Integrated Pest Management
University of Missouri

MARCH 2023

Missouri Produce Growers *Bulletin*
A Publication of University of Missouri

# Watermelon production under protected production systems in Missouri to reach the Fourth of July market

By Ramón A. Arancibia, Kathi Mecham, Joni Harper, and Cheryl Recker

Melon and watermelon production under high tunnels was investigated previously in Missouri (Jett, 2006: High tunnel melon and watermelon production. MU Extension). However, low tunnels and caterpillar high tunnels have the advantage that they are easy to relocate avoiding repeated crops in the same soil and more affordable in the short term. In this article, we provide information from our study that demonstrated that watermelon can be planted under protected production systems (low and high tunnels) in Missouri, early enough to reach the Fourth of July market window with premium prices. Securing a share of the Fourth of July market may increase the sustainability of small and medium-size specialty crop farmers in Missouri, especially those with direct sales in local markets.

Watermelon is a relatively important specialty crop in Missouri with 3,100 acres valued at $8.4 million in 2017 (USDA-NASS, 2018: 2017 Agricultural statistics annual bulletin, Missouri), but down from over 5,000 acres in the mid-1990s and early 2000s (Roach et al., 2017: Historical perspective of the Missouri specialty crop industry. MU Extension). Furthermore, of the 352 watermelon farms, 12 farms manage 100 or more acres for a total of 2,111 acres, but 313 farms manage less than 5 acres for a total of 209 acres (USDA-NASS 2019: Census of agriculture, 2017 census by state-Missouri). Therefore, increasing watermelon production and recovering lost market share may not only revitalize and improve the economic sustainability of the industry, but also improve the wellbeing of small and medium-sized farmers.

This study funded by a Specialty Crop Block Grant (MDA-USDA-AMS) was conducted at the Horticulture and Agroforestry Research Center (HARC) in New Franklin, MO following a completely randomized block design with four replications for statistical purposes. We compared three production methods (figure 1): 1) growing watermelon under caterpillar high tunnels covered with greenhouse plastic film and in 2022, with low tunnel inside the high tunnel; 2) growing watermelon under low tunnels made of wire hoops and covered with spun-bonded row cover (1oz/sq-yd); and 3) uncovered open control. All transplanting were on black plastic mulch with drip irrigation. Fertilization and cultural practices followed standard recommendations. We used the watermelon cultivar Yellow Doll, an early (70-75 days to maturity) and small melon cultivar for early harvest. Transplants were grown in trays in the greenhouse (February-March) and had 2-4 true leaves at field planting. The goal was to plant in the tunnels the first week of April, but we delayed the planting in 2021 to April 23 to avoid freezing events that would have affected the uncovered open control. This planting postponement delayed harvesting time beyond the target Fourth of July market in 2021. Therefore, in 2022, we planted the high and low tunnels the second week of April to subject them to freeze events and evaluate the level of protection. The low tunnel inside the high tunnel provided an extra layer of protection. The uncovered open control was planted the last week of April after the freezes had passed. We also followed a couple on-farm low and high tunnels watermelon production operations that farmers were practicing with other "icebox" varieties (one was Sugar Baby, 75-80 days to maturity).

***Figure 1*** *Watermelon production trial under caterpillar high tunnel (top left), low tunnel covered with spunbonded row cover (top right), and uncovered open control (bottom front). Horticulture and Agroforestry Research Center, University of Missouri-CAFNR.*

