



**What the NOP Rule says:**

- Must use organically grown seeds, annual seedlings and planting stock, except that:
  - Nonorganically produced, untreated seeds may be used when an equivalent organically produced variety is not commercially available (except sprouts)
  - Nonorganically produced seed that have been treated with a substance included on the National List of synthetic substances allowed for use in organic crop production may be used when an equivalent organically produced or untreated variety is not commercially available

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**What the NOP Rule says:**

- Nonorganically produced annual seedlings may be used when a temporary variance has been granted in accordance with §205.290(a)(2)
- Nonorganically produced planting stock to be used to produce a perennial crop may be sold, labeled or represented as organically produced only after the planting stock has been maintained under a system of organic management for a period of no < 1 year
- Seeds, annual seedlings & planting stock treated with prohibited substances may be used to produce an organic crop when the application of the material is required by Federal or State phytosanitary regs

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**OP, heirloom, hybrid, GMO?**

**F1 Hybrid-** the first filial generation made by crossing two different parent varieties

- Offspring produce a new, uniform seed variety with characteristics from both parents
- These unique characteristics are very uniform only in the first generation- saved seed may revert back to various ancestral forms
- To produce consistent F1 hybrids, the original cross must be repeated each season
- Examples: Early Girl, Celebrity or Caramello

(Shepherd, 1999)

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**OP, heirloom, hybrid, GMO?**

**Open-pollinated-** natural or human selection for specific traits that are reselected in every crop

- Kept true to type through selection and isolation
- Pollinated by wind or bees
- Traits relatively fixed within range of variability
- Example: 'Brandywine' seed selected year after year from best-tasting, earliest ripening fruit in hot, humid TN would be different than 'Brandywine' selected in hot, dry Northern CA

(Shepherd, 1999)

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## OP, heirloom, hybrid, GMO?

**Heirloom-** a variety at least 40-50 year old, no longer available in commercial seed trade, preserved and kept true in a particular region

- All heirlooms open-pollinated; all OP varieties not heirlooms
- Handed down from generation to generation
- Saved for superior flavor, color or texture; but generally lack keeping quality, disease resistance or early maturity

(Shepherd, 1999)

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## OP, heirloom, hybrid, GMO?

**GMOs-** an organism, animal or microbe that has been genetically altered using molecular genetics techniques such as gene cloning or protein engineering

- Examples:
  - Bt corn engineered to make crops resistant to lepidopteran pests
  - Roundup ready canola engineered to be resistant to herbicides so crop can be directly sprayed

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## Many Vegetable Crop Diseases Are Seedborne

- Most bacterial diseases
- Some fungal, viral and nematode diseases
- Diseases may be difficult to control once introduced into organic vegetables

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## Examples of Seedborne Diseases



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## Seed Treatments and Coatings

Purpose is to improve seed performance in one or more of the following ways:

- 1) eradicate seedborne pathogens or protect from soilborne pathogens
- 2) optimize ease of handling and accuracy of planting (reduce gaps in stand or the need for thinning of seedlings, particularly when mechanical planters are used)
- 3) improve germination rates

(Gatch, 2008)

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## Organic Seed Treatments

- **Priming**
  - Absorbed just enough water to dissolve germination inhibitors- activate early stages of germination
  - In suspended state of growth, so germinate faster & more uniformly over broader temperature range, reducing likelihood of very thick or thin stands
  - Results in earlier establishment- can aid in fending off attack of damping-off pathogens
  - Usually performed in conjunction with a pelleting to protect primed seed, which has a shortened life expectancy

(Gatch, 2008)

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## Organic Seed Treatments

- **Pelleting** (Gatch, 2008)
  - A coating, usually of clay mixed with other inerts-streamlines the size, shape, and uniformity of a small, non-round seed
  - Results in easier, safer and more accurate seeding, thus reducing need for labor-intensive thinning
  - Pellets somewhat permeable to oxygen & absorb water quickly so split immediately when hydrated
  - Conventional techniques using synthetic inert materials not approved for organic use, but now several materials approved for organic use

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## Seed Health Treatments

- **Plant extracts and oils**
  - New research area so currently little data on efficacy- more research required
  - Oils such as thyme, cinnamon, clove, lemongrass, oregano, savory, and garlic show some potential to suppress damping-off
  - Pure soybean or mineral oils have been shown to reduce storage molds of maize and soybean

