Integrated Pest Management
University of Missouri

**OCTOBER** 2019

# Missouri Produce Growers *Bulletin*

A Joint Publication of the University of Missouri and Lincoln University

## First Missouri Produce Auction is GAP/GHP Certified

James Quinn and Londa Vanderwal Nwadike

The Clark Produce Auction became GAP/GHP certified this summer, which was followed shortly by 15 or more growers getting their GAP certifications. This was a community- wide effort that took much time and was successful because they were both sincere and diligent. I thought it might be helpful to review the steps that were taken and include some additional information.

It is rare to meet a vegetable grower who 'wants' to get GAP certified, just to 'do it'. For the Clark community, it became a serious issue as a major buyer made it known he'd have to pull his business unless they did. And at least one other buyer was saying something similar. Furthermore, their buyers had been pushing on this issue for some years; they really couldn't dodge it anymore.

The training or educational steps they took started small and kept building. Here's a recap:

- November 2017 (Kirksville)- FSMA PSA training, with four from Clark.
- September 2018- an On Farm Readiness Review (OFRR) conducted at two farms. About 16 growers attended between the two farms.
- January 2019- FSMA PSA training at a Clark packing shed. Almost 30 attending.
- Early summer 2019- more OFRRs conducted in Clark.
- Mid-June- mock GAP audits conducted at two farms, with a number of growers attending at each (total about 12).
- Late June- GAP/GHP (Good Handling Practices) audit of the auction by Quality Fresh (Scott Bowman).
- Early July- GAP audit of 15+ growers by Quality Fresh (Salomon Meyer). This took a week. The GAP audit conducted was 'the combined harmonized produce safety standards' or Harmonized GAP.
- Missouri Department of Agriculture's efforts to round up water samples in 2019 and get them submitted for testing was very helpful.
- Also helpful, at the mock GAP audit a template of a succinct, yet complete farm food safety plan was identified. Growers were able to revise and adapt it specific to their farm.

### About Quality Fresh

Scott Bowman started his company about three years ago and the only service the company provides is GAPs auditing or similar work on food safety of fresh produce. For 2019, he employed seven auditors. This year they performed audits in more than 10 states and their focus or niche is for Amish and Mennonites. While Quality Fresh provides audit service to many communities, not many have a GAP certified produce auction. Ohio is the most with four, but three or four other states have at least one. Quality Fresh can be contacted at:

**9825 Cleveland Ave SE**
**Magnolia, OH 44643**
**Telephone: 330-575-9401**

The audit cost per grower was $405. For anyone that 'passed', they were issued temporary certificates at the time. Several growers had items to follow up before they could get even a temporary certificate; this usually involved water testing or usage. After passing, official certificates came in 2-3 weeks. The growers I spoke with said the auditor generally spent 60% (or more) of his time going over the paperwork. A couple of interesting comments were:

- 'my packing shed sure looks a lot different now than it did last year'.
- 'it was really a lot to deal with, we're all taking a breather now, but we really can't relax too much, because we have to keep these forms and records up'.

My comment is, that if someone told me 18 months ago that the Clark auction and almost all of its principal growers would be GAPs certified, I would have said 'no way!'. This is a great example of teamwork, from the Clark growers, to our colleagues at Missouri Department of Agriculture, and a number of us at MU Extension. Lastly, their customers who requested this are satisfied and purchasing.

It is important for growers seeking to be GAP certified to check with their buyers first. Verify with them which GAP certification they will be satisfied with- GAP/GHP, Harmonized GAP, or other. Many buyers are still ok with GAP/GHP, but there seems to be a shift to wanting Harmonized GAP. It is also important to check with your buyer(s) on the certification company or organization you plan to use (such as USDA, Primus, or other organization), to make sure they are acceptable.

**Also in this Issue:**



# Fusarium Wilt of Tomato in Greenhouses and High Tunnels

David Trinklein

Given their high dollar value, it is understandable that crops such as tomato are grown year after year in heated greenhouses and high tunnels in Missouri. Unfortunately, this practice has led to an increase in soil-borne diseases such as fusarium wilt which, in certain areas, has taken on epidemic proportions. Hence, the profitability of greenhouse and high tunnel tomatoes is at risk unless new management practices are followed.

