In This Issue

Nitrogen Loss from Wet Soils

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High rainfall amounts lead to loss of nitrogen from the soil. Sometimes the loss is great enough that a crop will benefit from additional nitrogen application. This article will describe how nitrogen is lost and factors to consider in deciding whether to apply extra nitrogen.

There are two main ways nitrogen is lost from wet soils. Nitrogen is lost to the air by denitrification. Denitrification occurs in saturated soils when there is little oxygen in the soil. In the denitrification process, nitrate is broken down by bacteria to form oxygen and volatile nitrogen compounds including nitrous oxide and nitrogen gas. These volatile compounds move into the air and nitrogen is lost from the soil. Denitrification is common on heavier soils. In Indiana, saturated soils lose 4% to 5% of their nitrate nitrogen for each day they are saturated.

Nitrogen is lost below the root zone of the crop by leaching. Nitrogen in the soil solution will be carried with water as it percolates down through the soil. Nitrate leaches very readily. Leaching losses are greater on light-textured soils and when rains fall over a period of time so that water has time to soak into the soil rather than run off the surface. An inch of rain may move nitrogen a foot deeper in a sandy soil; after 4 inches the nitrogen may be down 4 feet and below the root zone of many crops. Leaching losses from rainfall are much reduced when nitrogen is applied under plastic mulch.

For both denitrification and leaching, it is the nitrate form of nitrogen that is lost. Some fertilizers, such as calcium nitrate and potassium nitrate, contain all the nitrogen in the nitrate form and so are very susceptible to nitrogen loss as soon as they are applied. Other materials, such as urea or diammonium phosphate, break down initially to supply nitrogen in the form of ammonium, and then the ammonium is converted by bacteria into nitrate in the process called nitrification. The bacteria are not active in dry or cold soil; most nitrification occurs when soil temperatures are 60 to 86 degrees F. Under typical Indiana conditions, the ammonium will be completely converted to nitrate in a month. With these materials, the longer it has been since application, the more nitrogen will be in the nitrate form, and the greater the potential for nitrogen losses. By this time in the growing season, much of the preplant nitrogen for summer crops will have been converted to nitrate.

What about organic fertilizers, or nitrogen from a legume cover crop? Nitrogen from these sources also eventually gets converted to nitrate, and then is susceptible to loss as described above. How quickly the conversion occurs depends on the C:N ratio of the material as well as other factors. Once the nitrogen becomes available to the crop it can be converted to the nitrate form. As an example, last year at Pinney Purdue Ag Center on June 16 we measured 80 lb. nitrate-N/A in plots where a hairy vetch cover crop had been incorporated in early May, and 128 lb. nitrate-N/A in plots where an organic 13-0-0 fertilizer had been applied in addition to the hairy vetch. On our sandy loam soil that nitrate would have readily leached, and on a heavier soil, it could have denitrified.

To evaluate the potential for nitrogen loss in a particular field this year, consider the following questions:

- How much nitrogen was in the nitrate form when it rained? Only the nitrate form is lost to leaching or denitrification. All kinds of fertilizer nitrogen eventually gets converted to nitrate. If ammonium or urea was applied, it would take about one month for all the nitrogen to be converted to the nitrate form.
- How warm has the soil been since fertilizer application? The warmer the soil, the faster the conversion of ammonium to nitrate, which can then be leached or denitrified. With soil temperatures in the 40s or 50s conversion to nitrate will be slow.
- Was plastic mulch used and when? Little leaching due to rains will occur under plastic mulch.
- What is the soil type? On a sandy soil 5 inches of soaking

- rain can leach nitrate beyond the root zone of most vegetables. On a heavier soil it will take more water to leach beyond the root zone.
  - How much rain has fallen, and how much at one time? Rains that soak the soil rather than run off will result in more leaching. Periods of soil drying between rains will cause water (and nitrate) to move upwards in the soil.
  - How long has the soil remained saturated? Denitrification occurs in saturated soils, but conversion of ammonium to nitrate does not.
  - How deep is the crop root zone? For a shallow-rooted crop like lettuce, nitrogen is effectively lost to the crop if it leaches below 12 inches; for a deep-rooted crop like pumpkin, nitrogen could be available even if it leached two or three feet down.
  - How much nitrogen has already been taken up by the crop?

