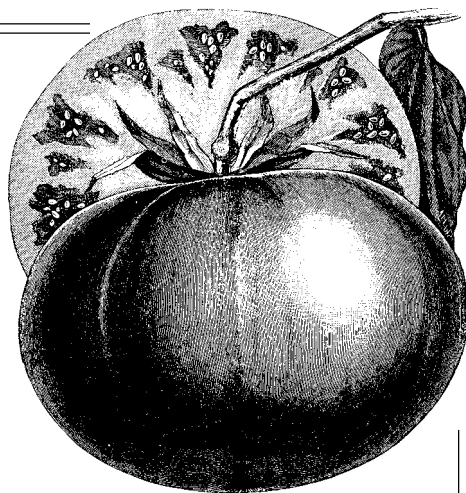


Commercial Growing of
Greenhouse Tomatoes





Commercial Growing of Greenhouse Tomatoes

Table of Contents	Page
Location of the Greenhouse	4
Soil Preparation and Fertilization	4
Hydroponic Culture	5
Operating the Gravel and Other Systems	5
Fertilizing Systems	6
Bulk Tanks	6
Injectors/Proportioners	6
Injector Calibration	6
Important Considerations in Design	8
Nutrient Solutions	8
Nutrient Concentrations	8
Preparation of Micronutrient Concentrate	10
Varieties	11
Producing Transplants	12
Transplanting	12
Training and Pruning	13
Leaf Pruning	13
Fruit Pruning	13
Pollination	13
Temperature and Humidity Control	13
Harvesting	14
Marketing	14
Profits	14
Troubleshooting Greenhouse Tomatoes	16
Disease Control	17
Insect Control	18
Soil-associated Pests	18
Sucking Insect Pests	19
Chewing Insect Pests	19
Mites	19
Cultural Control of Greenhouse Pests	19
Chemical Safety in the Greenhouse	20
Table of Measures	20
Dilution Tables	20
Calculation of Greenhouse Volume	21
Insecticides for Greenhouse Tomatoes	22

Growing tomatoes in greenhouses at a time when there are no field tomatoes can be profitable, but it does require considerable care and exacting knowledge. You must try to provide ideal conditions. One mistake can cause serious trouble, resulting in reduced profit or even total loss.

Start out small in greenhouse tomato production. If you make acceptable profits and you want to enlarge, then the experience gained may allow you to make a better decision about enlarging. For this reason, we will describe simple structures and growing in soil beds, but also more advanced commercial production systems.

Since twin-walled plastic-covered greenhouses are relatively inexpensive, consider using them if you're just starting in the business. Construction costs range from \$3 to \$5 per square foot. Plans for greenhouses are available through your county agent's office.

Location of the Greenhouse

For operations that will use soil beds, consider several factors in locating the greenhouse. The soil should be well drained, fertile, have a medium to light texture and be high in organic matter. It may be impossible to find a site that meets all requirements, but some factors can be altered by improving drainage, building up the fertility level and increasing organic matter content. The greenhouse should be near adequate supplies of fuel, good water and reliable labor (if required).

In construction of any greenhouse, the long dimension should run north-south with the rows also running north-south. This allows for more even light distribution, especially in the late fall and winter when light intensity is normally low. It also allows for longer rows and more efficient use of the house space. The north wall can be painted white to reflect light back onto the crop. If you use cooling pads, position them at the north end. The exhaust fans are at the south end.

Locate the greenhouse away from buildings or trees that will shade it. A windbreak of buildings or trees on the north side of the house will give added protection against cold wind in winter and help to reduce the cost of heating.

Soil Preparation and Fertilization

The soil in a tomato greenhouse should be worked as deeply as possible to break any existing hardpans or those that may have developed because of repeated traffic over the area. Fumigation or steaming of the soil is a must before each crop or at least once a year. This will help to destroy disease, nematodes and weeds. If soil is steamed, hold it at 180 degrees for 4 hours. Avoid deep tillage after fumigation or steam sterilization.

Build up the organic matter content of the soil with compost, composted barnyard manure or other organic matter. Apply it before the soil is fumigated so weed and disease pests in the compost are destroyed. Allow the required time to elapse from fumigation until plants are transplanted.

Take a soil sample before planting each crop. In each house, collect at least 10 samples to a depth of 8 to 10 inches. Mix these, and take a pint sample from the mixture. The fertilizer program can then be governed by the results of your soil analysis. Your county agent will have your soil tested.