Fusarium wilt of tomato is caused by the fungus Fusarium oxysporum f. sp. lycopersici. It is a soil-borne fungus found in many regions of the United States, especially where soils are warm. Typical symptoms of fusarium wilt include yellowing on one side of a plant followed by wilting and necrosis. In time, the entire plant wilts and dies. Field verification of the disease can be done by cutting the stem of a diseased plant longitudinally. The presence of reddish-brown vascular tissue is indicative of the disease's presence.

There are several unique features surrounding heated greenhouses and high tunnels that tend to favor soil-borne diseases such as fusarium wilt. First, the high humidity and temperatures typical of the interior of these structures are ideal for pathogen growth. In addition, the practice of growing the same crop year-after-year leads to an increase of disease inoculum in the soil as well as the formation of new races (strains) of a disease. Finally, pesticide options for the control of fusarium wilt are somewhat limited.

Currently, greenhouse and high tunnel tomato growers primarily rely on genetic resistance to fusarium wilt to control the disease. When available, the use of genetically resistant varieties is by far the least expensive and most effect way to combat any disease, including fusarium wilt. Today, most F1 tomato hybrids carry resistance to races 1 and 2 of fusarium wilt because of the dominant I1 and I2 ("I" standing for immunity) genes they possess. Multi-gene resistance as well as minor resistance (tolerance) have been identified as well.

Recently, several tomato growers in Missouri experienced significant fusarium wilt damage to tomato varieties that are marketed as being genetically resistant. A search of the literature revealed an article published in the Journal of Phytopathology that demonstrated that an increase in disease inoculum concentration caused an increase in disease expression, even when varieties tested were marketed as being genetically resistant. This was truer for varieties that carried only a single copy of the dominant gene for resistance (e.g. I1i1) versus those which contained a double copy (e.g. I1I1).

Alternatively, diseases tend to mutate as do other living organisms. The possibility of a new mutant strain(s) of Fusarium oxysporum f. sp. lycopersici able to overcome the mechanism of resistance in tomato might have developed locally. Such was the case in California and Florida where a third race of the organism (determined to have developed locally from race 2) has been identified for which there is no genetic resistance. More recently, race 3 also has been reported in North and South Carolina as well as in Mexico.

Whatever the cause of the recent outbreak of the disease, management of tomato fusarium wilt should employ IPM tactics. First, check to make sure the "disease resistance package" of the tomato variety grown includes resistance to races 1 and 2 of fusarium wilt. Whenever possible, crop rotation should be practiced which will help prevent the build-up of disease inoculum. Where this tactic is not economically feasible, other management methods need to be explored.

In the past, control of soil-borne pathogens of vegetable crops such as tomato was principally accomplished using soil fumigants such as methyl bromide. Due in large part to its adverse environmental effects, methyl bromide has been phased out of agricultural use. Replacement fumigants such as chloropicrin, Basamid® (dazomet), and Vapam® (metham sodium) are available. However, there are application problems associated with using these compounds because of their toxicity, leading us to explore other options.

Biofumigantion represents one such alternative. Biofumigation involves the use of plants, mainly from the Brassicaceae (or mustard) plant family, to both control soil-borne diseases and improve soil health. Many members of the mustard family contain compounds known as glucosinolates (GSLs). The latter are organic compounds that contain sulfur and are responsible for the pungency in crops such as mustard, cabbage and horse radish. Upon hydrolysis after plant tissue has been incorporated into the soil, the GSL contained releases chemicals known as isothiocyanates. Isothiocyanates have both fungicidal, nematicidal and weed suppressive properties.

Strains of mustard selected for high GSL content are commercially available for use as biofumagants. Rupp Seeds (800-700-1199) markets the Caliente series of mustards which have been used successfully in university trials. Alternatively, Mighty Mustard® (509-487-0755), a Washington-based company, markets its own series of biofumigant mustard. It must be noted, because of their high GSL content, biofumigant mustards are not suitable for livestock grazing.

Alternatively, mustard meal such as Pescadero Gold™ (831-763-3950) can be used to incorporate GSL into the soil instead of growing mustard plants. While this practice is more expensive, it will result in a higher amount of GSL being released into the soil resulting in superior disease control and weed suppression.

Recently, the active ingredient in mustard meal has been made available to growers under the brand name of Dizatol® (Champon Millennium Chemicals, 703-349-0511). It is labeled for tomato and reportedly controls a number of soil-borne diseases including fusarium wilt and nematodes.