**Also in this Issue:**

Opening and closing tunnels depended on type and weather conditions. High tunnels stayed closed during cold weather and freezing events, and open with relatively warm weather. Temperatures inside the high tunnels were hot when closed and maximum temperatures in several sunny days reached over 125°F. Temperatures were warmest at night with over 38°F during freezing events (28°F). High tunnels stayed open during and after pollination of female flowers by bees. In general, male flowers appear first and after a couple weeks female flowers develop. If there are no beehives near the tunnels, then, bumble beehives can be set inside to assure pollination. Row cover in low tunnels stayed on continuously for 3-4 weeks until female flowers started to appear and then removed permanently for pollination since no freezing event was in the forecast. Like the high tunnels, temperatures were hot inside the low tunnel reaching maximum temperatures over 120°F in sunny days, but not as warm during cold nights. Temperatures were only 1°F to 3°F warmer inside the low tunnel than outside during freezing nights. Temperature differences vary with the thickness of the row cover material and weather conditions (wind, relative humidity, rain/snow, etc.). Two to three layers of row covers or thicknesses of 2-3 oz/sqyd can increase protection during freezing events. Removing the extra layers in warm days is necessary to avoid excessive shading. Differences in temperature among the three production methods influenced plant growth at the time of row cover removal from the low tunnels as shown in figure 2. The largest plants were under the high tunnels, then under the low tunnels, and the smallest in the uncovered control.

***Figure 2*** *Differences in plant growth due to differences in microenvironmental conditions (temperature, wind solar radiation, and relative humidity) among treatments: high tunnel (top back), low tunnel (top right), and uncovered open control (bottom left).*

We were able to start harvesting watermelons 1 to 2 weeks before the target Fourth of July market in 2022 only because of the early planting (figure 3). In 2021, harvest started the week after the target market for high tunnel watermelons and 2 weeks after for the other methods (data not shown). Similarly, growers monitored for their production of "icebox" watermelons under low or high tunnels started the harvest at least 1 week prior to the target market in 2022 (figure 4). In our study, the first harvest in 2022 was 2 weeks prior to the target market from the high tunnels with 8% of the total marketable melons. Then,

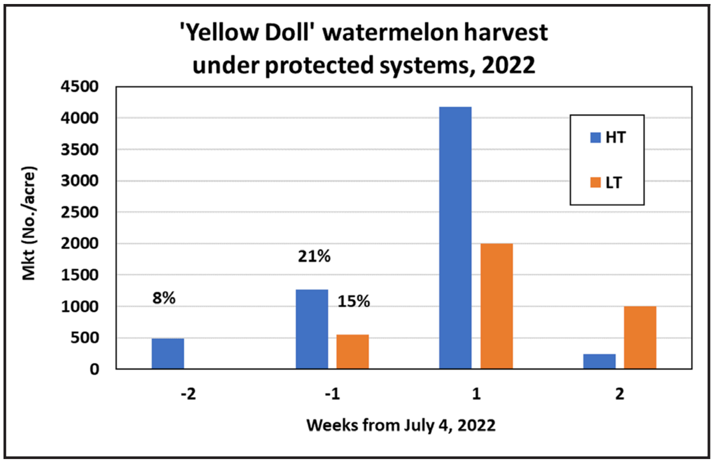


***Figure 3*** *Proportion of marketable watermelons harvested from high tunnels (HT) and low tunnels (LT) treatments prior to the target Fourth of July market in 2022.*

***Figure 4*** *"Icebox" type watermelon grown in a fixed high tunnel near Nevada, MO in 2022. Harvest started more than a week prior to the target Fourth of July market.*

we harvested an additional 21% of the marketable melons from the high tunnels and 15% of the marketable melons from the low tunnels 1 week before the target market. The rest was harvested after the target market. Harvest from the uncovered control in 2022 was lost due to activity of raccoons during the hot dry summer. In addition, watermelons grown under high tunnels had the largest yield both years. Also, yield of watermelons grown under low tunnel was larger than the uncovered control in 2021. Therefore, protected production systems have also the potential to increase yield.

In summary, it is possible and there is potential to produce watermelons under protected production systems for the Fourth of July market in Missouri. To accomplish this, it is necessary to use early varieties (70 to 80 days to maturity), plant in early April with transplants grown in greenhouses, and make sure to manage the systems properly to protect against cold/freezing temperatures as well as ensuring good pollination.