The optimum soil pH (acidity) for tomatoes is between 5.8 - 6.8. Soils below 5.9 should be limed to raise the pH and to supply the necessary calcium tomatoes need. Regular agricultural lime, if needed, should be broadcast over the greenhouse soil and worked in at least several weeks before planting. If the magnesium level of the soil is low as well as the pH, then apply dolomitic lime, which contains both calcium and magnesium. Some soils have a high pH (6.5 - 6.8) but are low in calcium. Regular agricultural lime would raise the pH too high and could possibly tie up other nutrients, especially the micronutrients. On these high pH soils, use gypsum or CaSO_4 (calcium sulfate). It will not raise the soil pH, but it will supply the needed calcium. If the pH is too high (7 or above), incorporate 15 to 20 pounds of ground sulfur per 1000 square feet to reduce the pH.

It's difficult to make a general fertilizer recommendation for all soils since soil types and native fertility differ greatly. A soil test is essential. Your county agent will help with its interpretation.

Generally, fertilizer recommendations for Louisiana soils will be as follows:

1. If soil test values read very low or low, you should split the fertilizer application. Apply half the recommended P and K at planting and topdress the other half one month later to avoid fertilizer burn.
2. If lime is required and Mg rates are low, choose dolomitic lime.
3. If soil test shows low Ca and pH is medium or high, add 50 to 80 pounds of gypsum per 1000 square foot while tilling the soil before planting.
4. If a soil test shows low Mg and is medium or high in pH and Ca, add Mg as 15 to 25 pounds per 1000 square feet. Use Epsom salt or potassium-magnesium-sulfate as your source of potassium this season.
5. Apply 1 pound of ammonium nitrate or 1/3 pound of N preplant per 100 foot row with the required P and K as beds are prepared. Sidedress at first fruit set. Repeat about every three weeks thereafter, as needed, with 1/2 pound of ammonium nitrate or equivalent per 100 foot row.
6. For long-term crops, begin using a complete fertilizer for sidedressing after the second N sidedressing. Apply 2 1/2 pounds per 100 foot row of 8-24-24 or 1 1/2 pounds of 13-13-13, then rotate back to ammonium nitrate.
7. Avoid salt buildup by using these or higher grade fertilizers and adequate watering and leaching.

A salt meter or conductivity bridge is a good investment considering what you've already put into the house. The problem of salt buildup has been encountered in greenhouses where low analysis fertilizers such as 8-8-8

have been used for several years in a row. A high salt content measuring over 2.25 millimhos conductance in a 2:1 (water:soil mix) results in reduced plant growth and yield and blossom-end rot. This is particularly true if plants are young. Values of conductance over 3.5 millimhos cause noticeable injury to plants. Use high analysis fertilizers to help delay this toxic buildup of salts. An 8-24-24 is commonly available in Louisiana, but it is also high in salt. By mixing equal parts of two low salt fertilizers, such as Triple Super Phosphate (0-46-0) and potassium nitrate (13-0-44), a 7-23-22 analysis can be made and used as the basic fertilizer with less salt buildup in the soil.

When using low nitrogen mulches (sawdust, rice, hulls, bagasse, etc.), an additional 3 ½ pounds of ammonium nitrate per 1000 square feet may be broadcast uniformly over the mulch and lightly watered in. This nitrogen is not to be leached into the root zone. This will prevent the mulch from temporarily robbing the plants of nitrogen.

If high salt is a problem, it can be corrected by leaching with 6 to 10 acre-inches of water. The amount of water needed will depend on the soil type; heavy soils require more than lighter soils. If the problem persists, allow the soil to dry to a crust at the end of the season. Then remove the top inch of undisturbed soil. It should contain most of the salts.

If plants are very dark green, seem stunted in top growth or develop creases or splits in the upper stems, delay or skip the sidedressing. Foliar spray boron every four days as Borax using 2 teaspoons per gallon. Periodic soil tests are useful.

Hydroponic Culture

Hydroponic culture is the method of growing plants without soil. The name itself implies that the plants are grown in water. Actually, the nutrients are supplied in water solution, but the plants may be suspended in water or they may be produced with roots in sand, haydite or gravel. The field production of vegetables in very sandy soils with high nutrient and water levels approaches hydroponic whole floor sand culture.

Eliminating soil as the culture medium also eliminates problems such as weed control, tillage, irrigation and the necessity for growing cover crops or adding manures for organic matter. But for each problem eliminated, another is created. As a result, hydroponic culture is not the easy and simple method it's often pictured to be. It is a highly specialized method of culture. Successful operators must be highly skilled farmers and trained technicians. What is not given to the plant cannot be scavenged elsewhere in a hydroponic system.

If you are to be successful at vegetable culture by hydroponics, you must carefully observe many details. While the procedures to follow in producing crops without soil are quite well established, following them does not automatically ensure financial success. It is necessary to obtain maximum yield over a relatively long

season and to sell at reasonably high prices to make a profit. Even the most skillful operators are not always able to secure this production or highest prices. The crops must be of high quality to sell readily at satisfactory prices.