Recently it has been demonstrated that a number of root endophytes (microbes that live between plant cells) can impart tomato fusarium wilt resistance by pathogen antagonism or by causing the host plant to trigger a response. As a result, a number of products containing beneficial microbes have been introduced to the market and are labeled for fusarium wilt suppression. Most contain strains of bacteria (e.g. Bacillus subtilis) or mycorrhizae (e.g. Trichoderma harzianum) that colonize the root system of plants such as tomato. Brand name examples include RootShield® and Cease® (Bioworks, 800-877-9443), Actinovate® (Novozymes BioAg, 800-245-4104) and Mycostop® (Veredera, 888-815-9763).

In summary, fusarium wilt of tomato is not a new disease. However, it recently has been occurring in situations where (seemingly) it should not be a problem. Regardless of the reason for the outbreak, new management practices need to be explored to keep this troublesome disease in check.

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*All product brands and company names used in this article are for informational purposes only. Mention of these brands does not imply endorsement by University of Missouri Extension.*

# Investigating the Optimal Planting Date for Garlic in Southwest Missouri

Kelly McGowan, Patrick Byers & Clydette Alsup-Egbers

## Introduction

Commercial garlic (Allium sativum) production is in its infancy in Missouri. To aid existing farmers and encourage other producers to grow garlic, research was needed to investigate the optimum planting date for garlic in southwest Missouri.

## Materials and Methods

- Two replicated sites –Braker Berry Farm, Oronogo, Missouri and Missouri State University's Darr Agricultural Center, Springfield, Missouri
- Study took place over two production cycles
- Five planting dates were compared – four fall and one spring
- Three garlic varieties were compared –Inchelium Red (softneck), German White (Hardneck) and Elephant Garlic
- Data was collected on bulb weight, entire plot weight, bulb

Study site at Braker Berry Farm. Plot layout was randomized among the three varieties.

## Conclusions

Implications from this research include the possibility of utilizing both fall and spring planting dates for commercial garlic production in Missouri. A variety of planting dates will give producers a research-based decision tool if planting conditions are not optimal during traditional fall planting periods.

Top photo: Harvested garlic after curing process
Bottom photo: Garlic harvest in the field

## Results

Spring planted garlic tended to have the lowest yields, while the higher yields varied among cultivars and planting locations. The mid-September planting date tended to have the highest yields for the most locations or cultivars, but it is evident that planting location and cultivar do make a difference in yields, as well as planting dates. The Elephant garlic variety produced heavier and larger diameter bulbs and cloves at all planting dates, while the German variety generally produced the smaller bulbs and cloves. The Inchelium variety, however, consistently produced the greatest number of cloves per plant, while the Elephant variety tended to produce the lowest number at all planting dates, suggesting that the Elephant variety produced fewer, but larger cloves, and the Inchelium variety produced smaller, but more cloves.