# Injector Installation and Performance Check

By Juan Cabrera-Garcia, *State Vegetable Specialist*

In this article we will show the recommended installation design for fertilizer/chemical injectors. We will also show two methods to determine if your injector is working correctly. The article uses a mechanical proportioner as an example, but the design applies to any type of injector that has adjustable ratios.

## Fixed permanent installation

Install the injection system off the mainline in a water bypass. This set up allows for clean water to flow to flush the irrigation lines or to water the crops when no injection is needed. The set up also allows water flow in case you need to maintain, repair or replace the injection system.

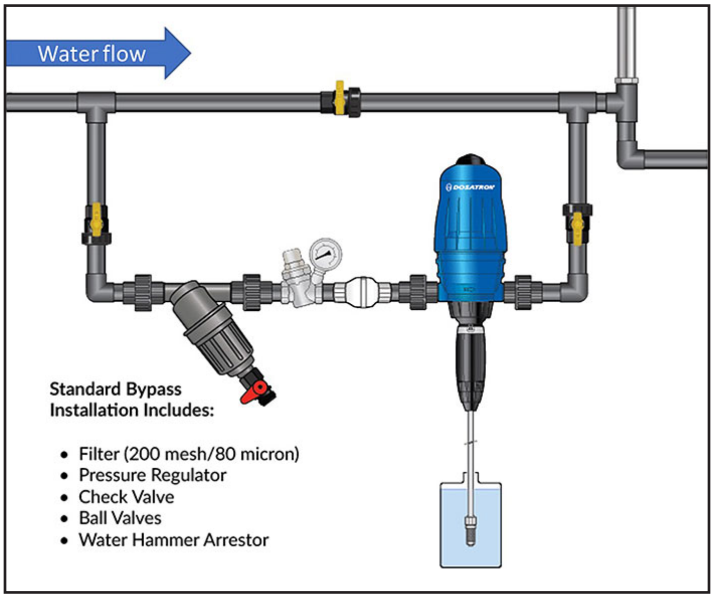


***Figure 1*** *Diagram of injector using fixed installation. Source: Dosatron, USA*

### Filter

Use screen or disk filters and establish a set schedule to clean the filters. The cleaning frequency will depend on the water quality.

### Pressure regulator

The pressure regulator is needed if the pressure in the main line is higher than the recommended operating pressure of the injector. Also, remember that emitters in drip irrigation system have a set range of operating pressures.

### Water hammer arrestor

A back flow pressure is created when you turn the irrigation system off, which can damage the injector. The water hammer arrestor captures and dissipates this pressure before it reaches the injector.

### Backflow prevention

A check valve (backflow prevention) is required to prevent contamination of the water source!

## Mobile cart

Growers with multiple production bays can benefit from having a single mobile injector. Each production bay needs to have the bypass irrigation lines with adapters to connect hoses. The injector needs to be primed whenever a new stock solution is used.

