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Soybeans appearing 'puckered' or 'crinkled' following high temperatures

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Temperatures across Wisconsin were in the 90's and upper 90's much of last week. Some areas were also in need of rain during the same time. I received calls and emails with concerns about puckered soybean leaves starting at the end of last week through the beginning of this week, (Figure 1). Plant growth regulating herbicides (PGR's) such as 2,4-D and dicamba used in postemergence corn herbicide programs cause this type of symptomology to sensitive broadleaf weeds and crops. Occasionally, this is observed as an undesirable response when PGR herbicides drift from neighboring fields during postemergence applications. Furthermore, PGR's are also prone to volatilize under certain weather conditions, and the vapors move off-site affecting sensitive plants hours or even days after application. Lastly, PGR's can be difficult to clean from application equipment and may contaminate spray applications later made to sensitive crops with the same equipment. To avoid drift, spray when winds are low and preferably blowing away (not toward) sensitive plants and use appropriate application technology. To avoid tank contamination, strictly follow tank cleaning procedures stated on the labels, especially between PGR and soybean applications. Unfortunately there is little control an applicator has to avoid volatility days after an application. All in all, there is no denying that drift, volatility, and tank-contamination of PGR herbicides are all possible scenarios that cause puckered soybeans, and many times one of these scenarios are often the cause. However, that does not rule out other possible causes for the same symptomology to occur. Sometimes when symptoms are observed, it is nearly impossible to blame a PGR herbicide.

Figure 1. 'Puckered' soybean leaves due to vapor drift of Plant Growth Regulator (PGR) herbicide in July 2011 at Arlington Agricultural Research Farm, University of Wisconsin.

There have been several extension articles over the last 12 years discussing the phenomena of crinkled and cupped soybean leaves for reasons other than PGR herbicides. From these other theories were put forth to explain the symptoms, but unfortunately, they are much more difficult to explain or characterize. One thing that is certain, and should be understood, is that PGR herbicides work by mimicking growth regulating compounds that are already produced by plants. Therefore, it is possible for anything that may cause an imbalance in normal hormone levels in actively growing vegetative tissue to be a cause. First of all, there are a few viral infections that will cause this symptomology, but they usually affect certain plants among plants with no symptoms. In many of the situations that raise questions, all the plants in large areas or even whole fields are affected. From reviewing former extension articles and observing plants from these situations, it seems this condition is most likely to occur when soybeans are under stress from heat and/or moisture, and following postemergence applications of translocated herbicides such as glyphosate. Exactly why it occurs is unknown.

The good news is that soybeans have a tremendous ability to regulate seed yield due to long reproductive growth stages. Therefore, if weather conditions improve to support normal

soybean growth then it is likely symptoms will subside. How much impact these symptoms cause on yield is more difficult to assess. It is always difficult to say yield is not adversely affected, however, in many cases significant yield penalties should not be expected. To learn more and study pictures of PGR herbicide damage and mimics, there are two great resources to read further: *Dicamba Injury Mimics* [http://soybean.uwex.edu/library/soybean/grain/Weed_Contol/dicamba2004.pdf.pdf] previously produced by the UW NPM program and *Plant Growth Regulator Injury to Soybean* [http://weeds.cropsci.illinois.edu/extension/factsheets/PGR.pdf].

Considerations for late season UAN applications

Matt Ruark, Extension Soil Scientist

When deciding to make any late-season, rescue application of nitrogen (N), you will need to evaluate your N management program relative to the potential for N losses. Heavy rainfalls can cause N losses due to leaching or denitrification; Dr. Carrie Laboski provides some guidelines in the previous Wisconsin Crop Manager article *Assessing the Potential for Nitrogen Loss from Heavy Rainfalls* (Laboski, 2011). If most of your N was applied pre-plant and heavy rainfall events occurred early to mid-growing season, then further investigation into N deficiency may be warranted. If you have split-applied your N fertilizer and there has been little potential for N loss, late-season N deficiency is unlikely. If you think that your corn may be N deficient during the late vegetative stages, scout your fields to evaluate any visual effects of N deficiency (e.g. lower leaves have yellowing in midrib, often called "firing" of lower leaves). Nitrogen deficiency (or sufficiency) can be confirmed with a plant tissue test. Follow the plant tissue sampling protocols set forth in the following documents to ensure reliable results: *Troubleshooting fields using plant analysis* (Laboski, 2010) and *Sampling for plant analysis* (Kelling et al., 2000).