If nitrogen has been lost, is it worth replacing it? One tool to help evaluate whether additional nitrogen will benefit the crop is the soil nitrate test. This test has had most research done in the context of a pre-sidedress nitrate test, or PSNT. That test measures the amount of nitrate in the soil shortly before the time of sidedressing. If the nitrate level is above a certain value, it is unlikely that additional nitrogen will lead to higher yields. The value depends on the crop, and is determined empirically for different crops and environments. Much of the development of the PSNT for use in vegetables has been done in the Northeastern and Mid-Atlantic states. The critical values suggested by John Howell of the University of Massachusetts are a good starting point for using this test in Indiana. According to Howell, for sweet corn no additional nitrogen is needed if the nitrate level is 25 parts per million (ppm) or greater. For pumpkins, squash, tomatoes and peppers, no additional nitrogen is needed if the nitrate level is greater than 30 ppm. Although the PSNT has not been evaluated for use on vegetables in the Midwest, it has been studied in field corn in the Midwest, and the response is similar to that in the Northeast. This gives us some confidence that recommendations for vegetables developed in the Northeast will be reasonable in Indiana.

Soil samples for a nitrate test are normally collected about a week before normal sidedressing, but in this situation they can be collected when soil conditions permit. Take 15 to 20 cores 12 inches deep and mix them well. Dry one cup of the composite sample by spreading it thinly on a clean, non-absorbent material. Quick drying will prevent changes in nitrate levels of the sample. Send the sample to be analyzed for nitrate by a reputable soil testing laboratory that will provide results quickly. Use the guidelines above to determine whether or not to apply more nitrogen. Or, for a more quantitative approach, see the June 18, 2015 Issue of Purdue's Pest & Crop Newsletter where Dr. Bob Nielsen has provided guidelines for calculating rates of nitrogen to apply to field corn based on a soil nitrate test and the amount of preplant nitrogen applied and considering the stage of crop growth. The principles presented there should be relevant for vegetables where fertilizer is broadcast as well.

Other factors worth considering when deciding whether and how much to apply include the cost and practicality of application, whether the initial nitrogen application was high enough that some loss could be afforded; whether the crop is still healthy enough to produce the quality and yield expected; and whether it is still early enough in crop development for the application to make a difference.

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Plants Recovering from Waterlogging Damage

(Wenjing Guan, guan40@purdue.edu, (812) 886-0198)

After the heavy rains in the past a few days, flooding/waterlogging injury stands out in my farm visit this week.

Regardless of tomato or cucumber, the injured plants showed leaf yellowing that occurred 2 to 3 days after waterlogging (Figure 1). The yellowing leaves are a result of chlorophyll loss, which is associated with N deficiency and abnormal N metabolism. In addition to yellowing leaves, plant responses to flooding injury can be premature leaf senescence, reduced plant growth, formation of adventitious roots, and increased susceptibility to disease and insect pests.

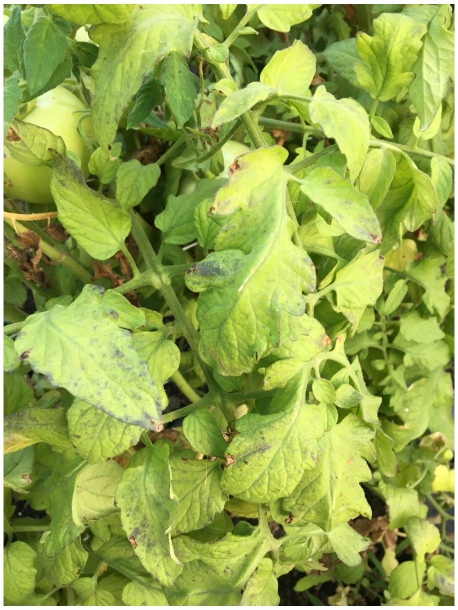

Figure 1. Yellowing leaves of a tomato plant suffered waterlogging damage

There is not much we can do in the middle of the season to avoid waterlogging happening on the vegetables. But here are some remedy approaches that may be taken to alleviate the deleterious effects and help the crops to recover.