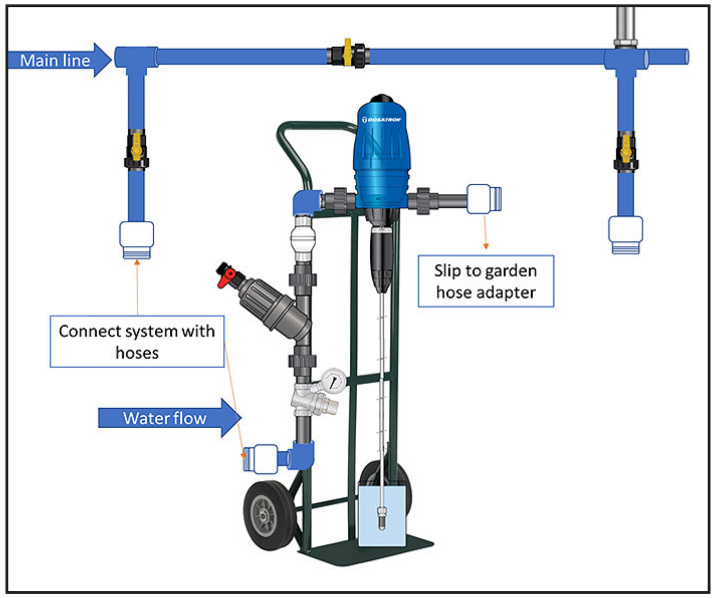


***Figure 1*** *Diagram of injector using standard bypass installation. Source: Dosatron, USA*

## Checking the injector calibration using EC (electrical conductivity) readings

I'm going to use the label instructions in the 21-7-7 fertilizer for demonstration purposes. Use the following steps with any fertilizers that you have in stock.

- Set the injector to the 1:100 setting
- Prepare stock solution according to the fertilizer label. In this example, I will prepare a solution to deliver 200 ppm N. According to the label, I need to mix 12.9 ounces of the fertilizer in 1 gallon of water.

**Weight (In Ounces) Of Product Needed To Mix One U.S. Gallon Of Concentrate**

| Target Fertilizer Concentration (ppm N) After Dilution | Injector Ratios | | | EC mmhos/cm of Target Feed Rate After Dilution |
|---|---|---|---|---|
| | 1:15 | 1:100 | 1:200 | |
| 50 | 0.5 | 3.2 | 6.4 | 0.26 |
| 100 | 1.0 | 6.4 | 12.9 | 0.52 |
| 200 | 1.9 | 12.9 | 25.7 | 1.04 |
| 300 | 2.9 | 19.3 | 38.6 | 1.56 |

***Table 1*** *Fertilizer mixing ratios using 1 gallon of water.*

According to the label, the solution coming out of the injector should have an EC of 1.04 mmhos/cm but this is based on laboratory tests using deionized water. Your water source has a natural EC so the final reading will be what is stated in the fertilizer label plus the EC of your water source (without any fertilizers).

- Calibrate your EC meter
- Measure the EC of your water source
- Turn off water flow through the injection system
- Disconnect the injector outlet from the downstream irrigation system. Attach a hose to the injector outlet to ease sample collection.
- Prime the fertilizer injector: place the suction line in the stock solution tank and run water through the injector. Keep the water flowing and observe the solution moving from the stock tank to the injector. Once the stock solution reaches the injector, count 15 clicks (the injector makes clicks as it mixes the solution).
- After 15 clicks, collect a sample coming from the injector outlet and measure the EC. The value should be what is stated in the fertilizer label plus the EC of your water source. It is normal for values to be 5% off the expected values.

## Checking the injector calibration using water volume

- Turn off water flow through the injection system.
- Set the injector to 1:100. See table below for different injection ratios.
- Disconnect the injector outlet from the downstream irrigation system.
- Attach a hose to the injector outlet and place it in an empty 5-gallon bucket.
- Measure 6.5 ounces of water in a cup.
- Remove the strainer from the edge of the suction line.
- Insert the suction line to the cup with the 6.4 ounces of water.
- Turn on water flow through the injector.
- The injector should suck the 6.4 ounces when the 5-gallon bucket is full.

| % | Ratio | Ounces of stock per gallon | Ounces of stock per 5 gallons |
|---|---|---|---|
| 2 | 1:50 | 2.6 | 13 |
| 1 | 1:100 | 1.3 | 6.5 |
| 0.78 | 1:128 | 1 | 5 |
| 0.5 | 1:200 | 0.65 | 3.25 |

***Table 2*** *Ounces of stock solution injected at different injection ratios for every gallon and 5 gallons of solution exiting the injector.*

Service the injector if the values deviate from expected values. Injector manufacturers sell maintenance kits and gaskets to service the injectors.