If you have decided to apply a late-season application of N, the N fertilizer source and application method are important selections to make. Late-season foliar (or "over the top") applications of UAN will result in moderate to severe burning. Research from the University of Missouri indicates that for 2 foot tall corn, broadcast applied 32% UAN results in much greater burn severity compared to broadcast ammonium nitrate or broadcast urea (Nelson et al., 2005). Between row applications resulted in little damage. The authors do not recommend broadcast applications of UAN when the corn is greater than 1 foot tall, while between row applications (of UAN and other N sources) are recommended when the corn is between 1 and 4 feet tall (when applications are warranted). It should be noted that this study was conducted on fields that had high leaching losses and were expected to respond to rescue applications of N (Nelson et al., 2005). Foliar application of UAN is not recommended after the V7 growth stage because the excessive burning of leaves can result in a yield decrease (Sawyer, 2003). Recently, foliar application of 28% UAN, at a rate of 10 gal/ac (30 lb/ac of N) was applied to corn at the V8 growth state at the Arlington Agricultural Research Station. This resulted in moderate to excessive leaf burn (Fig. 1 and Fig. 2). However, new leaf development has occurred and these leaves have no burn symptoms. We will have to wait to the end of the year to know the full effect of this application, but with other fertilizer sources available, it was clearly not worth the risk.

Foliar application of UAN has been identified as the least recommended option for N application (Fernandez, 2010). Early in the growing season, foliar application of UAN may still cause leaf burn, but it will not likely to lead to a yield reduction. Sawyer (2003) recommends no more than 90 lb/ac of N as UAN applied at the V3 stage or younger and no more than 60 lb/ac of N as UAN between the V3 to V7 stage. When the corn is too tall to risk damage during injection, UAN should be applied with drop nozzles between rows. If dry fertilizer is applied over the top of the corn canopy, urea and ammonium nitrate will cause some fertilizer burn if the granule falls in the whorl. It is best to apply dry fertilizer products when the canopy is dry.

Figure 1. Corn canopy after foliar application of 28% UAN on July 12, 2011 (picture taken July 19, 2011).

Figure 2. Corn leaf after foliar application of 28% UAN on July 12, 2011 (picture taken July 19, 2011).

In general, planned split-applications of N, even when they include applications made past V7, are preferable to applying all of the N pre-plant and relying on large (30 lb/ac or more of N) foliar applications as a rescue application. Split-applications prevent large amounts of applied N to be subject to environmental losses early in the growing season. If rescue applications are your only option consider the N source and application location. Stick to products like UAN, urea, or ammonium nitrate; slow-release fertilizers are not recommended late in the season. However, inclusion of NBPT (e.g. Agrotain®) would be beneficial for use with urea when surface applied to reduce volatilization (Fernandez, 2011). Further, avoid broadcast or "over the top" applications if possible to avoid risk of leaf burn and the potential decline in yield that would occur. If broadcast application of 28% or 32% UAN is your only option fully consider the potential tradeoffs between potential yield decrease (from leaf burn) and the potential for yield increase.

