Growing, Harvesting, Storing & Marketing Garlic in the Northeast

Ed Fraser, Fraser’s Garlic Farm
Crystal Stewart, Cornell University Cooperative Extension
Topics for today:

- A little about *Allium Sativum*:
- Soil preparation: Fertility, cover crops
- Weed control: Research results and experience
- Disease control: Research results and experience
- Harvesting, post-harvest handling
- Choosing seed stock
Allium sativum

Subs. sativum

Subs. ophioscorodon

Artichoke
Silverskin
Porcelain
Rocambole
Purple Stripe
Marbled PS
Glazed PS
Asiatic
Creoles
Turbans

Softnecks

Hardnecks
Porcelain bulbs & bulbils

German White, Georgian Crystal, Music
Rocamboles bulbs & bulbils

German Red, Killarney Red, Spanish Roja
Artichoke bulb

California early, California late, Inchelium
Purple Stripe, Marbled Purple Stripe

- Chesnok Red, Persian Star
Elephant garlic is a leek!

- *Allium ampeloprasum*
- Bulb contains compounds found in both garlic and leek, but is more closely related to leek
- Mild garlic flavor
Soil Preparation

- Optimum cover crop rotation for garlic
- Maximize Nitrogen, minimize wireworms
Biofumigant cover crops
# Garlic Fertility

<table>
<thead>
<tr>
<th>Garlic</th>
<th>Nitrogen (N) Lbs/A</th>
<th>Phosphorus (P2O5) Lbs/A</th>
<th>Potassium (K2O) Lbs/A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very low &lt;3lbs/A</td>
<td>Low 3-6</td>
<td>Medium 7-13</td>
</tr>
<tr>
<td>Soil Test Results</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incorporate at planting</td>
<td>0</td>
<td>200</td>
<td>150</td>
</tr>
<tr>
<td>Sidedress before emergence</td>
<td>25-50</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sidedress 2-3 times, 3-4 weeks apart</td>
<td>25-50 divided among sidedressings</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>50-100</td>
<td>150</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Cornell Recommendations for garlic, used by Agro-One Soil Lab. Based on use of a Morgan extract.
How to figure fertilizer...

<table>
<thead>
<tr>
<th>Element</th>
<th>Morgan lbs/acre</th>
<th>Very Low</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>Very High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phosphorus (P)</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>176</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Calcium (Ca)</td>
<td>2,717</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnesium (Mg)</td>
<td>509</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Element</th>
<th>Value</th>
<th>Element</th>
<th>Value</th>
<th>Element</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil pH</td>
<td>6.8</td>
<td>Manganese (Mn), lbs/acre</td>
<td>10.1</td>
<td>Organic Matter, %</td>
<td>2.9</td>
</tr>
<tr>
<td>Buffer pH</td>
<td>6.3</td>
<td>Zinc (Zn), lbs/acre</td>
<td>0.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron (Fe), lbs/acre</td>
<td>1.5</td>
<td>Aluminum (Al), lbs/acre</td>
<td>10.8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Crop History (1 = last year, etc.)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Crop</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Idle Land</td>
</tr>
<tr>
<td>2</td>
<td>Idle Land</td>
</tr>
<tr>
<td>1</td>
<td>Idle Land</td>
</tr>
</tbody>
</table>

**Soil Fertilizer Recommendations**

<table>
<thead>
<tr>
<th>Year</th>
<th>Crop</th>
<th>tons / acre</th>
<th>lbs / acre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lime</td>
<td>N Range</td>
</tr>
<tr>
<td>1</td>
<td>Garlic</td>
<td>0.00</td>
<td>50 - 100</td>
</tr>
</tbody>
</table>
Fertility Trials Results
<table>
<thead>
<tr>
<th>Nitrogen</th>
<th>50 lbs total</th>
<th>100 lbs total</th>
<th>150 lbs total</th>
</tr>
</thead>
<tbody>
<tr>
<td>All fall</td>
<td>All fall</td>
<td>All fall</td>
<td>All fall</td>
</tr>
<tr>
<td>75% fall, 25% quick split spring*</td>
<td>75% fall, 25% quick split spring</td>
<td>75% fall, 25% quick split spring</td>
<td></td>
</tr>
</tbody>
</table>