| Planting Date Effect On Garlic Growth | Bulb Weight (g)[z] | Average Bulb Diameter (cm) | Clove Weight (g) | Clove Number |
|---|---|---|---|---|
| **Variety: Elephant – at Braker Farm** | | | | |
| Mid September 2017 | 107.1 b | 8.3 a | 100.1 a | 5.5 a |
| Early October 2017 | 52.3 d | 6.4 b | 55.1 b | 4.5 a |
| Mid October 2017 | 102.5 b | 7.9 a | 93.0 a | 5.6 a |
| Early November 2017 | 135.2 a | 8.4 a | 110.6 a | 5.0 a |
| Spring 2018 | 62.4 c | 6.3 b | 48.5 b | 5.2 a |
| **Variety: German – at Braker Farm** | | | | |
| Mid September 2017 | 78.9 ab | 7.1 ab | 72.4 ab | 8.5 a |
| Early October 2017 | 83.2 a | 7.4 a | 77.8 a | 8.2 a |
| Mid October 2017 | 73.0 b | 7.0 b | 68.9 b | 9.0 a |
| Early November 2017 | 81.2 a | 7.3 ab | 75.5 ab | 9.0 a |
| Spring 2018 | 55.3 c | 6.2 c | 54.1 c | 5.2 b |
| **Variety: Inchelium – at Braker Farm** | | | | |
| Mid September 2017 | 95.8 a | 8.4 a | 90.7 a | 12.1 a |
| Early October 2017 | 96.0 a | 7.8 b | 96.0 a | 11.4 a |
| Mid October 2017 | 76.9 b | 7.9 b | 69.9 b | 10.4 a |
| Early November 2017 | 95.7 a | 8.5 a | 88.8 a | 11.8 a |
| Spring 2018 | 28.1 c | 5.5 c | 26.7 c | 11.1 a |
| **Variety: Elephant – at Darr Farm** | | | | |
| Mid September 2017 | 93.6 ab | 7.8 a | 87.3 a | 5.8 ab |
| Early October 2017 | 91.6 ab | 7.5 a | 86.5 a | 5.4 ab |
| Mid October 2017 | 83.7 b | 7.5 a | 79.6 a | 6.1 a |
| Early November 2017 | 116.1 a | 8.1 a | 101.7 a | 4.7 bc |
| Spring 2018 | 97.7 ab | 7.7 a | 92.2 a | 4.0 c |
| **Variety: German – at Darr Farm** | | | | |
| Mid September 2017 | 74.4 a | 7.0 a | 70.4 a | 7.7 a |
| Early October 2017 | 67.8 ab | 6.6 a | 64.0 ab | 6.3 b |
| Mid October 2017 | 67.8 ab | 6.7 a | 63.7 ab | 6.9 ab |
| Early November 2017 | 53.1 c | 6.5 a | 50.3 c | 4.1 c |
| Spring 2018 | 65.3 b | 6.6 a | 58.9 b | 6.2 b |
| **Variety: Inchelium – at Darr Farm** | | | | |
| Mid September 2017 | 58.3 a | 6.9 a | 54.0 ab | 58..3 a |
| Early October 2017 | 61.5 a | 7.0 a | 57.5 ab | 61.5 a |
| Mid October 2017 | 57.9 a | 6.8 a | 50.7 bc | 57.9 a |
| Early November 2017 | 65.6 a | 7.1 a | 61.0 a | 65.6 a |
| Spring 2018 | 46.6 b | 6.3 b | 44.7 c | 46.6 b |

[z]mean separation by variety within individual Planting Date/Location sections by Duncan; means followed by same letter are notstatistically significant at alpha = 0.05.
[y]mean separation by location within individual Planting Date/Location sections by ANOVA F-test; means followed by same letter are not statistically significant at alpha = 0.05. (Insufficient data available for mean separation in blank spaces)

# Upcoming FSMA Trainings

The Food Safety Modernization Act (FSMA) trainings are beginning for the off season. Consider one of the trainings below if you are interested or needing this training. Attendance is limited to 50; please reserve in advance.

$20 per person*, lunch is included and all participants will receive a training certificate along with a PSA Training Manual.

****The Missouri Department of Agriculture is providing generous support to offset the costs of this training so it is available at a reduced price for Missouri growers.***

| | |
|---|---|
| **November 13th** | **8 AM to 5 PM**** |
| 18761 Kelsay Rd. | (Morgan County Seeds) Barnett, MO 65011 |
| 573-378-5358 | Morgan County Extension Center |
| **December 4th** | **8:30 AM to 5:30 PM** |
| 111 E. Kelling Ave. | (Waverly City Hall) Waverly, MO 64096 |
| 660-542-1792 | Carroll County Extension Center |
| **January 9th, 2020** | **8 AM to 5 PM** |
| Fulkerson Center | (Great Plains Growers Conference) St. Joseph, MO 64507 |
| 816-279-1691 | Buchanan County Extension Center*** |

***** James Quinn will be at the Clark Produce Auction on Nov. 8th and will be able to take registrations at that time. Please have exact payment amount if using cash or use a check. The name and complete address of the person taking the training will also be required. (Nov. 8th is the Western Produce Auction meeting being held at the Clark auction)***

****** cost is $55 with a $35 rebate***

MU and LU Extension are pleased to offer the Food Safety Modernization Act Produce Safety Alliance training, open to fruit and vegetable growers and others interested in learning about produce safety. The Food Safety Modernization Act (FSMA) Produce Safety Rule training meets the requirement for farms subject to the FSMA Produce Safety Rule,outlined in §112.22(c) that requires "At least one supervisor or responsible party for your farm must have successfully completed food safety training at least equivalent to that received under standardized curriculum recognized as adequate by the Food and Drug Administration."

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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.