Effects of Growing Techniques on Yield, Grade, and Fusarium Infestation Levels in Garlic

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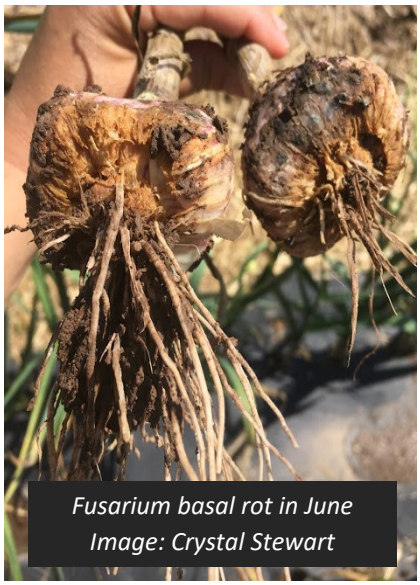

Fusarium basal rot in June
Image: Crystal Stewart

Background: Almost every garlic grower struggles to a greater or lesser extent with Fusarium diseases, which are naturally found in most soils. Two primary Fusarium diseases historically concern garlic growers: Fusarium Bulb Rot, caused by *F. proliferatum ,* causes brown to reddish sunken lesions on the bulb surface; and Fusarium Basal Rot, caused by organisms *F. culmorum,* causes the basal plate and gradually the entire bulb to break down. Because the diseases are nearly almost always present, the focus for growers and researchers alike is on management rather than eradication.

Fusarium diseases tend to be worse in fields with poor drainage, but we were unsure of the impact that other techniques such as the use of straw mulch or black plastic might have on Fusarium levels.

Fusarium Bulb Rot
Image: Crystal Stewart

We decided to trial different common and novel techniques growers use to cultivate garlic and track both the levels of Fusarium and the quality of the garlic in each approach. We separated the work into two sets of trials: one focusing on cultural changes such as variety selection, raised beds and mulches; and another focusing on inputs that growers can use to affect disease levels such as fertility and organic soil or bulb treatments. The trial including raised beds and mulches was located in the Hudson Valley and replicated in western New York, while the trial looking at inputs was located on Long Island and replicated in western New York.

During the growing season, each of the treatments was monitored for disease development as the garlic grew. Diseased garlic was sent to a Cornell lab in Geneva, NY where the Fusarium was genetically tested to see if the disease is always the same, or if there are different species or pathovars of Fusarium in different locations or situations.

In July the garlic was harvested in all four sites and brought to high tunnels to be dried. When it was dry, all the garlic was cleaned, roots and tops were trimmed, and it was graded into small (less than 1.5 inches in diameter), medium (1.5 to two inch diameter) and large (greater than two inch diameter) categories.

Samples of each treatment were kept in storage and are being assessed during the winter of 2017/18 to determine if Fusarium severity varied by treatment. Ten randomly selected cloves from ten different bulbs were rated for percent of total surface area infested with Fusarium.

This report will focus on the techniques and results used in the cultural controls trials. The results of the nitrogen fertility and organic controls will be discussed in a separate report.

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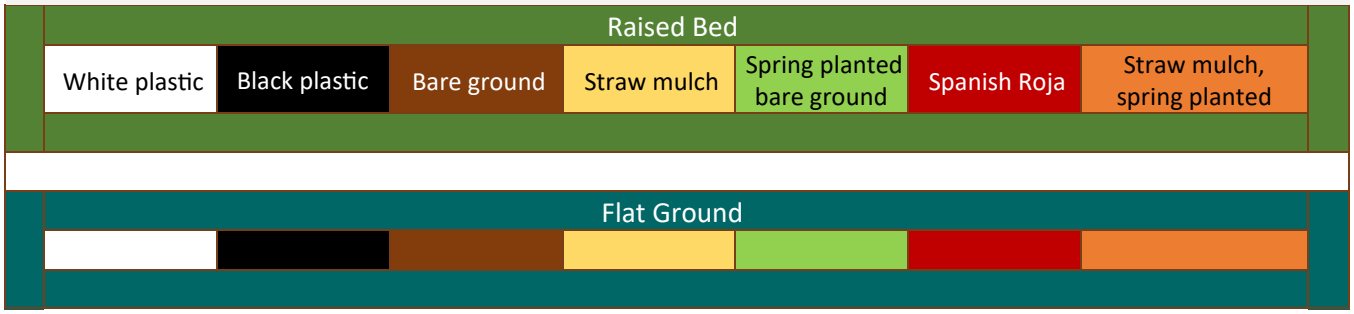
Trial Overview: the cultural controls trial included 9 different treatments, which are listed below. Two of the treatments, raised beds and flat ground, were blocked (not randomized) because of the difficulty of switching between raised beds and flat ground in one row. One row of the trial was a 4-inch raised bed, the other was flat ground. The other seven treatments were randomly replicated three times within the rows. Each treatment was twenty feet long, with a small buffer between treatments.