References (all links last verified on 21 July 2011):

Fernandez, F.G. 2010. Applying nitrogen after planting. http://web.extension.illinois.edu/state/newsdetail.cfm?NewsID=17983

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Kelling, K.A., S.M. Combs, and J.B. Peters. 2000. Sampling for plant analysis. (*white paper*) http://www.soils.wisc.edu/extension/pubs/pa_sampling.pdf

Laboski, C.A.M. 2010. Trouble shooting using plant analysis. Proc. 2010 Wisconsin Crop Management Conference. 49:26-31. http://www.soils.wisc.edu/extension/wcmc/2010/pap/Laboski_analysis.pdf

Laboski, C.A.M. 2011. Assessing the potential for nitrogen loss from heavy rainfall. Wisconsin Crop Manager, 18(6):61-63. http://ipcm.wisc.edu/WCMNews/tabid/53/EntryId/1191/Assessing-the-Potential-for-Nitrogen-Loss-from-Heavy-Rainfalls.aspx

Nelson, K.A., P.C. Sharf, G. Stevens, and B.A. Burdick. 2005. Rescue Nitrogen Applications for Corn. Missouri Soil Fertility and Fertilizers Research Update 2004, Agronomy Miscellaneous Publ. #05-01. http://aes.missouri.edu/pfcs/research/prop403b.pdf

Sawyer, J.E. 2003. Pay attention to management needs of fertilizer products. Iowa State Univ.-Extension. IC-490(4), p. 25-26, April 14. http://www.ipm.iastate.edu/ipm/icm/2003/4-14-2003/fert.html

Diagnosing nutrient deficiencies in vegetable crops

Matt Ruark, Extension Soil Scientist

Diagnosing nutrient deficiency symptoms in vegetables can be a challenge. They may be crops or plants with which we have little experience working with or the symptoms may not be expressed as clearly as in grain crops. Often these symptoms express themselves similar to herbicide injury or disease. So, how do we know if it is a nutrient deficiency? When beginning to diagnose a deficiency symptom, ask the client the following questions:

1. Can you provide a picture? When approached by a client to diagnose a problem, the first thing to ask for is a picture (or take a picture yourself). Without a picture we are only basing our diagnosis on verbal descriptions which are often vague and potentially misleading. Two types of pictures are helpful, a picture of the whole plant and a picture of the symptomatic leaf. A picture of the whole plant can let us know where on the plant the symptom is occurring (e.g. new leaf tissue or older leaves) and a picture of the leaf can let us know what tissue parts are affected (e.g. leaf margin or interveinal).
2. What is your fertilizer management? Try to obtain as much specific information as possible related to: how much N, P, K, and other nutrients were added, how the fertilizers were applied, when the fertilizers were applied, and in what form the fertilizers were applied (e.g. type of fertilizer, liquid or dry product, manure or compost). If the product is a specialty product, ask if they still have the bag or label. Ask about previous years applications and what crops were previously grown.
3. Have any other products been applied? Ask them for information related to timing and rate of any pesticide, insecticide, fungicide, or specialty product that has been applied. Ask about previous years applications as well.
4. What are the environmental conditions? Specific questions to ask are: Has the soil been excessively wet or dry? What were environmental conditions when you applied the product? Does the soil appear to be compacted? Is it difficult to push a shovel in the ground?
5. Have you had your soil tested recently? A recent soil test (within the past 3-4 years) may provide insight into the situation. Even some sort of knowledge of what their soil pH is can be incredibly beneficial for diagnosis. If they have not had their soil tested in the past 4 years, recommend a soil test.

If forwarding an issue to a colleague, attach photos and answers to all of these questions. This information will allow for a more accurate diagnosis and will provide a shorter turn-around time for recommendations. If a diagnosis cannot be made from a picture and a description of management and environmental conditions, the next step will be to recommend plant tissue and soil tests. Plant tissue sampling protocols (timing of collection and number of samples) can be found at www.soils.wisc.edu/ extension/pubs/pa_sampling.pdf. There are two ways to use plant tissue testing: (1) to evaluate the nutrient status of leaf tissue and (2) to comparison between symptomatic and healthy plants. When testing to learn about the nutrient status of the leaf tissue, you are essentially

