin. Feeding causes leaves to turn yellow, purple and finally brown as leaf tissue dies. Infestations on pre-boot sorghum can result in significant grain loss, but infestations present during grain development can also reduce yields. Large infestations can stunt growth and result in uneven panicle emergence from the boot. The sticky leaves and stalks clog combines at harvest and reduce separation of the grain from the plants. Combines may require service time to wash off the honeydew and remove stalks and grain heads. Infestations in forage sorghums also kill leaves, slow growth and reduce forage yields. Honeydew contaminating leaves and stems can also gum up cutter bars and machinery at harvest. Honeydew is composed primarily of plant sugars and water and eventually dries to a harmless residue, but a black sooty mold often grows on the honeydew on leaves. This black mold inhibits light absorption needed for photosynthesis and may reduce the effectiveness of insecticides and harvest aid chemicals. Sorghum stressed by SCA feeding may be more susceptible to stalk rots and lodging frequently occurs following heavy plant damage due to aphid feeding.

Sampling SCA Infestations in Grain Sorghum. Begin looking for sugarcane aphids when plants are in the 4-5 leaf stage in south Texas and the 8-10 leaf stage in more northern areas of the state. Mild winters may increase the potential for earlier infestations. The “First Detection” sampling plan detailed below is designed to determine if sugarcane aphids are present in the field and therefore the field is at risk. This sampling does not require counting aphids. If SCA aphids are found in the field, then it is necessary to begin the second sampling protocol to determine if the infestation has reached the action threshold at which time an insecticide should be applied to protect crop yield.

First Detection: Is the Field at Risk?

1. Once a week, examine plants along 50 feet of row, dividing the sampling effort between the field edge and at least 25 feet into the field.
2. If honeydew is present, look for sugarcane aphids on the underside of a leaf above the honeydew.
3. Inspect the underside of leaves from the upper and lower canopy from 15-20 plants per location.

4. Sample each side of the field as well as sites near Johnsongrass and tall mutant plants.
5. Check at least 4 locations per field for a total of 60-80 plants.
6. If no sugarcane aphids are present, or only a few wingless or winged aphids are on upper leaves, then continue once a week scouting.

If sugarcane aphids are found on lower or mid-canopy leaves, begin twice a week scouting. Use one of the two thresholds below to determine if aphid densities exceed a treatment threshold.

Making A Treatment Decision. Two action thresholds, the South-Central Texas Economic Threshold and the Texas High Plains Grain Sorghum Action Threshold, are presented below to aid in determining when an insecticide treatment is needed to protect yield.

South-Central Texas Economic Threshold

The South-Central Texas economic threshold is based upon the number of aphids per leaf during the pre-boot and boot stage and has been successfully used in south and central TX.

Field Sampling Protocol. Once sugarcane aphids are found in a field, use the following protocol to assess the infestation.

1. Examine the underside of one completely green leaf from the lower canopy and the upper most leaf (or leaf below flag leaf at boot to heading) and estimate and record the number of SCA per leaf [a].
2. Examine 2 leaves from each of 5 randomly selected plants (10 leaves) per location.
3. Repeat at 4 locations for a total of 40 leaves per field.
4. Calculate the average number of aphids per leaf for the field (total aphids counted/total leaves inspected).

[a] Counting exact numbers of aphids per leaf is impractical, and an aphid estimation tool has been developed, 'Scouting Sugarcane Aphid' and can be found at http://ccag.tamu.edu/sorghum-insect-pests/ under Quick Information Sheets and Guides.

Economic Threshold

1. If the **field average is 50-125 sugarcane aphids/leaf or greater**, apply an insecticide within 4 days and evaluate control after 3-4 days (refer to insecticide labels for re-entry intervals). Continue to monitor SCA infestations until harvest to determine if a second insecticide application is necessary.

