VEGETABLE CROPS HOTLINE

A newsletter for commercial vegetable growers prepared by the Purdue University Cooperative Extension Service

Issue: 654
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In This Issue

Figure 1. A variety of crops in the mustard family bolting in mid-March in a high tunnel.

Bolting and Blooming in High Tunnels

(Liz Maynard, emaynard@purdue.edu, (219) 548-3674)

Bolting of crops overwintered in high tunnels is common in the spring. 'Bolting' refers to lengthening and blooming of the flowering stalk. Bolting is often a problem because the quality of the marketable part of the plant declines. Also, plants subject to bolting are programmed to die once they complete flowering and seed production so yield will decline in quantity as well as quality. Sometimes bolting is not a problem because the stalk, buds, and flowers can be sold as a new product while they last; this is often the case with kale, mustards and related crops.

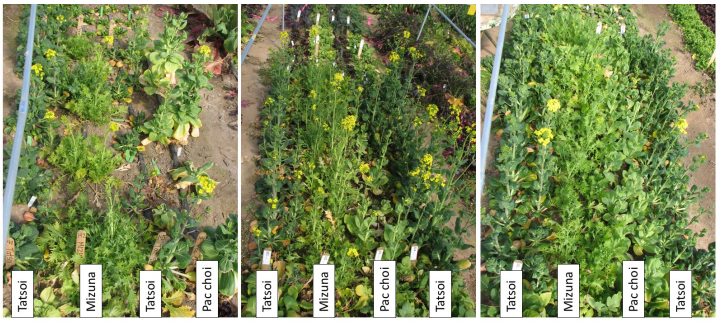
Crops susceptible to bolting include those in the mustard family such as kale, mustards, tatsoi, bok choy (pac choi), mizuna, turnip, radish, etc.; carrots; beets and in some cases Swiss chard; onions; lettuce; and spinach. (Figure 1)

Bolting is triggered by environmental conditions. Some plant types are triggered to develop flowers by extended periods of cool temperatures. This is called "vernalization." In high tunnels vernalization might occur from late fall to early spring, depending on when a crop is planted and temperatures in the structure. After vernalization, when temperatures warm, the flowering stem lengthens, flowers continue to develop, and eventually bloom. Generally the warmer it is after vernalization has occurred, the faster the flowering process proceeds. All of the crops listed above except lettuce and spinach are triggered to flower by cool temperatures; for mustard family crops (e.g. radish) lengthening days further promote flowering. The wild relatives of crops with these traits are typically winter annuals or short-lived biennials: they emerge from seed one season, bloom the following spring, and then die–think of yellow rocket or Queen Anne's Lace (wild carrot).

Lettuce and spinach also bloom in the spring, but their flowering is not triggered by cool temperatures. Long days trigger the switch to flowering in spinach, and high temperature combined with longer days trigger flowering in lettuce. These crops may not bolt until after the high tunnel has been rotated into summer crops.

Bolting is often predictable, so the first step in dealing with it is knowing what to expect for the crops you grow. With fall-planted crops it may be difficult to manage the high tunnel environment to eliminate spring bolting in crops where cool temperatures trigger flowering. However, it might be possible to slow development of the flowering stalk in the spring by keeping temperatures cool in the tunnel with frequent venting. For crops triggered to bloom by cool temperatures that are planted in the spring, it might be possible to reduce bolting by planting them a little later and managing for warmer temperatures inside the high tunnel. This is an area in which more research would likely lead to more useful recommendations.

Another way to deal with bolting is to look for existing crops and varieties of crops that are less susceptible to bolting, and over time, develop new ones through selection and breeding. This can be done on an individual farm, at research farms, and by those who breed new varieties. There are plenty of lettuce and spinach varieties already available that have been bred for delayed bolting in field production. Figures 2, 3, and 4 below illustrate some of the existing differences in bolting among kinds, types, and varieties of crops in the mustard family. In Fig. 2, tatsoi, mizuna and pac choi are all bolting by March 8. In Fig. 3, mustard 'Ruby Streaks' has completely bolted by March 30, but 'Golden Frills', 'Giant Red', and 'Green Wave' mustards are still mainly vegetative. In Fig. 4, kale varieties haven't bolted by March 8, but by April 10, 'Red Russian', 'Ripbor', and 'Vates' are all flowering, while only a few plants of 'Lacinato' have bolted. With continuing increases in high tunnel production we can expect more knowledge about and development of crops and varieties that resist bolting in those environments.