comparing the nutrient concentrations in the symptomatic plant to predetermined values of sufficiency. If your plant tissue test value is in the sufficient range for a given nutrient, then that nutrient can be ruled out as the cause of deficiency. But if your plant tissue test value is below the sufficient range for a given nutrient, this does not necessary mean that this nutrient is the cause of the deficiency symptom. Sufficiency ranges are based on the best available knowledge, but may not reflect advancements in variety selection or differences in region. In addition, the sufficiency ranges pertain only to specific growth stages of the crop. If your deficiency symptom occurs during a growth stage not listed, then no sufficiency range is available. Thus, it is always preferable to diagnose a nutrient deficiency in vegetable crops by comparing them with healthy plants. If there is a clear portion of the field that has the deficiency symptom, we recommend that you collect plant tissue samples and soil samples (0-6" depth) from the "deficient" area and plant and soil samples from the "healthy" area. If your plant tissue analysis comes back below the sufficiency range for a given nutrient, and if there is a soil test for that nutrient, the soil can be analyzed to determine if the soil is also deficient. It is important to note that even if the deficiency can be identified as a nutrient deficiency, there may not be adequate time to correct the deficiency. Also, even if there were time, the deficiency may have already caused a reduction in yield or quality.

When the area of production is small (often a small garden) and the area of infection is small the client may not have adequate plant tissue to make reliable comparisons. In these cases, we would recommend only submitting the symptomatic plant tissue for analysis along with a soil test. We will have to rely only on pre-established sufficiency ranges to make our diagnosis. Make sure the symptoms are well documented (multiple photos). The minimum amount of material that is needed for analysis is one gram; however, submitting such a small sample will not allow for re-analysis if necessary.

When collecting leaf tissue samples, wipe off any soil particles and remove any foreign particles, but do not wash the samples. Use paper bags for storage and shipment. If the sample is to be mailed, then air-dry the sample (near a heating vent or in the direct sun are two options). We also recommend the samples not be tightly packaged during transit. Soil samples should also be collected in paper bags. Collect 10 to 15 soil cores and composite them as one sample and mix thoroughly.

Further information on plant testing:
www.soils.wisc.edu/extension/pubs/pa_sampling.pdf

Further information on soil testing:
http://www.soils.wisc.edu/extension/pubs/A2100.pdf

Vegetable Crop Update 15 is Now Available

The fifteenth vegetable crop manager is now available.

To view this update go to the Veg Crop Update page or follow this link

http://ipcm.wisc.edu/WCMNews/VegCropUpdate/tabid/115/Default.aspx

This issue includes information regarding:

- Crop updates in potatoes, processing, and fresh market veg
- Insect updates: cole crop insects, aphids, potato leafhoppers, onion thrips, and western bean cutworm
- Late blight & early blight updates
- Cucurbit and basil downy mildew updates
- Cucurbit bacterial wilt
- Diagnosing nutritional deficiencies in veg crops
- Potato petiole nitrate sampling update
- Control release fertilizers

UW-Extension/Madison Plant Disease Diagnostic Clinic (PDDC) Update

Brian Hudelson, Ann Joy, Amanda Zimmerman, Adam Greene, and Erin Schmid, Plant Disease Diagnostics Clinic

The PDDC receives samples of many plant samples from around the state. The following diseases/disorders have been identified at the PDDC from July 20, 2011 through July 26, 2011:

PLANT/SAMPLE TYPE	DISEASE/ DISORDER	PATHOGEN	COUNTY
FIELD CROPS			
Corn	Drought Stress	None	Grant
	Yellow Leaf Blight	*Phyllosticta maydis*	Marinette
Wheat (Winter)	Cephalosporium Stripe	*Cephalosporium gramineum*	Dodge
FORAGE CROPS			
Alfalfa	Aphanomyces Root Rot	*Aphanomyces euteiches*	Fond du Lac
	Brown Root Rot	*Phoma sclerotioides*	Kewaunee
	Crown/Root Rot	*Pythium* sp., *Fusarium* sp., *Mycoleptodiscus* sp.	Fond du Lac, Kewaunee, Outagamie
	Phytophthora Root Rot	*Phytophthora* sp.	Outagamie
FRUITS			
Pear	Pear Scab	*Venturia pirina*	Dane
VEGETABLES			
Onion	Smut	*Urocystis cepulae*	Dodge
Snap Beans	Root Rot	*Pythium* sp., *Fusarium* sp.	Green
Tomato	Herbicide Injury	None	Dane
	Septoria Leaf Spot	*Septoria lycopersici*	Langlade, Lake (IL)

For additional information on plant diseases and their control, visit the PDDC website at pddc.wisc.edu.

Twospotted Spider Mite Potential on Soybean in Dry Areas

Eileen Cullen, Extension Entomologist

On July 22 Phil Pellitteri, UW-Madison Insect Diagnostic Clinic, received a report (confirmed with a plant sample) of twospotted spider mite on soybean in Green County near Monroe. While some areas of the state have ample rainfall, other areas are dry. For the remainder of the season, be aware of the potential for twospotted spider mite in soybean.

Spider mites are associated with dry, drought stressed plants. Drought stress accelerates spider mite movement to soybean from surrounding vegetation (grasses, field margins, other crops). Drought stress also diminishes spider mite fungal pathogens that normally suppress populations under good crop moisture. Hot temperatures speed up spider mite reproductive rate such that predatory mites and insects may not be able to suppress populations. (Ostlie and Potter 2009).

Regardless of temperature, check soybean fields that are on the dry side through R5 soybean growth stage. This can be done while scouting for soybean aphid. Now is a good time to make sure you are not overlooking spider mite colonies in the field. It is easy to attribute leaf yellowing to drought stress, soybean leave virus symptoms, etc. and miss a twospotted spider mite population because the mites are so small. Careful field inspection is required.

Soybean Damage Symptoms

Spider mites insert mouthparts into leaf cells. Contents of the individual, living cells are extracted resulting in many small white or yellow spots, called "stippling" (speckled or sand-blasted appearance in early stages). From a distance, affected fields are apparent by leaf yellowing. Often infestations start at field edges, but can also be seen within fields on knolls (drier soil) and can be patchy in distribution within the field.

With increased mite injury leaves become yellow, bronzed, brown, and may eventually drop off the plant. Apparently healthy plants within the field can have live mites. Spider mites disperse within and between fields by climbing to the top of plants and spinning silk strands that, when caught on breezes, allow mites to drift to new host plants.

Figure 1. Chlorotic stippling on soybean leaf from twospotted spider mite.
(Photo: Tom Klubertanz)

Confirm presence of live mites in the field

Two-spotted spider mite adults are tiny (<0.002 inch), yellow-green with eight legs and dark spots on either side of their oval bodies. Eggs are round and white to light yellow and laid on the underside of leaves. Two-spotted spider mites in northern states overwinter as adult females in sheltered field margin areas. In most years, with adequate rainfall and a fungal pathogen as a primary natural control, outbreaks do not occur. In the absence of these checks, spider mites reproduce quickly with several overlapping generations during an outbreak (eggs, nymphs and adults found together on infested plants).

Figure 2. Twospotted spider mite adults on underside of soybean leaf
(Photo: P. Sonnentag, UW-Madison Entomology)

Eggs hatch in 2 to 4 days; nymphs develop in 2 to 4 days; and adults can live up to 21 days with better survival in hot, dry environments. Depending on temperatures, generations are completed in 4 to 14 days, with the fastest developmental rates above 91°F.