# Low-Temperature Injury to Unprotected Blackberries

By Michele Warmund, *State Fruit Specialist*

Blackberry floral buds are often injured when temperatures fall below 5°F. The 2021-2022 winter was relatively mild in Missouri, with little or no mid-winter cold injury in mid-Missouri. However, on December 22 and 23, 2022, the overnight temperature dropped to -7.6 °F at the University of Missouri Horticulture and Agroforestry Center (HARC), near New Franklin. In both winter seasons, low-temperature injury to nine erect-growing blackberry cultivars was assessed. Plants at this site were grown on a T-trellis and were not protected with row covers.

Tissue for laboratory freezing tests was collected on January 17, February 8, and November 21, 2022. Sampling dates were selected to assess flower bud hardiness during mid-winter, just before bud swell in late winter, and in the fall as buds were acclimating to low temperatures. For each sampling date, tissue was collected from the middle portion of one-year-old lateral canes at about 3.5 feet above the soil surface.

Immediately after samples were collected, the cuttings were wrapped and then placed in a programmable freezer, and exposed to a range of temperatures (16 to -22°F) likely to produce tissue injury. After removal from the freezing chamber, samples were thawed at room temperature for five days before floral bud evaluation. Low-temperature injury was expressed by oxidative browning of the floral axis when buds were bisected (Figure 1). Green tissue within the buds indicated survival of the floral axis. The mean T50 value (temperature at which 50% of the buds were injured) was calculated for each cultivar for each of the sampling dates and is shown in Table 1.

| | $T_{50}$ value (°F) | | |
|---|---|---|---|
| Cultivar | 17 Jan. | 28 Feb. | 21 Nov. |
| Ouachita | -7.1 a[1] | -6.3 a | -2.0 a |
| Von | -3.8 b | -3.5 b | -1.3 a |
| Arapaho | -3.5 b | -0.9 c | -0.2 abc |
| Osage | -3.1 b | 4.5 d | 1.6 cd |
| Apache | -2.7 b | -1.3 c | -1.3 a |
| Navaho | -2.4 b | -2.7 bc | -0.6 ab |
| Ponca | 0.5 c | 5.5 d | 3.2 d |
| Caddo | 0.9 c | 4.8 d | 1.2 bcd |
| Natchez | 5.9 d | 18.1 e | 10.2 e |

[1] Means represent 5 replications of each cultivar. Means within columns followed by common letters do not differ at the 5% level of significance.

***Table 1*** *Mean T50 values of primary flower buds of nine blackberry cultivars grown at New Franklin, Missouri at selected dates in 2022.*

***Figure 1*** *Left: Injured flower primordia indicated by oxidative browning of tissue of a blackberry bud. Right: Uninjured tissue with viable flower primordia in a bud.*

Due to the low temperatures recorded at HARC in December 2023, a different procedure was used to assess low-temperature survival of blackberry flower buds. On January 11, 2023, 150 buds of each of cultivar were sampled as described above and were examined for injury to the floral primordia after 72 hours exposure to room temperature. The percent bud survival was then calculated and are shown in Figure 1.

| Cultivar | Flower bud survival (%) |
|---|---|
| Apache | 15.3 e[1] |
| Arapaho | 16.7 d |
| Caddo | 22.7 c |
| Natchez | 4.7 f |
| Navaho | 38.7 b |
| Osage | 12.7 e |
| Ponca | 17.3 d |
| Ouachita | 46.0 a |
| Von | 39.3 b |

[1] Means represent 5 replications of each cultivar. Means followed by common letters do not differ at the 5% level of significance.

***Table 2*** *Percent survival of flower primordia in primary buds of nine blackberry cultivars grown at New Franklin, Mo in January 2023.*

Results from these studies showed that at all test dates, 'Ouachita' had consistently low T50 values and 'Natchez' had the highest values. Although T50 values of 'Ponca' were lower than 'Natchez' at all sampling dates, this cultivar was injured at warmer temperatures than most other cultivars. Thus, 'Ponca' plants planted in colder, more northern regions of Missouri than the central part of the state are at risk for substantial bud and crop loss during severe winters. Based on the early results of this study, 'Ouachita' flower buds had superior cold tolerance among the cultivars tested in mid-winter and just before budbreak in late winter (Table 2).