It's unlikely that a commercial hydroponic establishment can compete profitably with field-grown crops unless the products have a ready market at prices well above those of regular farm products. Usually vegetables of high quality grown hydroponically command a premium price because of eye appeal and the novelty in advertising. There are no known mysterious hidden benefits such as higher nutritive value or vitamins in a hydroponic product as compared to a field-grown commodity, but greenhouse tomatoes come closer in off-season to true vine-ripened fruit in most cases.

Although you may use either the water-solution method or a perlite, coarse sand or gravel system, the ground pinebark culture is often used in Louisiana. The information on methods and descriptions of equipment given here apply to all culture systems.

Operating the Gravel and Other Systems

The entire hydroponic system is relatively simple to operate and may be made at least semi-automatic. Coarse sand or gravel should infiltrate at 12 inches to 14 inches per hour. The quantity of solution in the tank should be just sufficient to bring the water level to within 1 inch of the top of the gravel in the beds. A centrifugal pump of sufficient capacity to fill beds in one-half hour or less is generally best for forcing the solution into the beds. It should be of sufficient capacity to drain the system for cleaning. In cool weather, you may pump only once a day, but in warm, dry weather, it may be necessary three or four times a day. You can install a time clock to start and stop the pump automatically. With a centrifugal pump, you may allow the solution to flow by gravity through the pump back into the tank.

How often to operate the pump is simply a matter of keeping the gravel wet enough so plants always have an adequate supply of water. This requires judgment on the part of the operator. No automatic device has been developed to take the place of personal inspection. A good indication of need for repeating the pumping operation is wilting of the plants.

Other hydroponic system setups are available, such as NFT, bags or troughs. Irrigation water and nutrients are supplied by a drip system with enough emitters per plant to provide sufficient quantities of solution to seep through the container with each watering. Leachates should be monitored frequently for total dissolved solids. When levels exceed 3000 ppm, media should be leached with water until leachates are less than 1000 ppm.

Troughs and beds may be filled to a depth of 8 inches to 10 inches with materials such as sand, pine bark, rice hulls or perlite. Beds and troughs are usually 30 inches wide with at least 24 inches between rows. A drain line (1 1/4 inches - 3 inches I.D.) should be placed at the

bottom of each structure with a fall of at least 2 inches per 100 feet. Nutrient solution is supplied using a drip system as described above.

Most greenhouse vegetables are grown in containers or bags using the same types of media discussed for bed and trough culture, usually pine bark or perlite. Containers should be large enough to provide good aeration and drainage. Five- to seven-gallon containers are best. Nutrient solutions are also supplied by a drip system.

The nutrient flow technique also can be used effectively for vegetable production. In this system, nutrients flow either continuously or frequently through a tube in which the plants are grown. The volume and quality of the nutrient solution are maintained similarly to those in gravel culture, and nutrient solutions are recycled for the week, then discarded.

Fertilizing Systems

There are two principal systems for mixing fertilizers: the bulk tank system and the injector or proportioner system. Both methods can produce high yields and excellent quality tomatoes.

Bulk Tanks

The bulk tank system consists of a tank (plastic, concrete, steel, PVC, etc.) of appropriate size depending on the square footage of the greenhouse(s). A 500-gallon tank is fine for one greenhouse, whereas a 2,000-gallon tank is preferable for several greenhouses. The larger the tank, the less frequently it must be filled. For a new grower, or a grower with only one or two bays, the bulk tank system is easier to understand and probably causes fewer mistakes.

Mixing fertilizer is a matter of adding so many ounces of dry fertilizer per 100 gallons of water. The fertilizer must be completely dissolved in the water. When mixing the fertilizer solutions, use hot water to speed dissolution of the fertilizer. For small batches, mechanical stirring is satisfactory. For large batches, it might be better to invest in an electrical agitator.

It's best to work in small batches. Mix them first, and then dump each into a larger stock tank. Be sure to check the pH and EC of the solution each time you mix a new batch. Install a filter in line before the pump.

Injectors/Proportioners

With the injector system, a concentrated mixture of fertilizer solution is diluted with the injector (proportioner) to the final concentration required by the plants. The simplest and least expensive type of injector is a Hozon proportioner, often used for garden plants. It is not appropriate for commercial production. The most complicated and expensive is the Anderson Injector. There are many intermediate models which vary in cost and complexity.

Generally, the more you spend, the more accurate the injector is. Inexpensive models will vary the injection ratio depending on water pressure, which is often variable. Better models are dose specific, meaning the concentrate

injected depends on a given volume of water passing through the device. Equally important, the higher-priced injectors are adjustable. A knob on the head can be turned to increase or decrease the dose of fertilizer concentrate injected into the water.

