2016-2018 Garlic Fusarium Trial Results: Part II: Nitrogen and Fungicides/Sanitizers

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2019 Garlic School
Batavia, NY: March 20, 2019
Effect of Nitrogen on Fusarium of Garlic: Treatments

Nitrogen Rate:
• 50 lb/A
• 100 lb/A
• 150 lb/A
• Urea (46-0-0 NPK), broadcast by area – Apr 13, 2017

Seed Source:
• Crystal – German Hardneck
• Swedan – German Hardneck
• Infested – German Hardneck
• Planted: Oct 26, 2016
• P: 50 lb/A as MAP (11-52-0) + K: 100 lb/A as potash (0-0-60) on Oct 25

Infested seed
Effect of Nitrogen on Fusarium of Garlic: Trial Design – Batavia, NY

- 6-inch plant spacing
- 15-inch row spacing
- Flat bed
- Chateau 6 oz after planting in fall
Effect of Nitrogen on Fusarium of Garlic: Trial Design – Batavia, NY

Top necks to 4-6-inch

Curing: high tunnel with shade cloth

Storage: inside front door of steel barn in mesh bags
Effect of Nitrogen on Fusarium of Garlic:
Trial Design – Batavia, NY

Yield assessment:
Sept 26 & 28

Sub-sample 1 clove per 10-bulb random sample

Estimate % clove coverage
With Fusarium
Nov 1
Effect of Nitrogen on Fusarium Garlic: 2017 Results – % Clove Coverage (Nov 1)

Effect of Nitrogen Rate on Percent Fusarium Clove Coverage (%)

Seed Source: Swedan

In Crystal, 150 lb N resulted in significantly almost 2x as much Fusarium as 100 lb N and 3x as much as 50 lb N.

50 lb N consistently had least Fusarium (<6%).
Effect of Nitrogen on Fusarium Garlic: 2017 Results – % Clove Coverage (Nov 1)

No significant differences among sources, not even in the infested seed lot

Where did the Fusarium go?
Effect of Nitrogen on Fusarium Garlic: 2017 Results – % Stand Loss due to Fusarium

No significant differences among N rates or seed source
Effect of Nitrogen on Fusarium Garlic: 2017 Results – Yield (Sep 19)

Long Island, 2017

No response to applied nitrogen between 50 and 150 lb/A
Seed Source had greatest effect on yield – infested seed had lowest yield
Effect of Nitrogen on Fusarium Garlic: 2017 Results – Yield (Sep 26 & 27)

No response to applied nitrogen between 50 and 150 lb/A

Seed Source had greatest effect on yield – infested seed not the lowest yield
Effect of Nitrogen on Fusarium Garlic: 2017 Results – Soil NO₃-N and Tissue N

Batavia, 2017

No difference between 100 and 150 lb/A

Slight increase in tissue N as applied N increased
No response to applied nitrogen between 50 and 150 lb/A
Effect of Nitrogen on Fusarium Garlic: 2018 Trial in Albion

- Planted: Oct 20, 2017
- Plant Spacing: 6-inch
- Row spacing: 7-inch
- Planted flat, grower hilled
- Chateau 6 oz in fall after planting
Effect of Nitrogen on Fusarium Garlic: 2018 Trial in Albion

Seed Source:
• Clean bulbs from 2017 trial (Crystal & Swedan)

Seed Size:
• Medium Bulbs (1.5-2 inch)
• Large Bulbs (>2 inch)

Nitrogen Rate:
• 0 lb/A
• 50 lb/A
• 100 lb/A
• 150 lb/A

Urea (46-0-0) applied concentrated over each row (Apr-23 2018)

Seed from Medium Bulbs (1.5-2”)
Seed from Large Bulbs (>2”)

Clean and Med
This is Clean Large
Effect of Nitrogen on Fusarium Garlic: 2018 Results - Fusarium

Slight trend that large seed has more Fusarium

Albion, 2018
Effect of Nitrogen on Fusarium Garlic: 2018 Results – Fusarium (Pooled across seed size)

Slight trend that higher rates of applied Nitrogen resulted in more Fusarium

- + 48%
- + 52%
Effect of Nitrogen on Fusarium Garlic: 2018 Results – Yield (Oct 17)

Effect of Nitrogen Rate and Seed Size on Total Marketable Yield
(lb per 20-foot row)

- Highest yield 50 lb/A
- 20% yield response with 50 lb/A N
- No yield response after 50 lb/A applied Nitrogen

Medium seed
- Average Medium Seed 3.0 lb/20-ft
- None - 0 lb/A
- Low - 50 lb/A
- Standard - 100 lb/A
- High - 150 lb/A

Large seed
- Average Large Seed 4.5 lb/20-ft
- a 4.8
- b 4.5
- ab 4.5

Albion, 2018
Effect of Nitrogen on Fusarium Garlic: 2018 Results – Bulb Size Distribution (Oct 17)

Medium

Effect of Nitrogen Rate on Bulb Size Distribution (No. bulbs/20-foot row)
Planted Seed from Medium Bulbs

Large

Effect of Nitrogen Rate on Bulb Distribution (No. Bulbs per 20-foot row):
Planted Seed From Large Bulbs

Generally, there were more large bulbs when grown from seed from large bulbs.