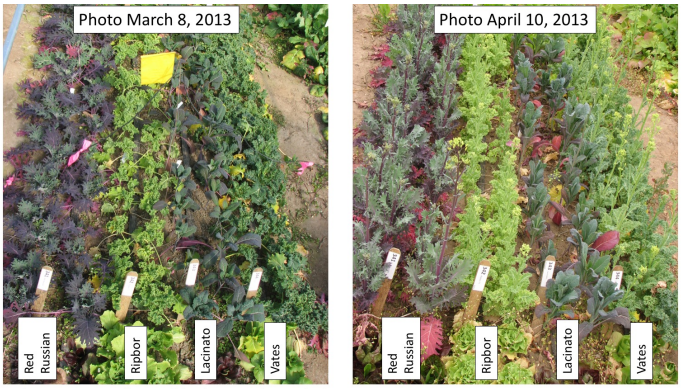


Tatsoi, mizuna, and pac choi grown in unheated high tunnel, photographed March 8, 2013.

Figure 2. Tatsoi, mizuna, and pac choi seeded in a high tunnel in late Sept. – Oct. bolted by early March the following year.

Mustards grown in unheated high tunnel, photographed March 30, 2013.

Figure 3. Mustards seeded in a high tunnel in Oct. varied in how early they bolted the following year.



Kale grown in unheated high tunnel, seeded Oct. 13, 2012.

Figure 4. Kale varieties seeded in a high tunnel in Oct. varied in how soon they bolted the following spring.

Yellow and Green Zucchini Varieties for the Local Market

(Petrus Langenhoven, plangenh@purdue.edu, (765) 496-7955)

Gowers always want to know which variety is the most suitable one for their farming location and market. I do understand the frustration of growers when looking online at all the varieties being sold by different

vendors. There are a plethora of varieties available that have different fruit types and growth habits. Characteristics like potential yield and disease resistance are always important considerations for growers. Which variety will work best for my farming operation and market? During 2018, I attempted to address growers' concerns and need for local variety performance data, hosting a zucchini field trial at the Throckmorton Purdue Agriculture Center/Meigs Horticulture Facility, Lafayette, Indiana.

How was the evaluation conducted?

Soil of the test plot comprised of a Toronto-Millbrook (47%) complex, Drummer (27%) and Starks-Fincastle complex (26%) (ranged from a silt loam to silty clay loam). The spring 2018 soil test showed 2.8% organic matter, pH 5.7, and 34 ppm phosphorus (P), 83 ppm potassium (K), 245 ppm magnesium (Mg), and 1500 ppm calcium (Ca).The cation exchange capacity was 13.4 meq/100 gram. Micro nutrients tested at 2.0 ppm zinc (Zn), 29 ppm manganese (Mn), 49 ppm iron (Fe), 1.6 ppm copper (Cu) and 0.3 ppm boron (B). On May 8, 660 lb/A 9-23-30 was applied pre-bedding. At bedding (May 25) 140 lb/A 46-0-0 was applied.

The ten zucchini varieties (Table 1) were grown in raised beds covered with a 4 feet wide black plastic mulch (Fig. 1). Drip tape with a 12-inch emitter spacing and flow rate of 0.22 gpm/100 ft was used for irrigation. The zucchini entries were seeded May 7 and transplanted into raised beds (2 feet wide) on May 28 with an in-row spacing of 2 feet and between-row spacing of 6 feet (3,630 plants per acre).