The fertilizer goes from the concentrate tank to the injector, where it is diluted by being injected into the irrigation delivery system. Install a filter in line before the injector.

Concentrate is held in small containers (20 to 50 gallons). At least two heads and two concentrate tanks are needed: one for the calcium nitrate (tank B) and the other for all other nutrients (tank A). This is necessary so calcium does not combine chemically with phosphorus when the two elements are in high concentration, especially under a high pH. The resulting compound, calcium hydrogen phosphate, is a very hard precipitate and can clog the injector and irrigation system. Once these two elements are diluted, there is no problem. If the pH is higher than 5.8, it is advisable to use a third head to inject acid. This is needed to keep the pH in the 5.6-5.8 range.

Furthermore, as better precision in the fertility program is desired (as money permits), more injector heads can be added. Ultimately, a head can be used for several fertilizer elements. Individual adjustments can be made based on regular tissue analyses.

Injector Calibration

It is important to know the injection ratio so you can calculate how much fertilizer to mix in the concentrate tanks. Some come with tables that designate this ratio, 1:9, 1:16, 1:100, 1:200, etc. On certain brands, the ratio is designated as a percentage, 1% rather than 1:100. Some injectors let you adjust this ratio by turning a knob; others are fixed at one setting.

If you don't know the ratio, it is necessary to calibrate the injector to learn this important number. Using a beaker or graduated cylinder, measure how much water is sucked up by the injector in one minute. Then, using several beakers, one at each of several emitters, measure how much water is distributed to plants in one minute. Take an average of the number of beakers in which water is being collected in the greenhouse. Then multiply this average amount emitted per plant in one minute by the number of emitters in the greenhouse. The injection ratio is the ratio of the output to the input. Divide the total amount emitted in the greenhouse in one minute by the amount sucked up in one minute. State the ratio as 1:X where X is the number you get after dividing. Your concentrated solution is diluted X times with water. (There are X parts water for each one part of concentrated fertilizer solution.)

The following formulas are ways to calculate the concentration of any fertilizer element in water. They are easy to use, and examples are shown. By using these equations, you'll be able to know exactly how much of each fertilizer element you are feeding your plants. You can use the formulas to calculate the amount of any fertilizer element, not just nitrogen.

There is essentially only one formula. If you're using an injector system, however, there's another factor to use, namely the injection ratio. With a bulk tank system, there is no injector, and therefore no injection ratio.

Injector System Formula:

$$\text{ppm} = (\% \text{ fertilizer}) \times (\text{lb. added to tank}) \times (16 \text{ oz. per lb.}) \times (.75) \times (100/\text{gals. of concentrate}) \times (1/\text{ratio of injector})$$

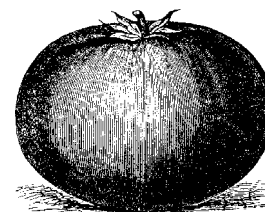
Example: Use 23 lbs. of 15-11-29 in a 30 gal. concentrate tank; then through a 1:100 injector. $\text{ppm} = 15 \times 23 \times 16 \times 0.75 \times (100/30) \times (1/100) = 138 \text{ ppm N}$

Bulk Tank System Formula:

$$\text{ppm} = (\% \text{ fertilizer}) \times (\text{lb. added to tank}) \times (16 \text{ oz. per lb.}) \times (.75) \times (100/\text{gals. of bulk tank})$$

When substitutions are to be made, the fertilizers should be listed along with the nutrient elements supplied so a feed is made to satisfy all the nutrients required.

Fertilizer	Pounds soluble in 100 gallons cold water
Ammonium nitrate	984
Ammonium sulfate	592
Calcium nitrate	851
Calcium chloride	500
Diammonium phosphate (DAP)	358
Monoammonium phosphate (MAP)	192
Potassium nitrate	108
Borax	8
Magnesium sulfate (Epsom salts)	592
Potassium sulfate	83



Mixing 1 gram per gallon yields these ppm element in solution		PPM						
Fertilizer	Analysis (Percentage)	N	P	K	Ca	Mg	S	Cl
Potassium nitrate	13.75-0-44.5 (37K)	36		97				
Potassium sulfate	0-0-50 (41.5K, 17S)			110			45	
Muriate of potash	0-0-60 (50K, 45Cl)			131				118
Monopotassium phosphate	0-52-34 (23P, 28K)		60	74				
K-Mag or Sul-Po-Mag	0-0-22 (18K, 11Mg, 22S)			48		29	58	
Conc. super phosphate	0-46-0 (20P, 13 Ca)		53		34			
Calcium nitrate	15.5-0-0 (19 Ca)	41			50			
Calcium chloride	77%-80% CaCl ₂ (28 Ca)				74			169
Ammonium nitrate	33.5-0-0	88						
Ammonium sulfate	21-0-0 (24S)	55					63	
Urea	46-0-0							
UAN liquid	32-0-0 (11.1 lbs/gal)	24 (1 ml/gal)						
Ammonium poly phosphate	15-60-0 (26.2P)	39	69					
Diammonium phosphate	18-46-0 (20P)	47	53					
Phosphoric acid (g)	75% H ₃ PO ₄ (23.7P)		62					
Phosphoric acid (ml)	75% H ₃ PO ₄ (12.3 lbs/gal)		93 (1 ml/gal)					
Epsom salts (magnesium sulfate)	(9.9Mg, 13S)					26	34	