Fall planted garlic was planted in Mid-October, and spring planted garlic was planted in April. All garlic was harvested in mid July. Many of the treatments were also chosen for their excellent weed control. The bare ground treatments were regularly hand weeded so that weed pressure would not interfere with the results of the trial.

Map of the first of three replications of the garlic treatments. Following replications in the same row were randomized.



Bare Ground cultivation of garlic is common because it allows for mechanical weed control as well as side-dressing nitrogen in the spring. Mechanical weed control is very time sensitive, so growers need to be quite attentive to keep weeds from competing with the crop. In a field with high weed pressure, up to 6 cultivations may be necessary for weed control.

An additional consideration in growing garlic in a bare ground system is that the soil becomes more compacted than in a system with straw or plastic mulch.

Straw Mulch is commonly used in organic garlic production where all fertility is applied in the fall, at planting. Straw mulch can help protect garlic from freezing and thawing in the winter and spring, can moderate soil moisture and temperature, and can suppress annual weed growth. It also reduces soil compaction and contributes to soil organic matter and soil health.

Concerns about using straw mulch focus on two main issues: the potential for mulch to hold too much moisture in wet years and contribute to fungal disease issues (Fusarium); and weed control failures, which can lead to increased labor weeding compared to bare ground mechanical cultivation. We were careful to use weed-free straw, applied at about 5 inches deep in fall which compressed to 2.5 inches deep after the winter.

Black Plastic is used as another option for weed control. Moisture levels under black plastic tend to stay relatively constant, because not much rainfall makes it under the plastic and because evaporation is minimized. Black plastic also warms the soil more quickly in the spring, encouraging earlier top growth than straw mulch or bare ground systems.

There are two primary concerns that growers have about black plastic. The primary concern is that it can actually get too hot under black plastic during the growing season, restricting garlic sizing in late June and early July. The second concern is that plastic can shed snow during the winter, leaving garlic more exposed to winter injury than in other growing systems. A third concern is that in very dry years, it may be necessary to irrigate garlic under plastic, which necessitates the use of drip tape.

White plastic has similar properties to black plastic related to weed control and moisture moderation. However, because it reflects light rather than absorbing it, it keeps the soil cooler rather than warming it. This reflective property might also provide more light to the garlic. White plastic has typically been used in brassica production during parts of the growing season, but has not traditionally been used in garlic production.

White plastic may shed snow during the winter similarly to black plastic, which was a concern with this treatment as well. The effect that temperature moderation would have on early growth was a question mark with this treatment, as was the cooler soil temperature during the summer.

Variety selection plays a role in disease susceptibility and adaptability to various environments. For this trial, we selected two varieties grown by the majority of garlic growers: a Porcelain variety (German White) as our primary, and a Rocambole (Spanish Roja) as a treatment for comparison.