Table 1. Zucchini variety characteristics

Variety	Seed Company	Days to Maturity	Mature Color
Green Varieties			
Paycheck	Syngenta	42	Medium green
Felix	Harris Moran	50	Medium dark green
Green Machine	Enza Zaden	44	Medium green
Partenon	Park Seed	48	Dark green
Desert	Enza Zaden	50	Dark green
Spineless Perfection	Syngenta	44	Medium green
Yellow Varieties			
Golden Rod	Harris Moran	51	Golden yellow
Gold Rush	Seminis	49	Deep gold
Sebring	Hollar Seeds	43	Golden yellow
Golden Glory	Syngenta	50	Golden yellow

Figure 1. Raised bed covered with plastic mulch. Bed spacing at 6 ft center-to-center with in-row spacing at 2 ft. Picture was taken 5 weeks after transplanting.

Diseases were managed by scouting and using recommendations from the Midwest Vegetable Production Guide for Commercial Growers (Egel et al., 2018). Bravo Weather Stik®, Cuprofix 40 UltraDisperss Initiate®, Cabrio®, Fontelis®and Bravo® were rotationally sprayed for disease control. Assail® and Warrior® were used for insect control. Weeds were controlled with Strategy® (pre-emergence) and Sandea® (pre-emergence and post-emergence). All herbicides were broadcast applied pre-plant after plastic was laid on the raised beds.

The zucchini was harvested three times a week (Monday, Tuesday and Friday) between June 18 and July 18. Fruits were harvested when they reached 6 to 8 inches in length. For each variety the marketable and unmarketable number of fruits were recorded. Fruit that was more than 8 inches long was classified as unmarketable.

How did the varieties perform?

The number of marketable fruit and yield per acre, as well as fruit weight differences among entries were significant (Table 2). Paycheck and Felix produced the most fruit and highest yield per acre (32,822 and 31,491 lb, respectively) of all the green zucchini entries tested. Spineless Perfection produced the lowest yield (19,460 lb/acre). Golden Rod produced the highest number of fruit per acre (89,704) followed by Gold Rush (49,825). However, there was not a significant difference between the yield of Golden Rod and Gold Rush (29,255 and 27,864 lb/acre, respectively). This was due to the higher fruit weight of Gold Rush (6.56 oz). The presence of disease and insects were very low and did not impact yield.

Table 2. Yield and fruit weight of zucchini entries

Cultivar	Marketable Yield				
	Number of fruit per plant	Number of fruit per Acre	Fruit Weight (oz)	Yield (lb per plant)	Yield (lb/Acre)
Green Varieties					
Paycheck	21.4	78,255	6.80	9.04	32,822
Felix	20.9	76,035	6.67	8.68	31,491
Green Machine	16.6	61,175	6.77	6.97	25,287
Partenon	16.5	42,700	6.63	6.69	24,291
Desert	15.7	30,126	6.51	6.22	22,585
Spineless Perfection	12.1	44,157	6.73	5.36	19,460
Yellow Varieties					
Golden Rod	24.6	89,704	5.29	8.06	29,255
Gold Rush	18.2	49,825	6.56	6.68	27,864
Sebring	16.0	40,139	6.47	6.50	23,595
Golden Glory	15.2	55,092	6.10	5.91	21,440

Unmarketable yield differences between entries were significant (Table 3) and was mainly attributed to oversized fruit. Partenon produced the highest unmarketable yield of all the green zucchini entries (34,848 lb/acre), while Green Machine produced the lowest unmarketable yield (15,893 lb/acre). The yellow zucchini varieties produced overall lower unmarketable yields' than the green zucchini entries. Unmarketable yields varied between 9,170 and 19,010 lb/acre. Other than the fruit being too large, these entries were very strong producers. Marketable yields could have improved if they were harvested more frequently. Daily harvests are encouraged for very vigorous varieties, especially green zucchini varieties such as Paycheck, Felix, Green Machine and Partenon and yellow zucchini varieties such as Golden Rod and Gold Rush. Gold Rush and Sebring also produced fruit with green tips.