3.5 ounces of the fertilizer compound dissolved in 100 gallons of water yield the same ppm of element in solution as those given above for 1 gram per gallon. (28.35 grams = 1 ounce)

Important Considerations in Design

1. The troughs or benches should all be level at the same height. Otherwise it will be difficult to regulate the pumping operation so all benches receive the same amount of solution. A drop of one inch in 8 to 9 feet will give adequate drainage when needed for NFT.
2. If you use asphalt paint for treating the concrete troughs, be sure it is of highest grade. Some highway and roofing materials contain tars and fluxes. Avoid them. When placed in hot water, good asphalt will not cause any discoloration and will leave no oily film.
3. If the gravel or sand contains considerable lime (calcareous), it will be difficult to maintain the proper pH in the nutrient solution. Lime will boil vigorously if muriatic (hydrochloric) acid is poured on it. It's best to test the gravel with this acid to determine whether it is objectionably high in lime.
4. If you use haydite instead of gravel as the culture medium, it may contain objectionable chemicals. Most of the substances that may cause injuries are soluble, and thorough washing and leaching will remove them.

Nutrient Solutions

No one nutrient solution is absolutely superior to all others. Several can be used with much the same degree of success. Often growers prefer to buy the ready-mixed chemical ingredients for the solution, such as Chem-Gro 4-18-38 or Pronto's 2-13-29. This avoids some of the labor and difficulties of mixing. The solutions are not hard to mix and may cost about half of ready-mixed salts.

A slightly modified version of the Steiner Nutrient Solution has been used successfully for greenhouse tomatoes and other plants. The original Steiner Solution (as published by Abram A. Steiner titled, "Soilless Culture," in the Proceedings of the 6th Colloquium of the International Potash Institute at Florence, Italy, in 1968) was modified according to the plant requirements and verified by tissue analysis.

Nutrient Concentration

It's important to know the nutrient levels in your fertilizer solution. You'll want to know if your mix turned out properly, or you'll want to know what the plant roots actually receive. Parts per million (ppm) of nutrient element in solution is milligrams of element in a liter of solution. One ppm is 0.1335 ounce per 1,000 gallons or 3.78 mg per gallon.

One simple way to understand nutrient concentrations is by percentages. If you know 100% is 176 ppm N, then a 90% solution has ($0.9 \times 176 = 158$) 158 ppm N. That requires using only 90% of all those fertilizer constituents containing N when mixing fertilizer.

One other common, quick and easy method to evaluate nutrients is to measure the soluble salt or electrical conductance (EC) level. Conductivity meters are used for this, and the measurement is easy and fast. This procedure, however, tells the grower only the

relative amount of total "salts" in the solution; it tells nothing about each specific nutrient in the solution.

EC can be stated in various units:

ppm = parts per million or mg/lt.

dS/m = decisiemens per meter.

m mhos/cm = millimhos per cm.

Note:

1 dS/m = 1 m mho/cm = 1,000 micromhos/cm.

Suppose the grower is accustomed to maintaining an EC of 2 dS m⁻¹ in the nutrient solution when using a high analysis mixed fertilizer. The grower then switches to a lower analysis fertilizer but keeps the EC at 2. In this case, the conductivity meter is misleading as to the true concentration of nutrients such as N, P or K, and nutrients may be deficient even though the EC remains the same. EC measures total salt in solution only, and all 2 dS could come from table salt! This is why we discard nutrients weekly in a closed (recycled nutrient) system.

EC readings can also help determine onset of salt damage to plants growing in solid media. We simply measure the leachate to see what the roots must contend with.

Use EC to determine % strength, and then you'll know how many ppm N etc. you are feeding. Make a standard curve of EC versus percent by diluting.

Example:

Accurately make a 100% solution. Dilute that solution with a fairly pure (low EC) water.

3 parts solution + 1 part W = 75%

2 parts S + 1 part W = 67%

1 part S + 1 part W = 50%

Measure EC of all four solutions and make a graph. Now you can read % nutrient for any EC you take of your mixture.