*All fertility treatments were organic
Average weight per bulb versus N rates

Nitrogen rates

Average Weight per Bulb (lbs)

50 lbs fall, 100 lbs fall, 150 lbs fall, 37 lbs fall, 13 lbs spring, 75 lbs fall, 25 lbs spring, 112 lbs fall, 38 lbs spring

Farm 1
Farm 2
Farm 3
### Average Weights from Farms 1 and 3 Combined

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Average Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 lbs fall</td>
<td>0.093</td>
</tr>
<tr>
<td>100 lbs fall</td>
<td>0.113</td>
</tr>
<tr>
<td>150 lbs fall</td>
<td>0.119</td>
</tr>
<tr>
<td>37 lbs fall, 13 lbs spring</td>
<td>0.104</td>
</tr>
<tr>
<td>75 lbs fall, 25 lbs spring</td>
<td>0.105</td>
</tr>
<tr>
<td>112 lbs fall, 38 lbs spring</td>
<td>0.127</td>
</tr>
</tbody>
</table>
Closing up

Image: Ed Fraser
Fred Forsburg’s platform planter. SARE grant FNE11-717
Left: Double offset rows at 6 inches
Right: Triple row on standard bed, 6 by 10 inch grid

Image: Ed Fraser

Image: Crystal Stewart
To mulch, or not to mulch?
Weed control in garlic

Garlic is an extremely poor competitor with weeds

Weed pressure can easily reduce yields by 30%

Weed control starts before planting and continues until shortly before harvest
Weed Control Step 1: Control Perennials

- Perennial weed control should happen **before planting**.
  - Tilllage
  - Cover Crops
Step Two: Winter annuals

Look for winter annuals such as chickweed emerging before the garlic emerges. These weeds can be controlled through flaming or very shallow cultivation.
Step Three: Season-Long Control

髻 Don’t stop! Don’t ever stop!!

Images: University of Maine
So many options to choose from!

- Mechanical cultivation (especially between rows)
- Hand weeding (especially in row)
- Mulch (plastic/Biotello, hay, leaves)
- Vinegar
Mulch

Image: Crystal Stewart
Vinegar for weed control

- 10% is the recommended rate
- Applications made on sunny days with temperatures greater than 70 degrees F are most effective
- Small (cotyledon stage) plants are most easily controlled
- Cosmetic damage to garlic may result
Scaping

Removal sends more energy back into the bulb. Scapes add value to the crop, with prices ranging from $2 to $8 per pound.
Diseases of the field

Fusarium bulb rot (left) and Fusarium basal rot (right).

Images: Crystal Stewart
Severity varies

Image: Crystal Stewart
Control factors

1. Start with clean seed
2. Create a great growing environment for garlic
3. Cull suspicious plants during the season and destroy them
4. Surface sterilization will not control *Fusaria*. 
Garlic Bloat Nematode

Image: George Abawi
Ditylenchus dipsaci

Images: George Abawi
Control measures:

1. Start with clean seed—have it tested!
2. Create a great growing environment for garlic
3. Cull suspicious plants during the season and destroy them
4. Surface sterilization will not control Garlic Bloat Nematode
Insect Pest: Leek Moth

Images courtesy of Masa Seto and Amy Ivy
Organic controls

Well-timed DiPel or Entrust application (7-10 days after flight)

Row covers applied prior to first flight
Harvest!

Image: Skymeadow Garlic Farm
Timing the harvest

- Softneck: ½ tops have laid down
- Hardneck: cut bulb in half and look at clove fill

Image: Crystal Stewart
How much do you like your back?

- Digging fork
- Undercutter
- Potato digger
- Root digger
- Middle buster
- Moldboard plow
- ETC

Harvesting garlic, Zanjan, Iran
Anyone modified a potato harvester?
Post-Harvest Handling

Image: Ed Fraser
Post-Harvest Diseases of Garlic

Embellisia (left) and Aspergillus (right). These two diseases are largely cosmetic, but can negatively affect the marketability of garlic. Closely tied to postharvest handling.

Images: Crystal Stewart
Disease continued

Penicillium blue mold (left) and Botrytis neck rot (right). Both diseases are airborne and widely present, but post-harvest conditions play a role in disease severity.