2. Consider treatment at 50 aphids/ leaf if limited to only once a week scouting or if the weather is warm and dry.

3. If the field average is less than the threshold level, continue scouting twice a week.

The economic threshold of 50-125 aphids/leaf is based upon the potential yield loss if sugarcane aphid is not controlled, the cost of control and the expected market value of the crop. Economic thresholds for different costs for control (insecticide and application cost) and market value are shown in the table below. As an example, if the cost of control is $20/acre and the market value is $5.00/bushel, then the treatment threshold is an average of 90 or more SCA/leaf.

The economic threshold can also be easily determined using the on-line Sugarcane Aphid Treatment Decision Tool for Grain Sorghum at: http://bitly.com/scasorghum

Table. Economic thresholds for sugarcane aphid infestations starting at or before boot stage of development in grain sorghum. An insecticide treatment should be considered when the average number of sugarcane aphids per leaf exceeds the value in the table .

Market value of crop	Cost of Control = $15/acre	Cost of Control = $20/acre	Cost of Control = $25/acre
$3.50/bushel, $6.25/cwt	100	130	165
$5.00/bushel, $8.93/cwt	70	90	115
$6.50/bushel, $11.60/cwt	55	70	90

These values are applicable to grain sorghum and infestations starting at or before boot stage of development. Infestations occurring during grain fill are less damaging than earlier season infestations, but may greatly reduce harvest efficiency due to honeydew contamination. At this time, late season movement to the head and detection of honeydew in the head are best indicators of the need to apply an insecticide.

Texas High Plains Action Threshold

The Texas High Plains Action threshold uses both aphid counts and percent of plants infested with SCA to make a treatment decision, varies with crop development and was used successfully in 2015 in west Texas where SCA infestations develop at or soon after bloom stage and into the later growth stages. Field Sampling Protocol.

Field Sampling Protocol. Once sugarcane aphids are found in a field, use the following protocol to assess the infestation.

1. Walk 25 feet into the field and lift up and examine the underside of green leaves from the lower canopy to the upper most leaf for presence of aphids on a plant. Watch for honeydew that indicates aphids on the leaf above.
2. Keep a record of the number of plants infested with any aphids and number of plants not infested with aphids.
3. Examine a minimum of 10 plants at 4 locations across the field. Calculate the percentage of plants infested (divide the number of plants with any aphids by the total number of plants examined and multiply by 100).
4. If grain sorghum is in the boot or flowering – milk growth stage also make an estimate of the number of aphids per leaf. At these growth stages it is critical to treat before aphid numbers reach levels above 100 per leaf.

West Texas Grain Sorghum Action Threshold

Growth Stage	Decision threshold specific to the sugarcane aphid
Pre-Boot	20% of plants with presence of aphids
Boot	20% of plants infested with 50 aphids per leaf
Flowering - Milk	30% of plants infested with 50 aphids per leaf
Soft Dough	30% of plants infested and localized areas with heavy honeydew and established colonies
Dough	30% of plants infested and localized areas with heavy honeydew and established colonies
Black Layer	Heavy honeydew and established aphid colonies. Only treat to prevent harvest problems. Observe preharvest intervals

This threshold was revised from a threshold originally from Mississippi State University.

Control Options After 1st Application.

- Check fields for control after 4 to 7 days.
- If poor control and aphid colonies of 50 or more/ leaf are still present another application is warranted.
- If there was good control of the aphid continue scouting fields 2X per week for re-infestation or a rapid increase in aphid numbers.
- For whorl to early dough growth stages the Grain Sorghum Action Threshold in the above table may still be used to determine the need for additional insecticide applications.
- From dough to late dough growth stages, a second application may be required when aphids are re-establishing, 40%-50% of the total leaf area has aphid damage, and predator populations are not suppressing aphid populations.
- At black layer growth stage through harvest an application may be required to prevent harvest problems.