50 and 100 lb/A N resulted in significant increase in large bulbs over untreated

Albion, 2018
Effect of Nitrogen on Fusarium Garlic: 2018 Results – Pooled Data

**Effect of Seed Size on Number of Large Bulbs at Harvest:**
Pooled Across Nitrogen Rate - No. bulbs at Cracking

<table>
<thead>
<tr>
<th>Seed Size</th>
<th>Large seed</th>
<th>Medium seed</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2.7x</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>9</td>
</tr>
</tbody>
</table>

**Effect of Nitrogen Rate on Bulb Size Distribution (No. bulbs/ 20-foot row):**
Pooled Across Seed Size

Significant ~ 50% increase in large bulbs with 50 to 150 lb/A N compared to untreated.
No difference between 50, 100 and 150 lb/A applied N.
Effect of Nitrogen on Fusarium Garlic: 2018 Results – Tissue %N

Very little tissue response to increased rates of applied Nitrogen composite tissue samples taken across treatments and reps.

- None - 0 lb/A: 3.18
- Low - 50 lb/A: 3.62 (+14.8%)
- Standard - 100 lb/A: 3.82 (+4.6%) 3.82 (4.6%)
- High - 150 lb/A: 4.05 (+5.7%) 4.07 (5.7%)

- 4 weeks POST N app (May 23)
- during bulbing (scaping) 20 June

Albion, 2018
Effect of Nitrogen on Fusarium Garlic: 2018 Results – Available NO$_3$-N in Soil

![Graph showing available NO$_3$-N in soil](image)

**Legend**
- **4 weeks POST N app (May 23)**
- **Harvest (Jul 10)**
Effect of Nitrogen on Garlic: Summary

• In 2 out of 7 datasets (= 29%), Fusarium clove coverage was higher with higher rates of applied N:
  • 2017 Batavia Crystal: 150 lb/A (16%) 2x more than 100 lb/A (9.3%), 3x more than 50 lb/A (6%)
  • 2018 Albion Medium Seed: 100 & 150 lb/A (~19%) greater than 0 & 50 lb/A (~12%)
  • 2018 Albion Large Seed: 100 & 150 lb/A (~23%) greater than 0 & 50 lb/A (~17%)
  • NOT ENOUGH OF A RELATIONSHIP BETWEEN NITROGEN & FUSARIUM TO BE RELEVANT

• In 8 out of 8 datasets (= 100%), no difference in yield between 50, 100 and 150 lb/A applied nitrogen
  • 50 lb/A resulted in significantly 20% higher total yield due to 1.4x to 2.3x more large bulbs

• Garlic only needs **50 lb/A nitrogen (available in spring when crop begins to grow)**

• Seed size was the most important factor associated with yield
  • Seed from large bulbs had significantly almost 3x greater yield than seed from medium bulbs
Clean Garlic Seed Artificial Fusarium Inoculation
Clean Garlic Seed Artificial Fusarium Inoculation

Artificial inoculation had no effect on incidence of Fusarium disease

**Batavia, 2017**

**Long Island, 2017**

**Effects of Fusarium Source on Percent Fusarium Clove Coverage (%)**

**Effect of Fusarium Inoculum Source on Fusarium Infestation (%) (N=100 lb/A)**
Evaluation of Sanitizers for Fusarium Control:
Treatments (100 lb/A N)

- **Swedan – Clean** – Oxidate 1% dip
- **Crystal – Clean** – Oxidate 1% dip
- **Fusarium-infested Seed** – Oxidate 1% dip
- **Swedan – Clean** – **Furrow artificial inoculation** – Oxidate 1% dip
- **Swedan - Clean** – Oxidate 1% dip + Terraclean/Terragrow drench
- **Fusarium infested Seed** – Oxidate 1% dip + Terraclean/Terragrow drench
- **Swedan – Clean** – **Furrow artificial inoculation** – Oxidate 1% dip + Terraclean/Terragrow drench
Evaluation of Sanitizers for Fusarium Control: Treatments

**Terraclean**: hydrogen peroxide, peroxycetic acid

**Terragrow**: microbe package

- **Terraclean 1**: 500 dilution
  - fb. Terragrow 1 oz/100 gal
  - 4 hours between Terraclean & Terragrow
  - 2000 ml per 20-ft