Figure 3. Twospotted spider mite eggs on underside of soybean leaf.
(Photo: P. Sonnentag, UW-Madison Entomology)

A hand lens is necessary to see two-spotted spider mites and eggs. Use a 10X magnification hand lens to confirm presence of live mites. Adults, with dark spots on the body, can also be detected by tapping soybean plants over a clipboard onto a white sheet of paper. Dislodged spider mites can be seen as tiny brown/black specks moving on the paper. Monitor fields along edges, and importantly, within fields. Examine upper, middle and lower canopy leaves for stippling. As spider mite populations increase you may also find webbing on the undersides of leaves in infested field areas.

Treatment Guidelines

Treatment decisions are based on amount of leaf discoloration due to spider mites and continued presence of live colonies in the field. Consider treatment when 20% to 25% discoloration is found before pod set, or 10% to 15% discoloration after pod set.

Spider mite populations often start along field edges, and spot or field edge treatments may be an option. However, before spot treatments are applied, thorough monitoring of the entire field is recommended. If mite injury is evident in the field interior, the potential for economic populations within 1-2 weeks should be recognized. A whole field treatment may be justified based on the guidelines below.

If mite presence is verified, it's time to progress into the field. Move at least 100 feet into the field before making your first stop. Walk a "U" pattern checking at least 2 plants at each 20 locations. You can assess mite damage using the following scale:

0 – No spider mites or injury observed.

1 – Minor stippling on lower leaves, no premature yellowing observed

2 – Stippling common on lower leaves, small areas or scattered plants with yellowing

3 – Heavy stippling on lower leaves with some stippling progressing into middle canopy. Mites present in middle canopy with scattered colonies in upper canopy. Lower leaf yellowing common. Small areas with lower leaf loss. (Spray Threshold)

4 – Lower leaf yellowing readily apparent. Leaf drop common. Stippling, webbing and mites common in middle canopy. Mites and minor stippling present in upper canopy. (Economic Loss)

5 – Lower leaf loss common, yellowing or browning moving up plant into middle canopy, stippling and distortion of upper leaves common. Mites present in high levels in middle and lower canopy.

Choose an insecticide labeled for twospotted spider mite control in soybean. Options are fairly limited to the organophosphate class of insecticide, chlorpyrifos or dimethoate.

Weather conditions and natural controls

Following rainfall, relatively cooler temperatures and high humidity can foster the most effective twospotted spider mite natural enemy - a fungal pathogen, *Neozygites floridana*, that attacks all stages of mites and is host-specific to spider mites. During early infection stages, mites have a discolored, waxy or cloudy appearance and mite death occurs within 1 to 3 days of infection.

Production of infective spores depends on environmental conditions which must be cooler than 85°F and with at least 90% relative humidity. At least 12-24 hours of such conditions are believed necessary for extensive spread of the disease, and TSM populations may decline rapidly in response to fungal disease activity.

References and Related Links

Cullen, E. and S. Schramm. 2009. Two-spotted Spider Mite Management in Soybean and Corn. University of Wisconsin-Extension, Publication A3890.

Cullen, E. 2006. Spider mites: A to Z. pp. 130-133. In Proceedings 2006 Wisconsin Fertilizer, Aglime, and Pest Management Conference, University of Wisconsin, Madison, WI. http://www.soils.wisc.edu/extension/wfapmc/2006/index.php

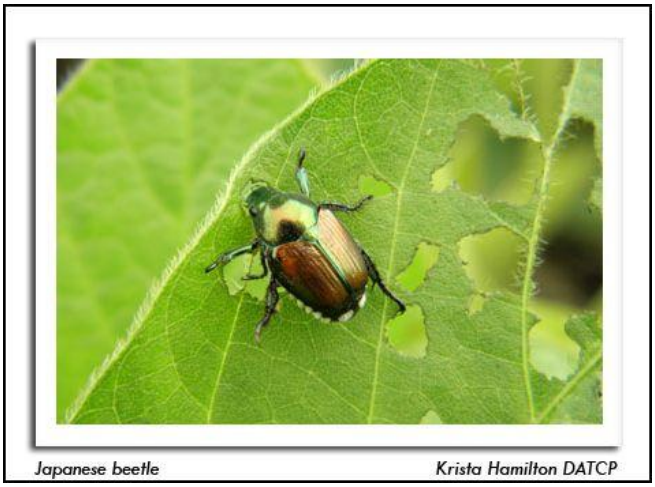
Ostlie, K. and B. Potter. 2009. Managing Two-Spotted Spider Mites on Soybeans and Corn in Minnesota. Just for Growers, MN Soybean Production. http://www.soybeans.umn.edu/crop/insects/spider_mites.htm