(Gatch, 2008)

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## Seed Health Treatments


- **Chemical disinfection**
  - Sodium hypochlorite, calcium hypochlorite, chlorine dioxide, hydrogen peroxide, and peracetic acid are restricted for use in organic production
  - Can be used under some circumstances for seed treatment
  - Check with your certifier before using any of these materials
  - Bleach (sodium hypochlorite) will eliminate pathogens on the seed surface but not inside seed

(Gatch, 2008)

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## Seed Health Treatments

- **Biological seed treatments**
  - May have potential in some situations for improving seedling health
  - In studies evaluating efficacy, results have been inconsistent
  - Commercially available products include:
    - Kodiak (*Bacillus subtilis*, Bayer CropSciences)
    - Subtilex (*Bacillus subtilis*, Becker Underwood)
    - Mycostop (*Streptomyces grieseoviridis*, Verdera)
    - SoilGard (*Gliocladium virens*, Certis)
    - T-22 Planter Box (*Trichoderma harzianum*, BioWorks)
    - Actinovate (*Streptomyces lydicus*, Natural Industries)

 Extension (Gatch, 2008)

## Seed Health Treatments

### ➤ Hot Water

- Critical to follow procedures EXACTLY or seed injury could result!
- Treat raw seed ONLY, otherwise you are washing off the treatment that you already paid for

▪ From Ohioline: "Hot Water and Chlorine Treatment of Vegetable Seeds to Eradicate Bacterial Plant Pathogens"

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## Heat treatment

- If used properly, hot water can kill most bacterial disease-causing organisms on or within seed
- Suggested for: eggplant, pepper, tomato, carrot, spinach, lettuce, celery, cabbage, turnip, radish, other crucifers
- Seeds of cucurbits can be **damaged** by hot water and should **NOT** be treated

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## Seed Treatment: CAUTIONS

- Use new, high quality seed
- Treat a small sample first and test for germination
- Treat close to time of planting (within weeks)
- Treat only once
- Treat only the amount you plan to use

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## Seed Treatment: CAUTIONS

- Follow instructions EXACTLY
  - Seeds may be damaged by temperatures that are too high or treatment times that are too long
  - Pathogens may not be eliminated if temperatures are not high enough or treatment times too short
  - The pre-warming step prevents heat shock
  - Check the scale of your thermometer (Fahrenheit (°F) or Centigrade/Celsius (°C))

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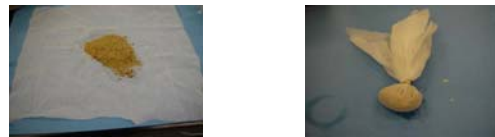
## Supplies for heat treatment

- Water bath
- Thermometer
- Cotton cloth or cotton bags
- Screen for seed drying



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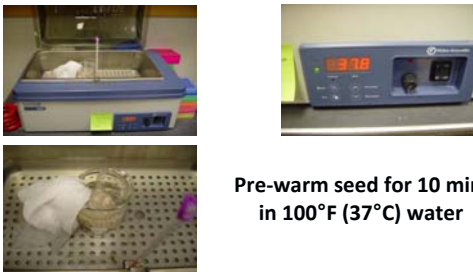
## Step 1



Wrap seed loosely in a loosely woven cotton (such as cheesecloth) bag

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## Step 2



Pre-warm seed for 10 min  
in 100°F (37°C) water

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## Step 3



Place pre-warmed seed in a water bath that will hold the water constant at the recommended temperature

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<u>Seed</u>	<u>Water temp</u> (°F)	<u>Time</u> (min)
Brussels sprouts, eggplant, spinach, cabbage, tomato	122	25
Broccoli, cauliflower, carrot, collard, kale, kohlrabi, rutabaga, turnip	122	20
Mustard, cress, radish	122	15
Pepper	125	30
Lettuce, celery, celeriac	118	30

## Step 4



Dip bag of seed in cold water  
to stop heating action

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## Step 5



Spread seed out to dry in a single layer

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## How to Test Seed Germination