Use nitrogen (N) fertilizers. There are many discussions on whether foliar fertilizers are beneficial. This is one of the cases that foliar fertilizers may do better than soil fertilizers. A study conducted in southern Florida on corn showed that foliar spraying of urea, calcium nitrate and potassium nitrate were more effective in recovering leaf greenness than soil N fertilizers. The study concluded N was more readily absorbed by the plants through leaves than by the damaged roots after waterlogging.

Although no significant differences in plant recovery were found comparing foliar sprays of urea, calcium nitrate, and potassium nitrate in this study, nitrate N fertilizers, especially potassium nitrate fertilizers are recommended. Ammonium nitrogen fertilizers are not the best option because the microorganisms that convert ammoniacal nitrogen to nitrate nitrogen compete for oxygen with plant roots in low-oxygen conditions, which could potentially exacerbate waterlogging damage.

Using oxygen-containing fertilizer might be a potential strategy to minimize the waterlogging damage. In a greenhouse experiment with basil, applying oxygen-containing fertilizers [carbamide peroxide (urea, hydrogen peroxide), calcium hydroxide] before waterlogging enhanced N use efficiency and improved crop recovery after waterlogging. The mechanism is not fully understood, but enhanced oxygen bioavailability and improved soil redox potential in vegetable root zones are considered factors that contribute to the positive effects.

Greenhouse studies also showed plant growth regulators such as synthetic gibberellic acid and synthetic cytokinin had positive effects to alleviate waterlogging damage. However, there was little evidence approving their effects in field conditions. It is important to note that some regulators may potentially inhibit crop recovery if inappropriately used, which affecting photosynthesis and leaf transpiration.

Reference

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Spray Less, Pay Less, and Get Better Control of Your Arthropod Pests

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Unfortunately, pests don't know when to take the day off. Even though we have bees in the field and watermelons reaching peak bloom, we still need to watch out for pest infestation and disease outbreaks. First and foremost, scouting fields to monitor pests will ensure that infestations never reach high enough populations to threaten yield. Secondly, we have a suite of insecticides and miticides that have low bee toxicity values but still can control damaging pest populations.

Since watermelons require insect pollinators it is essential that efforts are made to reduce pollinator exposure to make sure flowers receive enough visits from insects. All pesticides will pose some risk to pollinators but limit these risks whenever possible by either avoiding an application altogether or to apply products with reduced risk. In the table below, we have color-coded the products based on their toxicity to pollinators. Hopefully these options will let you pick the best product for the pest and phenology of the crop.

But it's not just the pollinators who are working for watermelon growers in their field; natural enemy insects such as lady beetles, lacewing larvae, and parasitoid wasps are often effective at controlling pest insects before they become a problem. Aphids, for example, are often controlled by either natural enemies or even a timely rain event. If you find signs that aphids may have entered your field, mark the infested plant(s) and then return to check for mummified aphids the following week (Figure 1a). If you see aphid mummies, this means that your natural enemy populations are hard at work. Tiny parasitic wasps lay eggs inside of the aphids (Figure 1b), and the resulting wasp larvae eat the aphid from the inside out. Thus, killing your problem aphids before you even need to pull out the sprayer. Unfortunately, the figures were removed due to copyright issues.

Weekly insecticide applications or "calendar" sprays that are not being applied in response to pest infestation, may have negative off-target effects to both natural enemies and pollinators. Broad-spectrum insecticide products, like those belonging to the organophosphate and pyrethroid classes, have been associated with outbreaks of mites and aphids. This is most likely due to the insecticides disrupting natural enemy populations (like the parasitic wasps described above) that would otherwise keep these pest populations in check. We have found that outbreaks of secondary pests such as aphids or spider mites are more likely to require insecticides if that field had previously been given pyrethroid sprays, eliminating the field's natural enemies.

Purdue entomologists continue to research both pest and beneficial insects in watermelon fields in hopes that they can provide the most effective recommendations to growers to protect yields while conserving pollinators and natural enemies.