Table 3. Unmarketable yield of zucchini entries

Cultivar	Oversized Fruit	
	Yield (lb per plant)	Yield (lb/Acre)
Green Varieties		
Partenon	9.60	34,848
Spineless Perfection	6.38	23,164
Paycheck	6.30	22,859
Felix	5.77	20,949
Desert	4.98	18,067
Green Machine	4.38	15,893
Yellow Varieties		
Gold Rush	5.24	19,010
Golden Rod	3.82	13,856
Sebring	2.61	9,458
Golden Glory	2.55	9,170

In summary, the best performing green zucchini squash entries include Paycheck, Felix, Green Machine and Partenon. Golden Rod and Gold Rush were the best performing yellow zucchini entries. A detailed report of the ten zucchini varieties tested is available in the 2018 Midwest Vegetable Trial Report https://ag.purdue.edu/hla/fruitveg/Pages/mvtr2018.aspx.

I would like to acknowledge the Indiana Vegetable Growers Association (IVGA) for co-funding this evaluation.

Literature Cited

Egel, D., Foster, R., Maynard, E., et al. 2018. *Midwest Vegetable Production Guide for Commercial Growers*, 2018 (*ID-56*). Purdue University. https://ag.purdue.edu/btny/midwest-vegetable-guide/Pages/default.aspx

Colored Sweet Pepper Varieties for High Tunnel Production

(Petrus Langenhoven, plangenh@purdue.edu, (765) 496-7955)

Sweet colored peppers can yield well in the protected conditions of an unheated high tunnel, but information is lacking about which varieties are adapted for high tunnel production and their performance. During 2018 we evaluated ten sweet pepper varieties at the Purdue Student Farm, West Lafayette, Indiana (Table 1).

Table 1. Colored sweet pepper cultivar characteristics*

Cultivar	Type	Immature Color	Mature Color	Recommended for
Chesapeake	Bell Pepper	green	red	open field
Zamboni	Bell Pepper	green	red	greenhouse
Flavorburst	Bell Pepper	lime green	yellowish orange	high tunnel
Vangaurd	Bell Pepper	dark green	red	open field
Archimedes	Bell Pepper	green	red	open field
Red Knight	Bell Pepper	dark green	red	open field
Marcato	Tapered Pepper	green	red	open field
Blitz	Bell Pepper	dark green	red	high tunnel
Tequila	Bell Pepper	lilac	red	open field
Delirio	Bell Pepper	green	orange	high tunnel

*Data obtained from seed company listed information

How was the evaluation conducted?

The evaluation was conducted on a Mahalasville (Md), silty clay loam. The spring soil test showed 9.5% organic matter, pH 7.5, and 201 ppm phosphorus (P), 250 ppm potassium (K), 810 ppm magnesium (Mg), and 4200 ppm calcium (Ca). The cation exchange capacity was 28.4 meq/100 gram. Micro nutrients tested at 11.5 ppm zinc (Zn), 34 ppm manganese (Mn), 100 ppm iron (Fe), 2.7 ppm copper (Cu) and 2.9 ppm boron (B). Nitrogen, 60 lb. N/A from Nature's Source® Professional 10-4-3 liquid plant food, was applied by fertigating 15 lb./A N four times at 2, 4, 6, and 8 weeks after transplanting.

The evaluation was set up in a high tunnel that was 30 feet wide and 96 feet long (Fig. 1). The high tunnel was equipped with louvered gable vents (one at each end

wall) and rollup side walls. The gable vents were open all the time, but the side walls were opened when inside temperatures reached 75°F and closed when temperatures dropped below 60°F. Peppers were seeded May 7, 2018 and transplanted into raised beds on June 4, 2018 with an in-row spacing of 1.5 feet and between-row spacing of 4 feet. (7,260 plants per acre). The entire area between the raised beds (4 feet center-to-center) was covered with a black woven polypropylene ground cover. Additionally, a 3 feet wide white woven polypropylene groundcover was placed between the rows to increase light in the lower plant canopy. Irrigation was applied once per day using 2 gallon per hour pressure compensated emitters (Netafim), flex vinyl spaghetti tubing and 90 degree angle stakes.