Images: Oregon State University
**Treatment combinations**

A = Trim roots flush with basal plate  
B = Trim tops to 6” long  
C = Wash  
D = Cure in high tunnel  
E = Cure in open-air structure  
F = Leave roots and tops un-cut

<table>
<thead>
<tr>
<th></th>
<th>A+E</th>
<th>A+D</th>
<th>A+E+B</th>
<th>A+D+B</th>
</tr>
</thead>
<tbody>
<tr>
<td>A+E+C</td>
<td>A+D+C</td>
<td>A+E+B</td>
<td>A+D+B</td>
<td></td>
</tr>
<tr>
<td>A+E+C+B</td>
<td>A+D+C+B</td>
<td>B+E</td>
<td>B+D</td>
<td></td>
</tr>
<tr>
<td>B+C+D</td>
<td>C+E</td>
<td>C+D</td>
<td>B+C+E</td>
<td></td>
</tr>
</tbody>
</table>
A. Root Pruning. Roots were cut while garlic was still moist using a knife or pruning shears. Care was taken not to damage the basal plate.

B. Top cutting. Tops were cut to a height of six inches while garlic was green. The mechanical cutting showed some variation of height.

All images from trial results: Crystal Stewart
Top cutting

Tops cut 6” tall with sickle-bar mower. Greens left in field. Garlic was undercut to harvest.
C. Washing was completed using a garden hose and a nozzle. Power washers were not used. After washing, garlic was air dried before being placed in the curing area. Garlic was washed until dirt was removed from the bulb.
D. Curing in high tunnels: Garlic was moved to high tunnels immediately after other treatments were completed. All high tunnels had a shade cloth and were ventilated with fans, preventing temperatures from exceeding 110 degrees F.

E. Open-Air Curing: These treatments were placed in solid but well-ventilated buildings such as barns and sheds to dry without supplemental heat from the sun.
About High Tunnel Drying

The high tunnel drying temperatures for this year were kept conservatively cool, relative to the outdoor temperatures. Temperatures inside only averaged about 5 degrees warmer in the tunnel than outside. Next year temperatures will be increased to an average of 110°F during the day in the high tunnel. Overall this was a warm, dry curing season whether drying in a tunnel or in an open air system. Increased benefits of the high tunnel system are expected in cooler years.
F. Roots and tops uncut: Garlic was left completely uncut in this treatment. It was spread out on drying racks to leave space for the bulbs to be one layer deep or it was tied into bundles of 6-10 and hung.
Results: HT vs Open Air

- Across the three trials, garlic in high tunnels dried an average of three days faster in high tunnels than in open air structures.
- Garlic dried in high tunnels had slightly better wrapper quality (tighter, less discoloration) at one site.
- Garlic dried in tunnels also had slightly lower disease incidence (*Aspergillus* and *Embellisia*) in two of the three sites, though disease was not severe in any site or treatment.
- No garlic treatments showed damage from being dried in the high tunnel.
Results: Root Trimming

Trimmed vs. untrimmed: No statistically significant differences were observed between these treatments in regards to bulb quality, weight, or disease incidence.

Treatment: Roots trimmed, tops trimmed, washed, open-air dried
Results: Washing bulbs

Washed garlic looked very good initially, but became more discolored than the unwashed garlic during the drying and curing process. Disease incidence, particularly *Aspergillus* and *Embellisia*, was slightly higher in washed garlic.

Additional question: In a wet year, would washing mud from bulbs be better than leaving large amounts of dirt on them?

R to L: Immediately after washing, after curing, 1 leaf removed, two leaves removed.
Year one conclusions

- Drying garlic in HT did not cause post-harvest breakdown or increase disease incidence

- Cutting the tops at approximately 6 inches did not increase post-harvest breakdown or increase disease incidence

- Washing garlic immediately improved appearance but had minor effect on long-term appearance and disease incidence
For more information...

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Thanks to Northeast SARE for the generous support of this project
Storage
Marketing!

- Green and fresh garlic
- Garlic Festivals
- Restaurants/Stores
- CSA’s
- Farmer’s Market
- Seed, table, processed, garlic powder,
- decorative braids, wholesale etc.
New? Garlic Scape Powder

Chef Organics Organic Scape Powder
cheforganics.com
$16 per 56g package (that’s about 2 oz)

Investment in drying facility: $1M +
Garlic is good for you….

Thanks to the many growers who graciously shared their pictures with us for this presentation.
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