In the table below, we have included some insecticide/miticide options for key watermelon pests (other alternatives are available in the *Midwest Vegetable Production Guide*, pgs. 92-102). As a reminder, **always check product labels for additional safety information and timing for both field re-entry and harvest.**

Pest	Ways to Scout and Determine Whether to Spray	Insecticide Options	Insecticide class (IRAC)	Risks to beneficial insects
Cucumber beetles	Scout 8-15 plants* per 20-acre field. Take action when beetles exceed a density of 5 beetle per plant. *or 1x1 m area when the plants vine together	Assail	Neonicotinoids (4A)	*Moderately Toxic*
		Admire Pro, Belay	Neonicotinoids (4A)	*Highly Toxic*
		Pyrethroids: Bifenture, Perm-Up, Warrior II	Pyrethroids (3A)	*Highly Toxic*
Aphids	Begin searching later in the field during prolonged hot/dry periods. Aphids most easily identified from "shiny" excretion overing plastic mulch. Mark infested plants and after 5 days look to see if infestation has spread.	Assail	Neonicotinoid (4A)	*Moderately Toxic*
		Pyrethroids: Bifenture, Perm-Up, Warrior II	Pyrethroids (3A)	*Highly Toxic*
		Harvanta	Anthrallic diamide (28)	*Toxic*
		Fulfill	Pymetrozine (9B)	*Relatively Nontoxic*
Mites	Outbreak likelihood increases during hot and dry periods. Prioritize scouting on field edges to identify early infestation; look for slight yellowing or webbing in the watermelon crown.	Portal	Fenpyroximate (21A)	*Relatively Nontoxic*
		Zeal	Extoxazole (10B)	*Relatively Nontoxic*
		Agri-Mek	Abamectin (6)	*Highly Toxic*
		Oberon	Spiromesifen (23)	*Moderately Toxic*

Minimum toxicity to beneficial insects. Lowest bee toxicity values through contact or oral exposure	**Toxic to beneficial insects, but reduced risk** compared to other products	**Toxic to beneficial insects** including pollinators and other	**High toxicity** across all insects including pollinators and other beneficial insects

LOWEST RISK TO POLLINATORS ⟷ **HIGHEST RISK TO POLLINATORS**

Japanese Beetles Emerging

(John Obermeyer, obe@purdue.edu)

A quick glance at my vegetable garden on Thursday, June 17, revealed a lonely Japanese beetle… I dutifully squished it! This does indicate that emergence is beginning in west central Indiana. Hatch has undoubtedly been going for several days in southern counties, whereas, northern counties will soon be graced with their presence. Oh joy!

Japanese beetles (Figure 1) will feed on more than 350 different species of plants, but are especially fond of roses, grapes, smartweed, soybeans, corn silks, flowers of all kinds, and overripe fruit. Beetle damage to cultivated crops is often minimal and defoliation (leaf removal) on soybean usually looks much worse than it is. The beetles often congregate in several areas of a soybean field – often field borders – feeding on and mating in the upper canopy. The beetles' iridescent, metallic color and their proximity to the field edge catches the attention of those doing "windshield" field inspections. Closer inspections will often reveal that weeds such as smartweed have made fields even more attractive to the beetles. Let's hope this season they feed on the weeds…especially giant ragweed and marestail.

Long Descriptionzsaqa

Figure 1. Japanese beetle newly emerged from the soil.

Getting Ready to Plant Strawberries in a Plasticulture System — Planting Materials

(Wenjing Guan, guan40@purdue.edu, (812) 886-0198)

In Indiana, strawberry is traditionally grown as a perennial crop using a matted-row system, in which strawberry bare-root plants (Figure 1) are planted in spring on bare soil. Each year, fruit is harvested from mother plants as well as daughter plants that are derived from established runners in the past year. Strawberries can also be grown using a plasticulture system, in which strawberries are grown on plastic-covered beds. Fruit is harvested from the mother plants. Runners are undesirable in the plasticulture system, and they need to be removed.

Figure 1. A bare-root strawberry plant.