Insecticides. Sivanto 200SL (Bayer CropScience) insecticide has a Section 2(ee) label for use on grain and forage sorghum to control sugarcane aphid. Bayer CropScience has applied to EPA for a 24c label to reduce the grain sorghum PHI from 21 days to 14 days, so check current label. A Section 18 Emergency

Exemption label for the use of Transform WG (Dow AgroSciences) for control of sugarcane in sorghum has been submitted to EPA but as of this writing EPA has not ruled on this request. Good coverage is necessary for effective control. Application rates of 5 gallons/acre by air or 10 gallons/acre by ground are recommended. Information below is for educational purposes. Read and follow label directions.

	Sivanto 200 SL	**Transform WG**
Use Rate for Sugarcane Aphid	4-7 oz / acre	
Minimum interval between applications	7 days	
Minimum application volume	10 GPA by ground 2 GPA by air	
Maximum rate per year	28 oz per acre	
Pre-harvest interval	21 days for dried grain or straw or stover. 7 days for grazing, forage, fodder or hay harvest	
Restricted entry	4 hours	

Chlorpyrifos (Lorsban®, Nufos®), dimethoate and malathion are also labeled for aphid control in sorghum. Although these products provide some control of SCA, university trials demonstrate that these products are not as effective as Sivanto.

Managing Sugarcane Aphids During Grain Fill and Prior to Harvest. Although sugarcane aphid infestations present after head emergence may have less impact on yield, these infestations can continue to produce large quantities of honeydew which can interfere with harvest. Rain can help wash honeydew from leaves. Insecticides can be applied at this time but their use is limited by their pre-harvest restrictions (see Table for days after application before harvest is permitted). Harvest aid chemicals such as glyphosate and sodium chlorate have been used to kill sorghum leaves and therefore reduce SCA infestations prior to harvest. Unfortunately, if plants are slow to desiccate, SCA may have time to move up into the sorghum head where they continue to feed and produce honeydew. For this reason, high rates of harvest aids that kill leaves quickly may be necessary. Read and follow label directions for these products.

Seed Treatments. Insecticide seed treatments provide control of aphids, including SCA, and some other early season insects for about 4-5 weeks after planting. Their value for control of SCA will depend on how soon after planting the SCA infests the field.

Managing SCA Infestations in Forage Sorghum. Sugarcane aphid can cause extensive damage to forage sorghums, sudan grass, sorghum/sudan hybrids, shattercane and Johnsongrass meadows. Aphid infestations can kill leaves, increase stalk lodging and honeydew contamination can plug harvest machinery. Treatment thresholds for SCA infesting forage sorghums and Johnsongrass meadows have not been determined. Until those thresholds are available, the thresholds listed above for grain sorghum can provide a guide to making treatment decisions. Forage sorghum fields should be monitored as described above at least weekly for SCA. Control of SCA with insecticides requires good coverage of the entire canopy, including lower leaves, which may be difficult to achieve in forage sorghum due to the dense canopy and especially if the crop is tall. For this reason, early harvest or grazing may be the best option if good insecticide coverage cannot be achieved. If a second cutting is desired, the field should

again be scouted once a week to determine if SCA re-infest the field after harvest. If SCA are found, the field should again be scouted twice per week to determine if an insecticide is needed to protect yield.

Beneficial Insects. Syrphid fly larvae, lady beetles, green and brown lacewings, and parasitic wasps feed on sugarcane aphid and can help suppress the increase of SCA infestations. Adult syrphid flies are small, about ¼-1/2 inch long and brightly colored yellow and black, resembling a bee. They are sometimes called hover flies because of their hovering flight. While the adult fly only feeds on nectar and honeydew, the maggot-like larvae stage feeds on aphids. The larva is a green, brown or gray slug-like maggot with no legs and a tiny head at the small end of the tapered body. Larvae move slowly among the aphid colony, sucking the juice from aphids. The adult and larval stages of several species of lady beetles also feed on SCA in sorghum. Several species of parasitic wasps also attack sugarcane aphid. These tiny wasps deposit their egg into the sugarcane aphid and the egg hatches into a larva that feeds on and soon kills the host aphid. Once the larva has completed development to the adult stage, the adult wasp emerges from the dead aphid. Aphids killed by parasites are called mummies. Parasitism by the *Aphelinus* wasp results in black or blue-back mummies. While these parasitic wasps are tiny and difficult to see in the field, the presence of aphid mummies is evidence of their impact. Another parasitic wasp, *Lysiphlebus testaceipes*, attacks greenbugs and corn leaf aphids in sorghum and wheat and results in a brown mummy. However, most sugarcane aphids are protected from attack by *Lysiphlebus* due to an internal bacterium that prevents the immature parasitoid from developing.