Figure 1. High tunnel layout, 9 weeks after transplanting

The Nature's Source® Professional 10-4-3 liquid plant food was mixed in a concentrated stock tank at 100 times the normal concentration and injected at a 1:100 rate using a water powered Dosatron D14MZ2 injection unit. Initial plant support was provided with a stake and Florida weave trellis system. The remainder was box stringed. Additionally, plants were treated with a biological fungicide BotryStopTM (BioWorks®) at a rate of 3 lb./A dissolved in 100 gallons water and RootshieldTM (BioWorks®) at 6 oz per 100 gallons water. The treatments were applied through the irrigation system. No pruning was done during the growing season. Weed control was minimal and done by hand. No pesticides were applied during the growing season.

Plots were harvested ten days after the peppers reached their mature color. Harvesting was delayed as a result of a planned field day. Harvesting continued once a week between 92 and 127 days after transplanting. For each plot the marketable and unmarketable number of fruits, fruit weight, fruit size (length and width) and flesh thickness were recorded. During the last harvest (October 9, 2018) all mature colored and mature green fruit were harvested and recorded.

How did the varieties perform?

The yield results are presented in Table 2. Chesapeake produced the highest number of fruits per plant (17.2), followed by Marcato (Fig. 2), Tequila and Flavorburst (Fig. 3). Entries producing significantly heavier fruit included Archimedes (11.07 oz), Blitz (10.73 oz) and Vanguard (10.71 oz). Tequila and Marcato produced the lowest fruit weight, 5.34 and 6.12 oz, respectively. Unmarketable fruit was insignificantly low and are therefore not reported. During harvest some fruits were affected by bacterial soft rot, but did not have a significant effect on yield. No fruit showed any symptoms of blossom end rot.

Table 2. Yield of colored sweet pepper cultivars in west-central Indiana

Cultivar	Number of fruit per plant	Fruit Weight (oz)	Yield (lb per plant)	Yield (lb per tunnel)
Chesapeake	17.2	7.05	7.76	2,328
Zamboni	11.3	8.80	7.03	2,109
Flavorburst	15.3	7.01	6.84	2,052
Vangaurd	9.9	10.71	6.78	2,034
Archimedes	9.4	11.07	6.61	1,983
Red Knight	10.0	9.38	6.60	1,980
Marcato	16.1	6.12	6.56	1,968
Blitz	9.8	10.73	6.25	1,875
Tequila	16.1	5.34	5.94	1,782
Delirio	9.2	7.73	4.65	1,395

Figure 2. Marcato just before harvesting

Figure 3. Flavorburst just before harvesting

Delirio produced the lowest yield. The combination of a lower fruit weight and a low number of fruit per plant contributed to the poor performance. There was no statistical difference between the yields of all other entries, which performed well under high tunnel conditions. Chesapeake produced the highest yield. For more information regarding this variety evaluation, download the full report from the 2018 Midwest Variety Trial Report https://ag.purdue.edu/hla/fruitveg/Pages/mvtr2018.aspx.

Chateau Herbicide SW 24(c) label

(Dan Egel, egel@purdue.edu, (812) 886-0198)

Chateau SW® herbicide now has a 24(c) special local needs label for cucurbits. This product is produced by Valent, but the label is held by the Indiana Vegetable Growers Association (IVGA). To obtain a label, one must be a member of the IVGA, pay an annual $100 processing fee, read and understand the 'conditions for use' and have the appropriate forms signed and notarized. **One cannot use Chateau SW® without completing these forms and obtaining a label.** This process must be repeated every year.

Chateau® can only be used in row middles between raised plastic mulch beds that are 4 inches higher than the treated row middle. The mulched bed must be at least 24 inches wide. The application must be directed between rows with a shielded sprayer. Chateau® cannot be applied post-transplant. Do not apply more than 4 oz. of Chateau® per acre at a broadcast rate during a single application. A rainfall is required after application, but prior to transplant. Plant injury can result through misapplication. More important details are available on the label.