As mentioned earlier, bare-root plants are used to establish new strawberry patches in the matted-row system, while it is more common to use plugs (Figure 2) in the plasticulture system. Strawberry plugs are usually grown in 50-cell trays. Similar to vegetable transplants, they have active growing roots and leaves. The advantages of using plugs in a plasticulture system compared to using bare-roots are easy establishment and labor-saving. Under conditions of high temperatures and lack of soil moisture, it can be a challenge to successfully establish bare-root plants. In addition, bare-root plants have to be planted by hand on plastic-covered beds. While plugs can be planted using a water wheel transplanter that makes planting more efficient.

Figure 2. A strawberry plug.

In certain situations, however, bare-root plants may be used in the plasticulture system. This is because plugs are only commercially available for a short period of time in the fall. In northern Indiana, fall planting could be too late and too high of a risk to get a satisfying yield in the next spring. Bare-root plants are typically available entire spring to early summer. So if growers want to plant strawberries before plugs are commercially available, they may use bare-root plants. The second reason to use bare-root plants in a plasticulture system is because of cultivar limitations. Many of the popular cultivars that are traditionally grown in northern Indiana are only available with bare-root plants. If growers stick to these cultivars, bare-root plants may be the only choice.

Two ways may improve the success of using bare-root plants in a plasticulture system. One is to plant on white plastic mulch. Soil temperature is cooler under white plastic mulch compared to black plastic mulch that makes summer planting of bare-root plants possible. A second approach is to start a strawberry plant in trays with a growing medium, and then plant the tray plants in the field.

Southwest Purdue Ag Center Virtual Field Day Research Highlight

(Wenjing Guan, guan40@purdue.edu, (812) 886-0198)

Southwest Purdue Ag Center held a virtual field day on June 24, 2021. Multiple projects are highlighted at the virtual field day. If you are interested in learning more about these projects, please check this playlist https://www.youtube.com/playlist?list=PLveWDgbh5ujHd6WjcbkVZIFSF5NhqtTyM that includes 24 videos.

Topics related to vegetable production include:

Pest and pollinator considerations in melon production
Herbicide updates
Strawberry production in alternative systems
Food safety updates
Fusarium wilt of watermelon
Corn earworm trapping and management in sweet corn
Maggot damage on onion transplants
Watermelon and cantaloupe variety trials at Southwest Purdue Ag Center

Small Farm Education Field Day and Webinar Series

(Wenjing Guan, guan40@purdue.edu, (812) 886-0198)

Small Farm Education Field Day will be held on July 29th, 2021 at the Purdue Student Farm.

Small Farm Education Field Day Webinar Series is scheduled on July 29, August 2, 4, 6, 9, 11, 13, 2021. A wide range of topics including but not limited to crop production, food safety, pest management, farm business will be covered in the webinar series. Registration, topics, and schedule of the webinar series can be found at https://www.purdue.edu/hla/sites/studentfarm/events/

Storm Tracks Favor Some Parts of Indiana Skipping Others

(Beth Hall, hall556@purdue.edu)

As we welcome July, Indiana seems to be in a very wet phase. Or, at least part of the state has been. The jet stream – a narrow band of fast-flowing air near the altitudes where commercial jets fly – naturally meanders in a north-south-north ribbon around the hemispheres. Typically, these "ribbons" also shift eastward as they are meandering. However, recently that eastward shift has seemed to stall more than usual, causing hot dry conditions in the western US while pulling up moist air from the Gulf of Mexico into the eastern half of the US. Storm systems track along with the location of the jet stream, so any slight stalling in its eastward migration seem to cause excess rainfall in one part of Indiana while the other part of the state stays dry. Looking over the past several months, if not into last summer, these storm tracks have seemed to favor southern Indiana, leaving northern counties getting less precipitation than normal. However, the past week or so has shifted these storm tracks to the north (Figure 1) bringing some areas 4”-6” above average rainfall, leaving the southern counties dry. This has helped to eliminate abnormally dry conditions within the northern counties, but several central and southern counties are still in abnormally dry conditions according to the US Drought Monitor (Figure 2).