Sorghum Hybrids Resistant to SCA. Research studies and field observations have shown that some commercial sorghum varieties exhibit less leaf damage or host fewer SCA aphids than other hybrids. Resistant hybrids have genes that provide some level of protection from rapid population increase (antibiosis) or damage (tolerance) by sugarcane aphid, thereby preserving yield potential of the crop. Resistance is a relative term and hybrids may be described as susceptible, moderately resistant or resistant. Resistance is not immunity and SCA will be present on resistant hybrids and an insecticide treatment will be necessary if infestations exceed the treatment threshold. Resistance can be expressed as tolerance or antibiosis. When resistant is expressed as tolerance, the hybrid can withstand or recover from insect damage that would result in yield loss in a susceptible hybrid. When resistance is expressed as antibiosis, the insect cannot survive or reproduce as well as on a susceptible hybrid, and thus fewer aphids are present on the resistant hybrid. Hybrids with some resistance to SCA, sometimes referred as "tolerant" hybrids, may delay an infestation from reaching the treatment threshold, thus providing more time for beneficial insects to have an impact. However, these hybrids must be frequently scouted to assess SCA infestation levels as described above. One strategy to use the scouting process described above to monitor the aphid population, and if the infestation reaches the threshold level, consider plant damage in determining the need for an insecticide treatment. .

Breeding lines of sorghum with high levels of resistance to SCA have been identified, but several years will be necessary to move this genetic resistance into commercial hybrids. Seed companies have identified hybrids with some resistance to SCA, and a list of these hybrids is available from the National Sorghum Producers at: http://sorghumcheckoff.com/pest-management/. Ask your seed dealer about the availability of grain sorghum hybrids with resistance to SCA.

Managing Sorghum Midge, Headworms and Stinkbugs When Sugarcane Aphid is Present.

The insecticides Transform and Sivanto are effective against SCA but are not labeled for control of midge, headworms or stinkbugs in sorghum. Many insecticides labeled for control of these pests are toxic to beneficial insects, including lady beetles, syrphid flies, and parasitic wasps which feed on

sugarcane aphids, which help reduce the rate of increase of sugarcane aphid populations. It is therefore important to preserve beneficial insects whenever possible.

Consider the following when selecting insecticides to control midge, headworms and stinkbugs when sugarcane aphids are also present in the field.

1. Midge, headworms and stinkbugs, when present at treatment thresholds, are a certain threat to yield and profitability. While there is some risk of SCA outbreaks following use of some insecticides, crop yield should not be jeopardized in an effort to protect natural enemies.

2. For midge and stink bug control, there are no labeled options that will not reduce the numbers of beneficial insects (see Table). If an insecticide is applied for control of midge or stinkbugs, monitor sugarcane aphids frequently and be prepared to make an application of Sivanto if sugarcane aphid numbers exceed the treatment threshold.

3. For headworm (corn earworm and fall armyworm) control, the pyrethroid insecticides (Group 3 and 3a in table below), methomyl and chlorpyrifos, are broad spectrum insecticides and are toxic to most natural enemies (see Table). In comparison, Prevathon and Belt are less toxic to natural enemies and very effective on caterpillar pests including corn earworm and fall armyworm. Besiege is a pre-mix of the same active ingredient as Prevathon plus a pyrethroid, and hence will not be as safe on beneficial insects as Prevathon alone. Spinosad, the active ingredient in Blackhawk, is much less toxic to many natural enemies than these other insecticides. Use of higher rates and long residual insecticides extend the time before natural enemies can re-populate a field.