- **Terragrow**:
  - Bacillus  *licheniformis*
  - Bacillus  *subtilis*
  - Bacillus  *pumilus*
  - Bacillus  *amyloliquefaciens*
  - Bacillus  *megaterium*
  - Trichoderma  *harzianum*
  - Trichoderma  *reesei*
  - Humic Acids (derived from leonardite)
  - Soy Protein Hydrolysate (microbial nutrient)
  - Kelp (Ascophyllum nodosum) (microbial nutrient)
  - Molasses (microbial nutrient)

**Oxidate 1%**
- 2 min dip
- Plant wet

Applied every 2 weeks:
- Apr 18, May 3, May 17, Jun 1&2,
- Jun 13, Jun 28
Evaluation of Sanitizers for Fusarium Control: Results – Incidence of Fusarium

Batavia, 2017

Effect of Oxidate Dip 1% and Terraclean/Terragrow:
(100 lb N) Percent Fusarium Clove Coverage (%)

- Natural Infestation
- Soil Inoculated Swedan Clean
- Infested Seed

Significantly highest Fusarium with Oxidate Dip + Terra drenches
Otherwise, no significant differences

Long Island, 2017

Effect of Oxidate Dip 1% and Terraclean/Terragrow Drench on Fusarium Infestation (N=100 lb/A)

- Clean Seed
- Clean Seed (Soil Inoculated)
- Infested Seed

No significant differences
Evaluation of Sanitizers for Fusarium Control: Results – Marketable Yield

Batavia, 2017

+30%

Oxidate Dip + Terra drenches

Long Island, 2017

Effect of Oxidate Dip 1% and Terraclean/Terragrow: Swedan Clean Seed (100 lb N) - Total Marketable yield (lb)

Effect of Oxidate Dio 1% and Terraclean/Terragrow Drench on Total Marketable Yield in Pounds (lbs.) (N=100 lb/A)

Only when seed was clean or when furrow not artificially inoculated did Oxidate or Oxidate + Terra drenches significantly increase yield by 13 to 33%. (Yield bump not related to Fusarium control).
### Evaluation of Fungicides for Fusarium Control: Treatments – Albion, 2018

<table>
<thead>
<tr>
<th>Trade Name</th>
<th>Active ingredient</th>
<th>FRAC Group</th>
<th>Application</th>
</tr>
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<tbody>
<tr>
<td>Maxim 4FS</td>
<td>fludioxonil</td>
<td>7</td>
<td>Seed slurry</td>
</tr>
<tr>
<td>Vibrance</td>
<td>sedoxane</td>
<td>12</td>
<td>Seed slurry</td>
</tr>
</tbody>
</table>
| Serifel             | *Bacillus amyliliquefaciens* strain MBI 600            | 44         | In-furrow at planting
In-season drench:
May 9, 23, Jun 8, 20 |
| Rootsheild Plus     | *Trichoderma harzianum, T. virens*                    | ??         | 2 min seed dip                                                            |
| Terraclean          | hydrogen peroxide, peroxyacetic acid                   | sanitizer  | 2 min seed dip                                                            |
| Terraclean Terragrow| See above Microbe package                               | Sanitizer 44 | In-furrow drench at planting
In-season drench:
Apr 23, May 9, 23, Jun 8, 20 |
Evaluation of Fungicides for Fusarium Control: Treatments

Clean Seed (2016 Infested Seed)  Fusarium Culls
Evaluation of Fungicides for Fusarium Control: 2018 Results: Fusarium-infested vs. Clean Seed
Evaluation of Fungicides for Fusarium Control: 2018 Results: Fusarium-infested vs. Clean Seed

Planting Fusarium culls reduced stand by ~50%

No significant differences among treatments, EXCEPT Vibrance had significantly lower emergence than other treatments in Fusarium-infested seed.
Evaluation of Fungicides for Fusarium Control: 2018 Results: Incidence of Fusarium
Evaluation of Fungicides for Fusarium Control: 2018 Results: Marketable Yield

**Albion, 2018**

Fungicide Evaluation for Control of Fusarium Basal Rot in Garlic, Holley, 2018:
Marketable Yield (lb/100 ft row)

**Long Island, 2018**

Evaluation of Fungicide Treatments for Control of Fusarium Diseases in Garlic, Long Island, 2018: Marketable Yield (lb/40-ft row)

No significant differences
Evaluation of Sanitizers and Fungicides for Fusarium Control: Summary

- Sanitizers applied as a pre-plant dip and/or fb. Terra products applied bi-weekly as a surface drench:
  - NO EFFECT on Fusarium.
  - In 2 out of 6 (=50%) of the data sets, had significantly higher marketable yield by 13 to 33%.

- Planting seed severely infested with Fusarium reduced emergence by ~50% in 2018 and not at all in 2017 – WHY???

- First year fungicide trial results did not yield any promising leads for Maxim (FRAC 7), Vibrance (FRAC 12), Serifel (FRAC 44) or Rootshield Plus.
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Questions? Discussion