An important point: Any time dissolved solids or EC are measured in a solution, it's critical to know the dissolved solids or EC of the water source used to make the solution (it cannot be assumed to be 0). Sodium or some other dissolved element in your tap water can lead to false readings when you measure nutrient solution. Subtract the water source EC or dissolved solids measurement from that of the nutrient solution to find the true value caused by fertilizer. This is the number to compare to various charts to decide if the correct amount of fertilizer is in solution.

Tech notes:

1. To calculate the ppm contained in 1 ounce of material per 100 gallons, solve for B

$$A \times 75 = B$$

A = the % active ingredient (AI) in the fertilizer as a decimal.

B = ppm contained in 1 ounce of the material in 100 gallons of water.

2. To calculate the number of ounces of material required to make up a desired ppm concentration, solve for C:

$$C = \text{desired ppm divided by B}$$

B = ppm contained in 1 ounce of the material in 100 gallons of water (from above).

C = number of ounces of material to add to 100 gallons of water to achieve the desired concentration.

Also:

$$\text{ppm element} = (\% \text{ element in fert. as a decimal}) \times (\text{lbs. fert. added}/100 \text{ gal}) \times 1,200$$

Example:

Add 2.5 lbs. of 8-5-16 per 100 gal.
 $(0.08 \times 2.5 \times 1,200 = 240 \text{ ppm N})$

Modified Steiner Solution for Tomatoes*

Material	Grams 100/gal	or Oz. 100/gal	PPM of element	Final conc. in ppm of element
Calcium Nitrate (15.5-0-0)	360	12	140 N 171 Ca	140 N 171 Ca
Potassium Magnesium Sulfate** (0-0-22)	170	6	81 K 50 Mg	299 K 50 Mg
Potassium Sulfate (0-0-50)	198	7	218 K	
Chelated Iron (Fe 330-10% Fe)	11.5	0.4	3 Fe	3 Fe
Phosphoric Acid (75%)	50 ml	2.6	47 P	47 P
Micronutrient concentrate	200 ml	200 ml	1-2 Mn 1 B 0.4 Zn 0.2 Cu 0.1 Mo	1-2 Mn 1 B 0.4 Zn 0.2 Cu 0.1 Mo

* Diluted nutrient solution may range in pH from 5.8 to 6.0. Use pH near 6.8 for calcareous sand. Use sulfuric acid to lower pH and sodium carbonate to increase pH.

**Potassium magnesium sulfate (K-Mag or Sul-Po-Mag) dissolves slowly although it is very soluble in that it can be concentrated about 140 times that given in the table. It's usually best to predissolve this material in a concentrate of 100 to 1, which is then used in preparing the dilute solution.

Micronutrient Concentrate*

Material	Grams/16 liters	PPM of element dilutes as given
Manganese Sulfate (27 1/2% Mn)	118 - 237**	1 - 2**
Boric Acid	172	1
Zinc Sulfate (36% Zn)	6.4	0.4
Copper Sulfate (25% Cu)	19***	0.2***
Sodium Molybdate (40% Mo)	6	0.1

(or 5.0 grams of ammonium molybdate)
 (Add 10 ml sulfuric acid to help keep chemicals in solution.)

* For most plants other than tomatoes, drop manganese and boron to 0.5 ppm each.

** Use the lower ppm except during December, January and February. Increase Fe 1 ppm if Fe deficiency occurs in December and January.

***When ripening fruit crack in hot weather, increase Cu to 0.5 or 0.6 ppm. If medium is calcareous sand, use chelated Cu during fruit cracking period. For Cu to = 0.5 ppm, use 47.52/16 l.

- A. A one crop system is seeded August 1 and transplanted in September. Harvest runs fall through spring. Use the following suggestions for one crop system (modify as needed):

- Forty percent to 50% concentration of nutrient solution after transplants are set into greenhouse, but keep micronutrients at 75%.
- Change to 85% to 90% concentration by the time of first bloom on fourth truss or cluster, but keep micronutrients at 100%.
- Increase to 100% concentration by the time of first bloom on the fourth truss.
- Increase to 120% or 130% concentration about December 1.
- Drop to 100% concentration about February 10.
- Drop to 75% concentration on May 1.
- Drop to 60% concentration on June 1 to end of crop.

Note: Keep stems 3/8 to 1/2 inch thick.

- B. For a two crop system (fall crop seeded in July, transplanted in September, harvested October through December; the spring crop seeded in late November, transplanted by early January and harvested March through June), use the following:

- Forty percent to 50% concentration of nutrient solution after transplants are set in the greenhouse on both fall and spring crops. Keep micros at 75%.
- Change to 85% to 90% concentration by the time of first bloom on fourth truss for both the fall and spring crops. Keep micros at 100%. Continue with this concentration until end of fall crop.
- Increase to 100% concentration by the time of first bloom on fifth truss of spring crop.
- Drop to 75% concentration on May 1.
- Drop to 60% concentration on June 1 until end of crop.