At this point in the dormant season, it is too late to protect blackberry buds from winter injury. Also, in our previous studies, applications of cryoprotectants to prevent injury to flower buds after they began to grow were ineffective. Even though substantial primary bud injury has already occurred, these blackberry cultivars also have secondary buds at the base of primary buds. Secondary buds are usually more freeze-tolerant than primary ones and have the potential to produce berries.

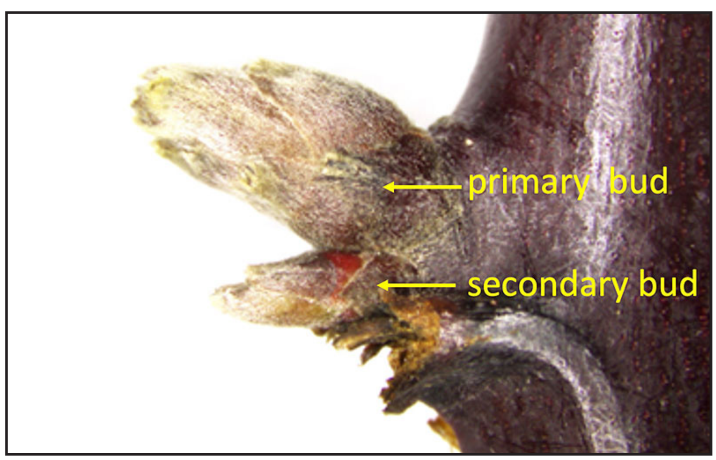


***Figure 2*** *A large primary bud subtended by a smaller secondary bud on a blackberry cane.*

# How To Submit a Sample to The University of Missouri Plant Diagnostic Clinic? By Peng Tian, Dhruba Dhakal, Pierce Taylor

Every year, different types of plant diseases cause severe problems for Amish and Mennonite communities to maintain plant health and food security. There are issues related to nutrient deficiency in horticultural and field crops in those communities. Meanwhile, the occurrence and spreading of plant diseases can cause yield reduction and economic loss to the growers. The disease and insect infestation also reduce the marketability of the produces. To minimize these issues, it is important to receive timely diagnosis to check if the issues are related to disease, insect pest damage, nutrient deficiency, or off-target herbicide damage. Effective disease management requires prompt and accurate disease diagnosis, and it can be challenging to perform it in the field as it requires specialized approaches, equipment, and trainings. The University of Missouri Plant Diagnostic Clinic in Columbia, Missouri is part of MU Extension and provides plant diagnostic services such as plant disease identification, insect identification and weed identification. When you suspect health problems on your plants, please take your sample to local County Extension center or send it directly to the MU plant diagnostic clinic. If you go to Clark Produce Auction in Audrain County, you can bring plant samples to the auction where a MU Extension Specialist provides plant diagnostic services from 9:30 AM to 10:30 AM during auction season in the morning of each Friday. Regarding sample collection and submission guidelines, here are some tips:

*Photos courtesy of National Plant Diagnostic Network*

## 1. Collecting your sample

Please pick up fresh representative plants displaying symptoms. Avoid complete dead or healthy plant tissues. Include the entire plant when possible because leaves, stems and roots together allow a complete and thorough diagnosis. For larger plants, select plant tissues that best represent problems.

## 2. Submitting your sample

Contact local MU Extension County center for receiving information about standard procedure for plant sample submission. The office staffs there work closely with the clinic and will assist you in correctly submitting samples. If you choose to submit your sample by yourself, here are a few things to consider:

**Packaging:** Wrap the sample with newspaper or place it loosely in a plastic bag. Use a plastic bag to wrap the root separately and label each sample correctly with details to avoid confusion with the result. Never add water or wet paper towels along with the sample to avoid high humidity that may trigger the growth of mold. Cushion fragile samples to avoid damages during the shipment.