- Mix seeds in each seed lot and count out 50-100 seeds per seed lot
- Hot water-treat 1/2 of the seeds exactly as described above
- After treated seeds have dried, plant the two groups of seeds separately in flats containing planting mix
- Allow the seeds to germinate and grow until the first true leaf appears

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## Testing Seed Germination

- Count seedlings in each group separately
- Determine the % germination in each group
 
$$\frac{\text{\# seedlings emerged}}{\text{\# seeds planted}} \times 100$$
- Compare % germination in each group (should be within 5% of each other)

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## Home Hot Water Seed Treatment

### ➤ Stovetop water bath

- Kitchen pot or large pan
- Buy a good quality thermometer; tape to wooden spoon to keep thermometer away from bottom or sides of pot



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## Home Hot Water Seed Treatment

- Practice heating water and maintaining correct temperature without seeds first
- Keep separate containers of hot and cold water nearby
- Meanwhile place seeds in a tea ball; weight to keep submerged (but not touching bottom of pot)
- When T can be maintained as desired add bag/tea ball; start timer

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## Home Hot Water Seed Treatment

- Stir constantly; monitor temperature
- Adjust temperature as needed; maintain temperature within 1-2 degrees
- Remove seeds when time is up
- Transfer seed to cool water, then dry on paper towels
- Plant seeds in potting mix
- Check germination

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## Why grow transplants?

- Early replacement of harvested vegetables
- Rapid production of another crop
- Elimination of yield loss caused by poor germination
- Allows you to decide the variety or cultivar
- Allows you to determine size of transplants
- Reduces chances of introducing insects and diseases to the garden
- Transplants available when you need them
- Generally increases survivability and vigor

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## Seed

- High quality transplants can be produced only from high quality seed
- Seeds should state the year it is intended for planting
- If not intended for the same year, it may not germinate well, and seedling vigor may be reduced

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- Purchased seed:
  - Reputable producer with good track record
  - Seed should be tested for bacterial pathogens
  - Seed should be hot water treated
- Saved seed:
  - Save seed from healthy plants only
  - Hot water treat all seed

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## Producing Pathogen-Free Transplants

- Do not raise exotic or experimental varieties, or saved seed, in same greenhouse with commercial seedlings unless all seeds are hot water treated

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## Transplant Growth Stages

1. Sowing seed to root emergence
  2. Root emergence until seed leaves or cotyledons expanded
  3. Growth of true leaves and root system
  4. Hardening off
- Generally, moisture level & T tend to decrease and light and fertility will increase with progression of each stage

 Extension (Biernbaum, 2006)


## Light Management

1. Low light intensity needed for germination
2. Light intensity increased during stage 2 prevent rapid stem elongation
3. For late spring and summer, shade cloth may be needed to reduce heat
4. Growth depends on intensity and duration

 Extension (Biernbaum, 2006)


## Temperature Management

1. Difference between day and night T, average daily T (ADT) and species response to T all important to consider
2. ADT greatest influence on rate of growth
  - In 45-50 degrees, most species grow very slowly
  - Grow rapidly up to 75-77 degrees
3. Average range for stage 3 60-65 degrees

 Extension (Biernbaum, 2006)


## Temperature Management

4. T also effects nutrient availability
5. Mineralization of N depends on microorganisms
6. Soil T of 55F or above adequate for N conversion
7. Bottom heat recommended is air T below 55F for prolonged period

 Extension (Biernbaum, 2006)

## Temperature Management

8. Day and night difference
  - When day very warm and night cool, plants taller
  - When day and night T same, plants will be shorter than above
  - When night T warmer than day T through supplemental heating, plants shorter

 Extension (Biernbaum, 2006)

## Relative Humidity

- Light, T and ventilation will influence
- High RH limits nutrient uptake and increases potential for disease

(Biernbaum, 2006)

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## Containers

- No container- soil blocks (Eliot Coleman)
  - Pulled or cut apart at transplanting
- Mostly plastic & polystyrene used
  - Less transplant shock
  - Add material cost and disposal issue
  - Must be new or properly sanitized
    - Bleach is an acceptable if residual chlorine levels do not exceed 4 ppm
  - Use proper rates & rinse thoroughly to reduce possible toxicity to next crop