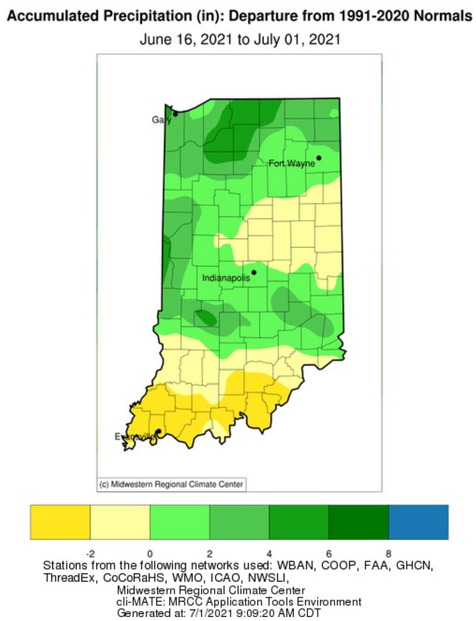

Figure 1. Precipitation departures from normal for the last few weeks in June.

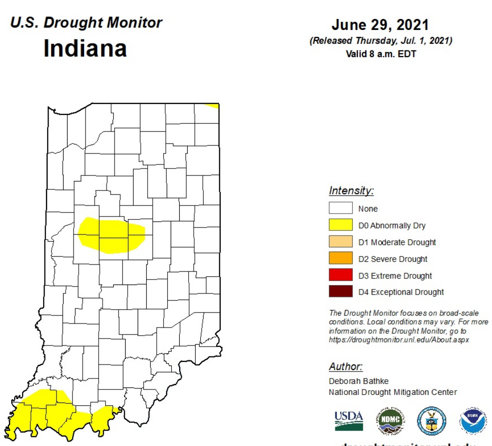

Figure 2. US Drought Monitor status for Indiana as of data through June 29, 2021.

Things will clear up across the state for most of the next week, and then wet conditions are expected to return by the end of next week. The July outlook issued by the national Climate Prediction Center is slightly favoring above-average temperatures and precipitation. However, how much falls and when will be driven by those storm tracks. At this time, there is a slight risk of heavy precipitation falling across Indiana from July 8-10, 2021.

With respect to temperatures, June was a relatively normal month. There were certainly periods of above normal and below normal temperatures, but when averaged over the entire month, those extremes seemed to wash out. This meant that modified growing degree day accumulations are still lagging behind average amounts in the southern part of Indiana, and are slightly ahead of average in the northern counties (Figure 3). Figure 4 shows a comparison of 2021 accumulated modified growing degree days around the state compared to recent years.

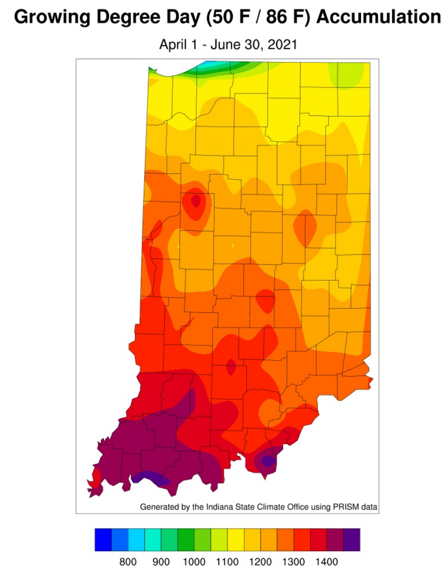

Figure 3. Modified growing degree day accumulations from April 1 to June 30, 2021.

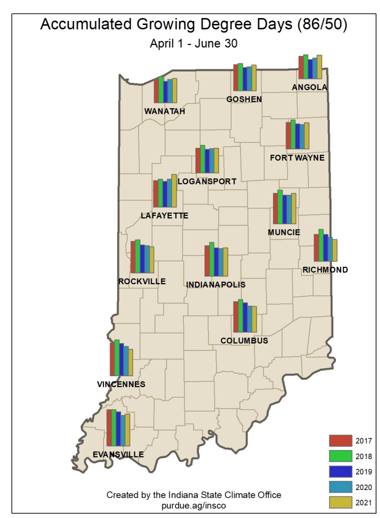

Figure 4. Comparison of 2021 modified growing degree day accumulations from April 1 – June 30 to the past four years.

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