Japanese Beetle - Scouting and Thresholds for Soybean and Corn

Eileen Cullen, Extension Entomologist

Questions have come in this week concerning Japanese beetle on soybean and corn. There is one generation of Japanese beetle per year and we typically see adults from mid-July well into August. Certainly they are more of an issue in home garden and fruit and ornamental settings, but the following reminders are warranted for soybean and corn.

Adults (beetles) are being reported in soybean or corn in Columbia, Dane, Jefferson, and Eau Claire counties, and other locations in the state on fruit and ornamental crops.



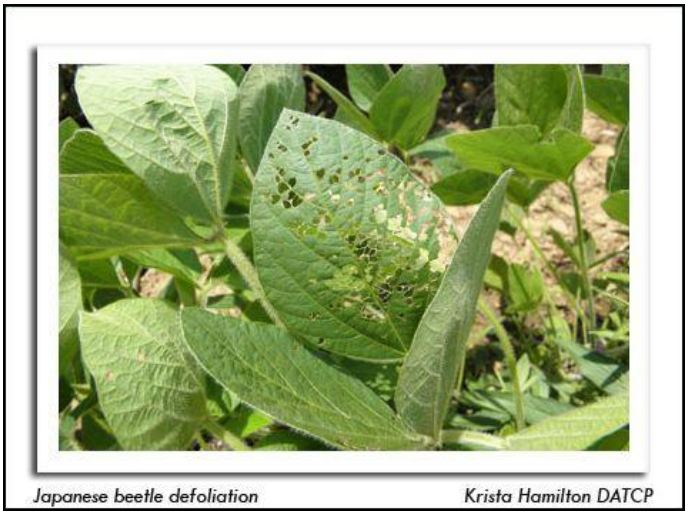
Japanese beetle Krista Hamilton DATCP

Soybean

Adults feed on soybean leaf tissue between leaf veins leaving a skeletonized appearance. The treatment threshold for Japanese beetle in soybean is based on percent leaf defoliation and not number of beetles per plant. Treatment should be considered at 30% leaf defoliation pre-bloom, and 20% leaf defoliation bloom to pod-fill.

It is easy to overestimate defoliation percentage, it often looks worse than it is. In her recent Iowa State University Integrated Crop Management newsletter, Extension Entomologist Erin Hodgson referred readers to this leaf defoliation resource to help you judge what percent defoliation is occurring.

Scout leaf defoliation throughout the field, not just field edges where Japanese beetle aggregation and feeding can sometimes be more concentrated. Field edge/border row treatments may be sufficient if damage is confined to this area. Sample from 10 different plants throughout the field choosing a trifoliate leaf from the upper, middle, and lower canopy on each plant. This will give you a 30 leaf sample to assess whether the feeding is progressing down the canopy or only in the upper canopy.



Japanese beetle defoliation *Krista Hamilton DATCP*

Corn

Consider a foliar insecticide treatment during tasseling and silking if there are three or more beetles per ear, silks have been clipped to less than 1/2-inch AND pollination is less than 50 percent complete.

Aim for a representative field sample as Japanese beetle may aggregate or clump near corn field edges. Edge/borer row treatments may be sufficient if damage is confined to this area, but scout inner field locations to make sure.