## Containers

- Many sizes, shapes and configurations
- Different vegetables require differing amounts of space, nutrients & water
- Smaller cells used for cole crops & lettuce
  - 1-1 ½-in. cells, 200-338 cells/tray
- Larger cells used for tomato, pepper, cucurbits
  - 1 ½-2 ½-in. cells, 50-128 cells/tray

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## Media

- Soilless media is best
- Must be insect, disease, nematode, and weed seed free!
- Media properties vary according to ingredients:
  - Peat moss, coir, perlite & vermiculite
  - Other ingredients: compost, rock phosphate, worm castings

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## Media

- Select media that:
  - Drains well
  - Provides good aeration
  - Holds water moderately well
- Choose the media best suited for your crop
- Several specifically for growing transplants from seed
- Media with finely ground perlite, vermiculite & peat moss best for vegetables

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## MSU Media Recipe

- 50% peat and 50% homemade compost
  - 1 bale straw
  - 1 bale grass hay or grass alfalfa mix
  - 1 bale wood shavings for bedding
  - 1 bale peatmoss
  - 6 cubic ft of soil
  - 6 cubic ft of grass clippings
  - 6-12 cubic ft of green plants like comfrey, weeds without seeds, green manure, etc.
    - Layer in manure spreader and mixed as comes out the back in a pile
    - Add water during layering
    - Mixture reaches over 140F in 4 days & held at > 130F for 1 wk or more
    - Put back in spreader for mixing & add 25 lbs alfalfa meal to about 4 yds
    - Started in June and July when green manure readily available
    - Allowed to mature through remaining part of summer
    - Covered and left outside during winter

 Extension (Biernbaum, 2006)



## Media Amendments

- Blood meal (N)
- Rock phosphate (P and Ca)
- Greensand (K and micronutrients)
- Combine in equal parts
- Add 14 lbs/cubic yard of peat compost mixture
- Let sit for one month (Coleman, 1995)

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## Seeding

- Mechanical seeding options:
  - Hand held needle seeders with vacuum pumps
  - Inline needle seeders
  - Drum seeders
  - Make your own!



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## Production Systems

- Bench system-
  - allow air flow above and below plants
  - moving benches (space saving)
  - overhead watering & fertilizing
- Float system-
  - germinated trays placed in water reservoir
  - requires less labor & management
  - reservoir can be source of contamination

## Water & Fertilizer Management

- Keep media *moist* during germination
- After germination, irrigate when media surface becomes dry
  - Let top 1/8 in. media dry between watering
- Leaching not recommended unless soluble salt levels are excessive

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## Water Management

- Irrigate early in the day
- As time for field planting nears, apply slightly less water to help harden-off plants
- NEVER allow media to become completely dry

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## Water Quality

- Poor quality water can cause transplant problems
- Test your water before you begin production
- Low or high pH water can change the media pH & affect nutrient availability
  - Water pH of 5-7 ideal
  - High alkalinity & high pH problematic
  - High levels of soluble salts can injure plants

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## Water Soluble Fertilizers

- With well prepared media, likely only N will be required during production
- Fish emulsion (5-1-1): (6.4 oz in 5 gallons or 1 gallon in 100 gallons=500 ppm)
- Fertilization with every irrigation at low rate (50-100 ppm) common
- All organic N not readily available

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## Nutrient Concentrations

- Amount of fertilizer needed depends on:
  - Type of transplant
  - Frequency of fertilizer application
  - Stage of growth
  - Growing environment
  - Amount of fertilizer in the media (if any)
- The more often plants are fertilized, the lower the nutrient concentration required for each fertilization

## Fertilization

- If fertilizing every watering, start with N concentrations of 30-50 ppm
- Modify as needed:
  - Higher rates for tomato, pepper & cole crops; lower for cucurbits
  - Higher rates when temperatures high (late spring/summer); lower rates when cooler

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## Adjusting Fertilizer Levels

- If N levels > 50 ppm applied daily, transplants probably over fertilized
- If plants fertilized 1-3 times/wk, use a more concentrated fertilizer solution
  - Example: If fertigation scheduled once a week, N concentrations of 250-300 ppm may be required

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## Over Fertilization

- Can cause excessive growth, lowering quality
- Can be phytotoxic (“hot”): burn foliage, injure roots & kill plants
- If “hot” solution accidentally applied, leach with clear water thoroughly