4. Scout fields and base decisions to apply an insecticide on pest counts of midge, headworms and stinkbugs. That is, do not decide to treat based solely on crop growth stage or time of year.

5. The economic threshold depends on the current value of the crop, the number of grain heads per acre and the cost of control. These variables can be entered into calculators available on-line to determine the number of midge, headworms or rice stinkbugs that should be controlled to avoid crop loss greater than the cost of the insecticide application. These calculators are available at: https://insects.tamu.edu/extension/apps/index.html

Insecticides Labeled for Control of Midge, Headworm (Corn Earworm, Fall Armyworm) and Stinkbugs in Sorghum.

Active Ingredient	Brand Name	Group	Labeled for Control of:			Relative Impact on Aphid Natural Enemies[2]	Days to wait after application before harvest
			Midge	Head Worm[1]	Stinkbugs		
cyfluthrin	Baythroid, Tombstone	3a	Yes	Yes	Yes	High	14
esfenvalerate	Asana XL	3	Yes	Yes	No	High	21
lambda cyhalothrin	Karate Z, Warrior, Lambda-Cy	3	Yes	Yes	Yes	High	30

zeta-cypermethrin	Mustang Max	3	Yes	Yes	Yes	High	14
gamma-cyhalothrin	Declare	3	Yes	Yes	Yes	High	30
alpha-cypermethrin	Fastac	3	Yes	Yes	Yes	High	14
chlorpyrifos	Lorsban, Nufos	1B	Yes	Yes	No	High	30 (1 pt) 60 (> 1 pt)
methomyl	Lannate	1a	Yes	Yes	No	High	14
dimethoate	Dimethoate 400	1b	Yes	No	No	High	28
spinosad	Blackhawk	5	No	Yes	No	Low	21
flubendiamide	Belt	28	No	Yes	No	Low	14
chlorantraniliprole	Prevathon	28	No	Yes	No	Low	1
lambda-cyhalothrin plus chlorantraniliprole	Besiege	3 and 28	Yes	Yes	Yes	High	30

[1] Headworms include corn earworm and fall armyworm. Pyrethroids are often ineffective on larger FAW

[2] Data on impact on aphid natural enemies is often lacking. Rating may be based on impact on honey bee only.

[3] Groups refer to insecticides with similar modes of action. As examples, Group 3 consists of pyrethroid insecticides while organophosphate insecticides are Group 1. Rotating between groups is an important method of slowing the development of pests with resistance to insecticides.

Additional Resources:

http://txscan.blogspot.com. Sign up to receive current information on SCA provided by Texas AgriLife Extension Entomology can be accessed at: Texas Sugarcane Aphid News:

http://ccag.tamu.edu/entomology/. A web site for research and Extension information on sugarcane aphid in south Texas.

Acknowledgements: Research on economic thresholds used in south and central Texas was generated from several test locations along the Texas Gulf Coast and also Louisiana as provided by David Kerns, Louisiana State University. Information also provided by members of the Texas A&M AgriLife Sugarcane Aphid Task Force, USDA-ARS and other state universities.

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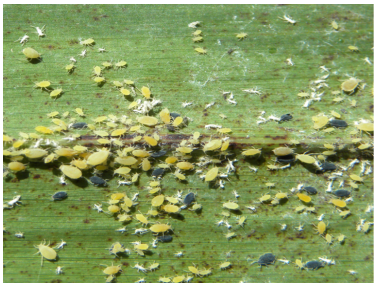
A few of the photos to be considered.

(Photo: Dr. Jourdan Bell, Texas A&M AgriLife Extension)

Figure 1. Aphid identification. Same as Figure 2 in publication NTO-035



There are about 50 SCA aphids on the leaf below