Note: Keep stems 3/8 to 1/2 inch thick.

Nutrient Requirements for Tomatoes Grown in Pine Bark Fines

Fertilizer Nutrient	Transplant to 4th Cluster	4th Cluster to 6th Cluster	6th Cluster to Maturity
• • • • • Parts Per Million • • • • •			
Nitrogen	70-90	90-110	110-125
Phosphorus	24	40	48
Potassium	150-200	200-250	250-300
Calcium	90	100-150	150-175
Magnesium	25	40	50
Iron	1.5	2.5	3
Manganese	1	2	2
Boron	0.5	1	1
Zinc	0.2	0.4	0.4
Copper	0.1	0.2	0.2
Molybdenum	0.1	0.1	0.1

Adapted from Mississippi Cooperative Extension Service Pub. 1828

Recommended Levels of Fertilizer Elements in Tomato Leaf Tissue

Element	Percent	Element	PPM
Nitrogen	4.0-5.5	Iron	100-250
Phosphorus	0.3-1.0	Manganese	40-300
Potassium	4.0-7.0	Boron	35-100
Calcium	1.0-5.0	Zinc	30-150
Magnesium	0.4-1.5	Copper	5-25
		Molybdenum	0.15-5.0

Adapted from Mississippi Cooperative Extension Service Pub. 1828

These guidelines may need to be altered as dictated by weather conditions. For example: During extremely high incidence of cloudy weather in winter, the 120% to 130% concentration of nutrient solution may need to be continued through February. Also during extremely high incidence of sunny weather in May, the concentration may need to be dropped to around 60% before June 2. Watch the stem.

The balling of the new growth may serve as a guide to alter the nutrient solution concentration. In general, the nutrient solution concentration is too high when the tops of the plants are balled. Also the stem size can serve as a guide to nutrient solution concentration. When the stem size is too small (pencil size), the concentration may be too low. These characteristics are mainly true in sand culture when at least 25 ml of nutrient solution are leached per plant per day. Other deficiency symptoms are in 'Troubleshooting Greenhouse Tomatoes' section.

When nutrient flow technique (NFT) is used, these guidelines for changing concentration of the nutrient solution may not be as timely as that for sand culture. As a result, it's better to observe the plants closely for abnormal growth indicators (such as balling of the tops and small stems) and then drop or increase the concentration as needed. For example: With balled tops in NFT, drop the concentration gradually (15% - 20%) until the balling symptoms disappear and then increase the con-

centration until just a trace of balling occurs. For thin stems, increase the concentration gradually until the new stem becomes enlarged above the original spindly section.

Preparation of Micronutrient Concentrate

Obtain a 5-gallon plastic bucket with lid. Add 16 liters of water to the bucket, and set bucket on a level surface. If you have no easy method of measuring 16 liters of water, add 17 quarts of water then remove one-third cupful from the total in the bucket. The water remaining will be very close to 16 liters. With a waterproof marker or with a file, make a line around the inside of the bucket at the surface of the water. This line is the 16-liter reference mark to which the bucket will be filled with water after all the micronutrient ingredients have been added.

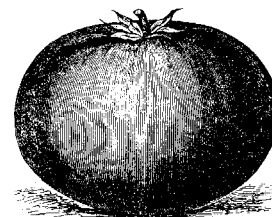
Weigh the powdered boric acid and place in bottom of empty bucket. Add sufficient water to make a thick paste while stirring with a piece of plastic pipe. Add about 3 gallons of water and continue stirring until boric acid is dissolved. It usually requires about three minutes of stirring. If boric acid crystals are used, heat the water or use hot water from hot water tap.

Weigh the other micronutrient ingredients, and add them to the boric acid solution while stirring. Use fine or small crystal copper sulfate because the coarse crystals require considerably more stirring time than the fine. There is no special order in adding these to the boric acid solution.

After all the ingredients are apparently dissolved, add 10 milliliters to concentrated sulfuric acid. Pour acid slowly into the micronutrient concentrate to avoid any possibility of splashing the acid on yourself. The acid maintains sufficiently low pH to keep the micronutrient elements from dropping out of solution by precipitation. When agricultural grade manganese sulfate is used, there will always be a slight amount of gray undissolved material in the bottom of the bucket. Ignore it.

Fill the bucket with water to the reference mark as described. Cover the bucket, and store out of the reach of children.

The 16-liter batch of micronutrient concentrate is sufficient for preparing 8,000 gallons of 100% dilute, ready-to-use nutrient solution. Thus, for example, if you wish to add the individual micronutrients directly to a 1,000-gallon tank rather than prepare a concentrate, weigh one-eighth of each ingredient given in the micronutrient concentrate table. If you have an 8,000-gallon tank, you can add the amount given in the table to the tank.