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## Transplant Production Timing

- Plants need to be ready when field & weather are ready
- Light levels, greenhouse temperature, watering & fertility affect production time
- Hardening off crucial for success in the field

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Vegetable	Growing Time (wks)	Germination Temp (°F)	Growing Temp (°F)	Hardening Conditions
<b>Cool Season</b>				
Broccoli	5-7	70	60-65	50-55° for 10 d
Cabbage	5-7	70	60-65	50-55° for 10 d
Cauliflower	5-7	70	60-65	50-55° for 10 d
Head Lettuce	5-7	70	60-65	temp & moisture
<b>Warm Season</b>				
Cucumber	2-3	75	65-75	moisture
Cantaloupe	2-3	75	65-75	moisture
Eggplant	6-8	75	70-75	temp & moisture
Pepper	7-9	75	60-70	temp & moisture
Squash	2-3	75	65-75	moisture
Tomato	5-7	75	60-70	temp & moisture
Watermelon	2-3	80	65-75	moisture



## Insect Management

- Healthy plants your first defense!
- Favor growth of plant, not pest
- Scout for insects from plant emergence until harvest
- Most insects can be controlled when initial infestation is detected
- Biocontrols work well in GH
- Sticky traps



## The Most (Un-)Wanted

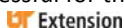
- |                 |                 |
|-----------------|-----------------|
| 1. White fly    | 6. Leaf miners  |
| 2. Thrips       | 7. Mealy bugs   |
| 3. Fungus gnats | 8. Caterpillars |
| 4. Aphids       | 9. Slugs        |
| 5. Spider mites |                 |

(Biernbaum, 2006)



## Insect Management

- Using sterile media can prevent soil insect problems
- Sanitizing & solarizing greenhouses between plantings reduces early problems with aphids, whiteflies, thrips & others
- Screening can exclude aphids, leaf miners, diamondback moth, armyworms, pepper weevil, seedcorn maggot & other large flying insects
- Must be carefully maintained & monitored
- Screening not successful for thrips & whiteflies




## Reducing Insect Problems

1. Grow no other crop in production greenhouse
2. Maintain weed free greenhouse
3. Scout weekly for insects & diseases
4. Monitor insects with yellow sticky cards
5. Maintain plant free zone around greenhouse
6. Banker plants can warn you when pests are on the rise
7. Minimize transplant time



## Sprays as Last Resort

1. Insecticidal soap
  2. *Beauveria* fungus
  3. Neem products
  4. Garlic or hot pepper barriers
  5. Compost teas
  6. Herbal preparations
  7. Pyganic
- \* Always check with your certifier first!

 (Biernbaum, 2006)

## Disease Management

1. Maintain adequate plant spacing for air circulation
2. Ventilate to minimize condensation & exchange with outside air daily (one full exchange/day)
3. Remove any diseased foliage from plant & remove from greenhouse
4. Anyone touching plants should wash hands & disinfect tools before entering houses

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## Producing Quality Transplants

- Practice good sanitation in greenhouse
  - Use new or sanitized plug trays or flats and pathogen-free mixes
  - Sanitize equipment
  - Install solid flooring; raise seedling trays
  - Limit movement of personnel and equipment between greenhouses
  - Clean benches, greenhouse structure thoroughly after the crop
  - Solarize- close up greenhouse and fry inoculum

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## Producing Quality Transplants

- Maintain conditions in the greenhouse that do not favor disease development
  - Maintain relative humidity as low as possible
    - Good air circulation      - Proper temperatures
  - Do not over-water
  - Minimize time foliage is wet
  - Do not over-fertilize
  - Handle plants as little as possible
  - Do **NOT** handle when plants are wet

## Weed Management

- Compete for light, nutrients, water & space
- Host for insects, diseases & nematodes
- Sterile media prevents most problems
- Wind-blown seed problematic if greenhouses exposed to open air- Screens can help!
- Control weeds under benches & along wall edges

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## UT Organic Crops Field Tour



- May 15, 8 AM – 11:15 AM
- Pre-register with ETREC by calling 865.974.7201
- Visit <http://organics.tennessee.edu> for more info

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## Questions?



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Organic Crops Field Tour: May 15

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