For more information about the 3rd party labeling process or a copy of the appropriate forms, contact Dan Egel. For more information about applications of Chateau®, contact Wenjing Guan.

Midwest Vegetable Production Guide for Commercial Growers 2019 Update

(Dan Egel, egel@purdue.edu, (812) 886-0198)

Midwest Vegetable Production Guide for Commercial Growers 2019 update-The on-line version of this guide has been updated. See below and update your hard copy.

Page	Comment
1	Add "Anthony Hanson, IPM program" under contributors, University of Minnesota
117	Under powdery mildew, last sentence in disease notes-"Protect pumpkin vines until approximately 21 days from **last** harvest."
128	FRAC code for Actigard should be P01
147	Buckeye rot products, Orondis Opti **3-day PHI**.
148	Under late blight, Orondis Opti **3-day PHI**.
Footnote 2 should read "X=permitted for at least one crop." Footnote 3 should read "X=may be used for that crop. *=processing crops only."	

In addition, a table of watermelon evaluations have been added to the cucurbit section on page 120.

FSMA Produce Safety Rule Inspections Will Begin in 2019

(Scott Monroe, jsmonroe@purdue.edu, (812) 886-0198)

Inspections of produce farms for compliance with the Food Safety Modernization Act Produce Safety Rule (PSR) are set to begin in July 2019. Passage of SB 331 in the Indiana General Assembly in 2018 gave the Indiana State Department of Health (ISDH) PSR enforcement authority in Indiana, making them the lead agency for inspections. SB 331 established no additional requirements beyond those of the federal rule.

The rollout of the inspection program will be staggered, to reflect the staggered compliance dates found in the PSR. During 2019, ISDH will be conducting inspections only on farms that have produce sales exceeding $25,000 and total food sales exceeding $500,000.

As inspections are rolled out, here are some things to remember:

1. Prior to an inspection, growers will be contacted by ISDH by mail and by telephone. There will be no unannounced inspections. The inspectors will be as flexible as possible when setting up an inspection date and time.
2. Most inspections across the U.S. will be conducted by state agencies. Those growers with operations in multiple states will be inspected by the lead agency in each state. The exception is Illinois, where FDA will be the lead agency for inspections. FDA has put considerable effort into insuring uniformity in application of the PSR across all the states. Inspections should be very similar regardless of the state where production is located and regardless of which agency is conducting the inspection.
3. FDA Form 4056 will be used as a standard for inspections and will be used by FDA inspectors. This form will not be used by ISDH inspectors, who will be using a modified version of the document. Form 4056 may be used to give growers insight into what to expect during the inspection process. Form 4056 can be found at https://www.fda.gov/downloads/AboutFDA/ReportsManualsForms/Forms/UCM630765.pdf.
4. Unlike audits, inspections will not utilize a point system. Growers will either be in compliance with the rule or not.

In advance of inspections, ISDH is offering On Farm Readiness Reviews for all produce growers. The On Farm Readiness Review is a FREE assessment of compliance with the PSR. Upon request, a team consisting of personnel from ISDH, Indiana State Department of Agriculture, and Purdue Extension will visit your farm and conduct the review. Upon completion of the review, you will be informed of where your farm is on the compliance spectrum and be advised concerning those aspects of compliance where you might improve. The whole process takes 2-3 hours. This is NOT an inspection and the service is completely confidential and free. Those interested in scheduling an On Farm Readiness Review should contact ISDH at (317) 476-0056 or email ProduceSafety@isdh.in.gov. For more information concerning the Produce Safety Rule and produce food safety, check out our website at www.SafeProduceIN.com.