**Information:** Please include your contact information such as home address and telephone number if available. Use a piece of paper to record the answers to the following questions: What is the species of plant submitted? How old are these plants? What are the symptoms of the plants based on your observation? When did symptoms first appear and how did they progress? How much of the area and how many plants are affected? The more information is received, the easier diagnosis for your sample can be performed.

**Payment:** There is a fee of $15 for general tests including microscopic observation and incubation test for identification. Additional cost (up to $20) is required for further tests such as serological tests for virus and bacteria or molecular tests. You can choose to attach a check with your sample when submitting it, pay it in the extension office or send a check to the clinic once you receive the final invoice. Please make sure the title of the check is MU Plant Diagnostic Clinic and the clinic doesn't not take cash through mail.

**Shipment:** Submit your sample early in the week using overnight shipping service to avoid delay. Our address is:

**University of Missouri-Plant Diagnostic Clinic**
**1100 University Ave, Room 28 Mumford Hall**
**Columbia, MO 65211**

## 3. Sample submitted, now what?

Once the clinic processes the sample and awards a diagnosis, you will receive a diagnosis report by mail within approximately one week. The clinic may contact local county extension field specialists for any additional requests or updates. The clinic and/or specialist will provide the research-based management options to control or minimize the plant disease issue.

# Sweet Potato Field Planting Date Influences Yield in MO

By Ramón A. Arancibia, Juan Cabrera-Garcia, and Patrick Byers

Sweet potato growers in Missouri can increase production and gain market share by growing their own slips/transplants under high/low tunnels for early field planting. This article discusses results of a study that demonstrated that early field planting with slips grown on-farm under low/high tunnels provide 2-4 weeks earlier start than with slips from open unprotected beds, which resulted in 18% to 82% larger marketable yield. This study was supported by a Specialty Crop Block Grant (Missouri Department of Agriculture and U.S. Department of Agriculture - Agricultural Marketing Service).

Sweet potato is a perennial tropical crop but cultivated as an annual in the U.S. It is sensitive to chilling temperatures (cold temperatures between 32°F and 60°F) and will die with freezing temperatures. Therefore, planting should begin when soil temperature is above 65°F and the risk of freezing has passed. In addition, sweet potato storage roots can keep growing in the Fall as long as temperature and soil moisture are favorable. The longer the growing season the larger the yield the crop can achieve. Therefore, an early planting with on-farm produced slips can extend the growing season and the sweet potato crop has the best chance to reach profitable yields.

In our 2-year study of slip production under protected systems, slip harvest and field planting started the last week of May with slips from the low tunnel inside a high tunnel in three Missouri locations (Oregon Co., Greene Co., and Henry Co.). About a week later, slips from the high tunnel without low tunnel were ready to harvest and used for field planting. Depending on location, 2 to 3 weeks after the first planting, slips from the low tunnels were harvested and field planted for storage root production. Finally, field planting with slips from the plots without any protection occurred 3 to 4 weeks after the first field planting. Figure 1 shows the difference in growth of sweet potato plants from the four planting times one week apart (Oregon, Co). The first planting date covered the surface area before the second, third, and fourth planting date. Similarly, the second planting date covered the surface area before the third and fourth planting date, and so on. This earliness in vegetative growth allowed the plants to initiate storage root development earlier than the later planting dates.

Early field planting allowed a longer growing season for the valuable storage roots to develop. In the earlier planting, sweet potato storage roots developed first and had a longer season to grow by harvest time.