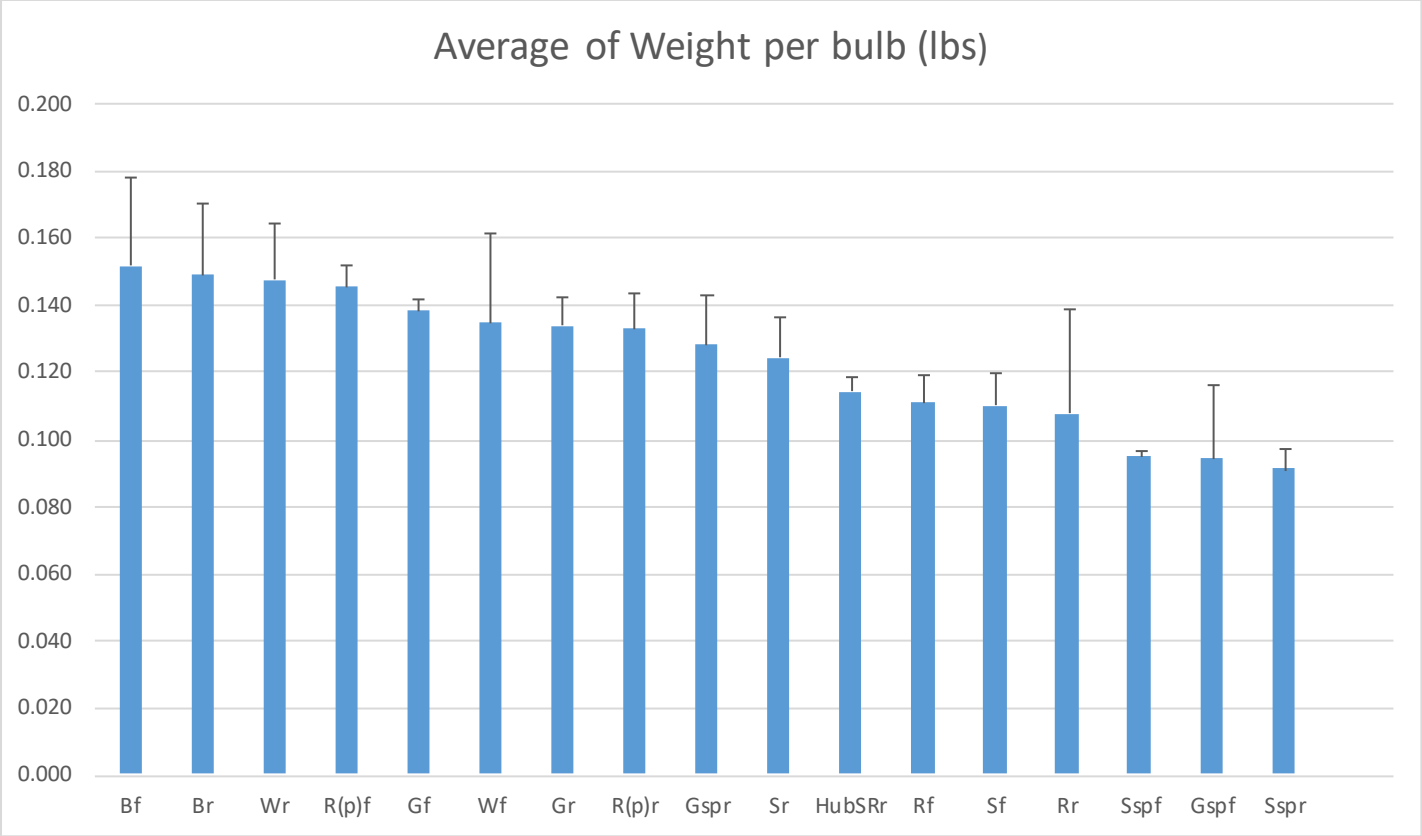
Porcelain varieties are very vigorous and perform well under most growing conditions; Rocambole varieties are often considered to have better flavor but seem more susceptible to disease under many conditions.

Spring planting of garlic is something that growers tend to avoid if possible, but occasionally we are asked if it is possible to do. We also wanted to know if winter injury is contributing to Fusarium levels on garlic. For this trial we cracked seed at planting time and then stored it in a standard refrigerator at 40 degrees F over the winter. As soon as the ground was thawed in the spring, we planted garlic into bare ground and straw mulch.

Cultural Control Trial Results:

After harvest, garlic from both the Hudson Valley and Western NY trials was dried at the Hudson Valley Farm Hub, in high tunnels. Each of the plots was kept in enough separate bags to allow for good airflow for optimum drying. All treatments had their tops clipped in the field at approximately 4 inches. When the garlic was dried, determined by the innermost wrapper leaf being dry to the touch, the marketable bulb and cull counts and weights were recorded by plot. Data analysis was based on the average weight per bulb, as well as by the size distribution. The average weight per bulb was used rather than weight per plot because some of the plots were damaged by factors not considered part of the trial, such as crows picking garlic from the mulched sections. This damage changed bulb number per plot.

The average weight per bulb metric showed black plastic providing the highest yield, followed by white plastic, bare ground, and then straw. Not surprisingly, spring planted garlic had the lowest yields.



While there are numerical differences between the treatments, only the black flat ground treatment was significantly different. White plastic (raised and flat), bare ground, and black raised were all statistically indistinguishable, and straw mulch and Spanish Roja were statistically indistinguishable from white plastic and bare ground. Only spring planted garlic was significantly smaller than all other treatments.