Indiana Climate and Weather Report

(Beth Hall, hall556@purdue.edu)

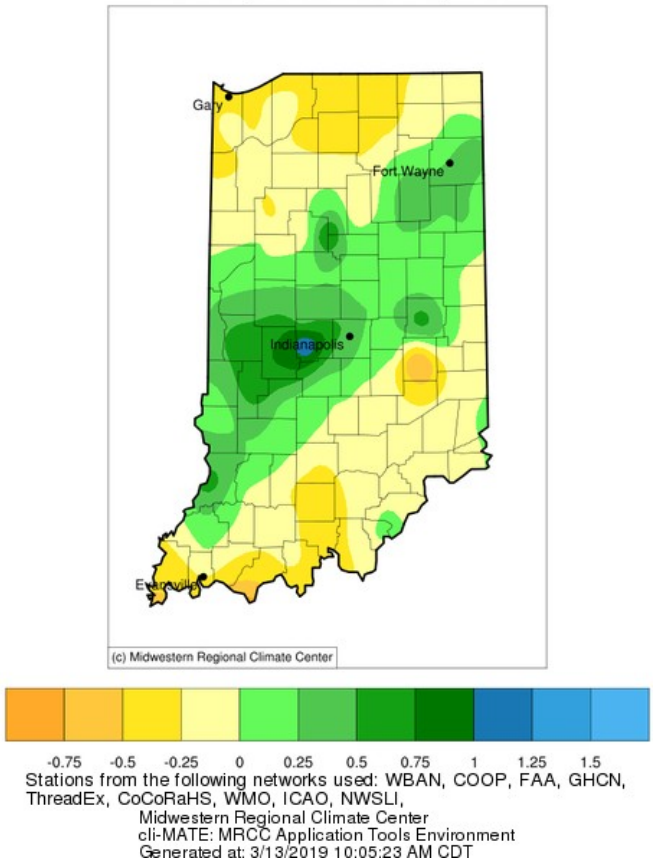
March has been welcoming Indiana like a lion with below-normal temperatures and a combination of above and below normal precipitation (see figure). Snowfall accumulated across the state ranging from less than 1” in the southwest and northwest to as much as 3-4” in the southeast part of Indiana. This precipitation has caused drought to be absent across the state, but monthly and seasonal climate outlooks from the Climate Prediction Center (https://www.cpc.ncep.noaa.gov/) suggest an increasing chance of below normal precipitation over the next few months. While temperatures will continue to gradually warm throughout spring, there are still significant risks for a late season freeze. The typical date of the last hard (28°F or less) freeze is late March in southern Indiana to late April in northeast Indiana. However, hard freezes have occurred as late as mid-April in the southeast counties into mid-May for northern Indiana. According to the Weather Prediction Center (https://www.wpc.ncep.noaa.gov/threats/threats.php), there are no weather hazards predicted over the next week. However, some soils across the state are well saturated due to recent rain and snow events, so any

additional rain in the forecast could cause localized flooding.

Dr. Beth Hall is the new Indiana State Climatologist. She hopes to get more engaged with communities across the state and is looking forward to providing regular climate and weather reports throughout this vegetable season. Please feel free to contact her at bethhall@purdue.edu or (765) 494-8060

Accumulated Precipitation (in): Departure from 1981-2010 Normals

March 01, 2019 to March 13, 2019



Upcoming Events

Cover Crop Workshop & Field Tour

Date: Thursday, April 4, 2019 9:00 am – Noon

Location: SEPAC – 4425 E. 350 N., Butlerville, IN 47223

PURDUE UNIVERSITY | Extension RIPLEY COUNTY

Cover Crop Workshop & Field Tour

Thursday, April 4, 2019 9:00 - Noon
SEPAC - 4425 E. 350 N., Butlerville, IN 47223

Topics to Include:

Drainage & Cover Crop Success - *Eileen Kladivko, Purdue University*

Drainage Videos & Lessons Learned - *Wes Summers, Wesley's Excavating*

Benefits & Challenges - *Shalamar D. Armstrong, Purdue University*

Soil Basics - *David Osborne—Purdue Extension & Alex Helms—SEPAC, & Dena Anderson, NRCS*

Sponsored By:
Central Muscatatuck Watershed, Ripley Soil & Water Conservation District, & Ripley County Purdue Extension
FREE Lunch

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