***Figure 1*** *Growth difference in field sweet potato plots planted sequentially (about a week apart) in Oregon Co. MO, 2022. First planting was the last week of May (left), second planting a week later (center left), third planting two weeks after the first planting (center right), and the fourth planting three weeks after the first planting (right). Plots were drip-irrigated, and pictures taken a week after the last planting date.*

*Figure 2 Yield difference in field sweet potato plots (15ft long) planted sequentially in Henry Co. MO and harvested the last week of September 2021. Sweet potato storage roots were separated by size: large (jumbo), medium (US1), small, and cull. Top left corresponds to the first planting the last week of May, top right corresponds to the second planting a week later, bottom left corresponds to the third planting two weeks after the first planting, and bottom right corresponds to the last planting four weeks after the first planting.*

The lengths of the growing period in subsequent plantings were shorter according to the planting dates since all plots were harvested the same day at the end of September. This difference in storage root growth was reflected in the yield (figure 2). The average marketable yield (the sum of large, medium, and small storage roots) and yield of large storage roots from the three locations were different among the planting times. The larger marketable yield (518lb/100ft planted row) was from the first planting time the last week of May, then the second planting time with 405lb/100ft, the third planting with 334lb/100ft, and the smallest marketable yield (284lb/100ft) from the last planting date. Also, the average yield of medium size storage roots was larger in the first planting date than the last planting date.

Based on these results, the shorter growing periods due to the delayed plantings resulted in reduced yield (figures 2). Consequently, sweet potato yield is influenced by the length of the growing season. However, scouting the field to harvest when most of the storage roots are of the most desirable size is recommended. In general, the medium size (U.S.#1) is the most valuable, but most direct sale farmers can sell all sizes at similar price. Too long growing season may promote development of large storage roots, so adjusting plant spacing may be necessary to obtain the highest proportion of desirable storage root size. In addition, irrigation plays an important role in growing sweet potatoes, which promotes growth and storage root development. In this trial, sweet potatoes were drip-irrigated in two locations and sprinkler irrigated in the other, which was crucial in obtaining high yields.

In summary, early planting with quality, on-farm grown sweet potato slips available early in the season (last week of May) can increase yield and reduce planting costs, which would improve the economic sustainability of the operation.


## WHO'S WHO

**Juan Cabrera-Garcia, *Editor***
State Vegetable Specialist
573-882-0567
Jcabrera-garcia@missouri.edu

**Michele Warmund**
State Fruit Crop Specialist
573-882-9632
warmundm@missouri.edu

**Cheryl Recker**
Research Technician, Horticulture & Agroforestry Research Center (HARC)

**Sam Polly**
Pesticide Safety & Education Program (PSEP) Coordinator
573-884-8596
sjpkkf@missouri.edu

**Londa Nwadike**
State Extension Food Safety Specialist
913 307 7391
nwadikel@missouri.edu

**Justin Keay**
Horticulture Field Specialist
Pike County
31-400-7388
justin.keay@missouri.edu

**Dave Trinklein**
State Floriculture Specialist
573-882-9631
trinkleind@missouri.edu

**Extension County Specialists**

**Adair:** Jennifer Schutter
660-665-9866

**Bates:** Ramón Arancibia
660-679-4167

**Henry:** Travis Harper
660-885-5556

**Morgan:** Joni Harper
573-378-5358

**St. Francois:** Kate Kammler
573-883-3548

**Webster:** Patrick Byers
417-859-2044

**Cole:** Dhruba Dhakal
573-634-5463

**Carroll:** Kathi Mecham
660-542-1792

**Morgan:** Joni Harper
573-378-5358

**Send a letter to the editor:**
110 Waters Hall
University of Missouri
Columbia MO, 65211



The Missouri Produce Growers (MPG) bulletin is published by the University of Missouri with funding support from both the Missouri Department of Agriculture (MDA) Cooperative Agreement to Enhance Produce Safety from the US Food and Drug Administration (FDA) and the USDA NIFA (National Institute of Food and Agriculture) CPPM – Extension Implementation Program.