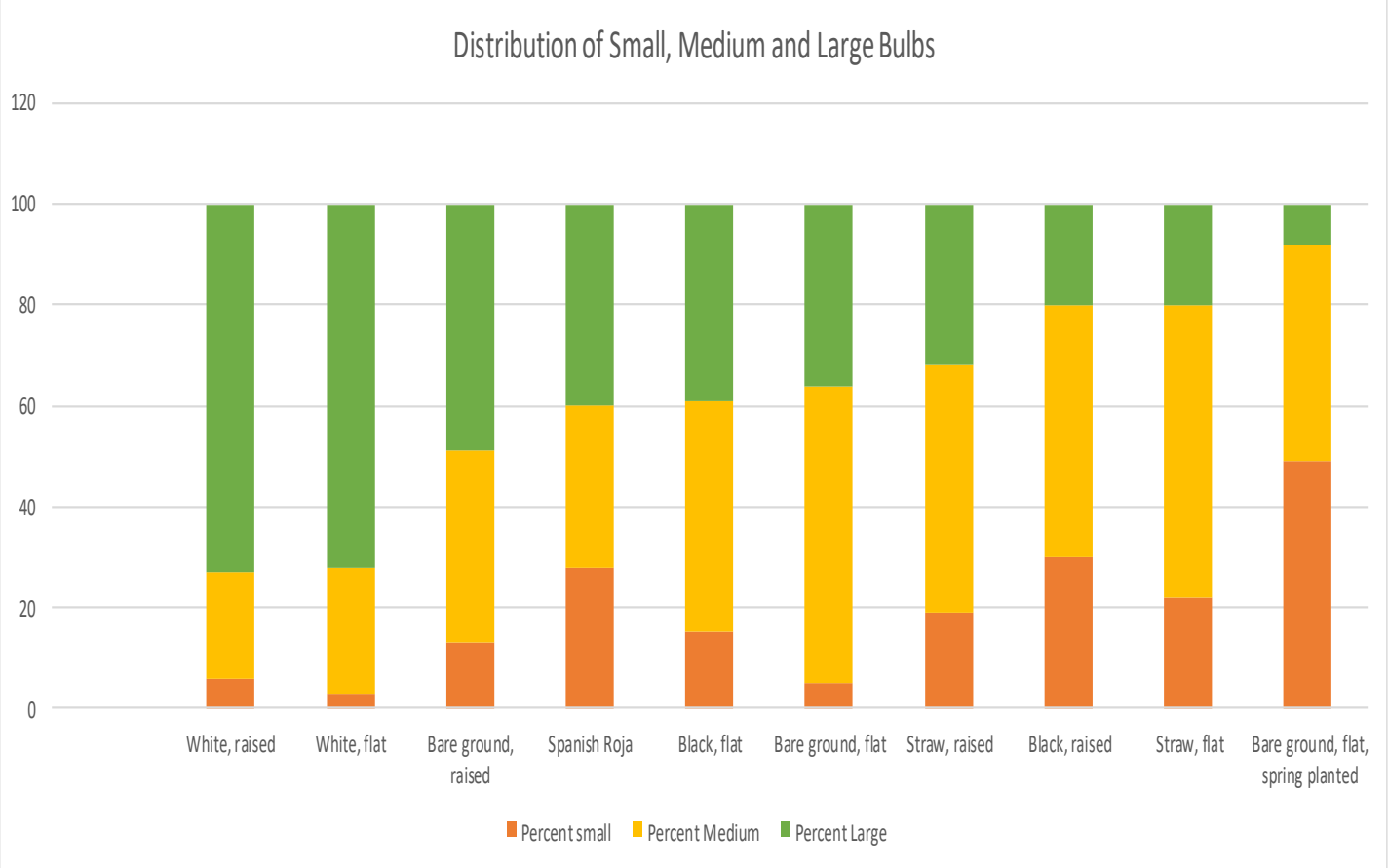
Besides total yield, we also examined the distribution of small, medium and large bulbs.

Small Bulbs: 1.5 inches or smaller

Medium Bulbs: 1.5-2 inches

Large Bulbs: 2 inches or larger

White plastic mulch yielded the highest percentage of large bulbs on both flat ground and raised beds. Spanish Roja had the most even distribution of small, medium and large bulbs. Black plastic, raised beds, and straw mulched garlic all yielded more medium bulbs than the white plastic. Not surprisingly, the spring planted garlic yielded the most small bulbs.



Fusarium Severity Across Treatments:

To assess Fusarium severity, we selected ten cloves per rep from storage and estimated total percentage coverage with lesions. Across two sites, Fusarium levels were significantly different between the Rocambole variety and straw mulch. Other differences were numerically but not statistically different. There was no effect of raised bed versus flat ground, so during the analysis data were combined to increase the number of plots.