Varieties

Here are red fruited varieties recommended for growing in a greenhouse in Louisiana. These have performed well in experimental trials and also in commercial greenhouses in the state.

- **Tropic** - average fruit size 8 to 9 ounces; nitrogen sensitive; Fusarium (Race 1), Verticillium and some leaf mold resistance; the old standard. OK for lower input production.
- **Jumbo** - similar to Tropic, but more number 1 fruit and green shouldered. OK for lower input production.
- **Trust** - fruit average 6 to 8 ounces; great disease resistance including Fusarium crown rot. This dependable, new generation hybrid has become the standard cultivar and should be used to learn basic production practices. It grows in soil or synthetic mixes. Some problem with fruit crack in high humidity and short shelf life.
- **Blitz or Match** - much like Trust.
- **Caruso** - fruit average; 7+ ounces; semi-green shouldered, good disease resistance but lacks crown rot resistance; excellent flavor.
- **Quest** - tasty fruit, average 7-8 ounces; great production; brittle, crooked vines with larger leaves; allow 4.5-5 sq. ft. plant.
- **Geronimo** - large 9.5 ounce, fruit are very sweet; good yields on very tall plants.
- **Clarence** - good "cluster harvest" type but small fruit. (4 fruit/lb); high yielding, tall plant.

Note: New hybrids are often sold by the seed; 1/5 ounce produces about 1,200 good plants.

A satisfactory container for storing small quantities of seed can be made from a wide-mouth jar with a tight cover. Cut a piece of hardware cloth or coarse plastic screening to fit bottom of jar. Place 3/8 to 1/2 inch of a drying agent such as anhydrous calcium chloride, calcium oxide or silica gel in the bottom of the jar and fit the hardware cloth or screening over it. Packets of seed can be placed on this rack and the jar sealed. Place sealed container in a refrigerator at 32 to 35 degrees F. Experimental work indicates that tomato seed have been stored under these conditions for 13 years with no reduction in germination of the seed or yield or resulting plants. The actual age of tomato seed is of much less importance than the environment in which they are stored; it must be cool and dry.

Two systems of producing plants can be used: (1) seeding directly into small pots and containers such as peat pots, cubes, etc. or (2) seeding in a flat and later transplanting into containers when plants show first true leaves. The first method involves less hand labor and causes less transplant shock to the plants.

The second method may produce a stockier transplant and allows further selection of plants.

Larger pots, up to 4 inches, produce better plants. The medium used to germinate the seed or grow the plants should be free of disease organisms. Either sterilize the

medium with chemicals or heat or use a commercial sterile potting medium (for example, Jiffy Mix, Promix, Metromix, etc.).

A third system looks promising. Start seed in a synthetic mix and grow until true leaves and a well-formed growing point are obvious. Select the normal, strong growing plants (there may be 10% of poor quality) and transplant into permanent grow bags. These plants have minimal transplant shock and less stem restriction.

Here are several mixtures you can mix and use.

- 1 part perlite, 1 part peat moss, 1 part vermiculite
- 1 part garden soil, 1 part peat moss, 1 part perlite or sand
- 2 parts garden soil, 1 part sand, 1 part peat moss
- 2 parts sand, 1 part peat moss
- 1 part peat moss, 1 part vermiculite

(Include 8 to 10 pounds dolomitic limestone per cubic yard of mix with each of these combinations.)

It will be necessary to water the plants grown in these homemade mixes with a soluble complete fertilizer high in phosphorus like 15-30-15 or use a 20-20-20.

Producing Transplants

To ensure that healthy plants will be ready when needed, greenhouse operators should grow their own plants. The best time to sow seed for the fall crop is late July through early August. Plants which are about four weeks old are then transplanted into the greenhouse in September when greenhouse temperatures can reasonably be controlled. If the two-crop system is used, the winter crop is sown toward the end of November and transplanted about six weeks later in early to mid-January. Transplants should generally be set into beds at least a week before the first flowers open.

One ounce of tomato seed contains from 7,000 to 12,000 seeds. With a standard 75% germination, this should produce 5,000 to 9,000 healthy plants. It is a good practice to grow 10% to 20% more plants than needed to ensure a sufficient supply of healthy plants. The cost of good seed is insignificant compared to the other costs of growing a crop.

If seed has not been previously treated (check seed packet), it could be treated before planting with a fungicide to reduce plants lost to damping off.

Place seeds 1/4 inch deep in the seedling growing mix. Maintain a high level of moisture in the growing mix, but don't drown the plants. Flats and other containers can be covered to prevent water loss, but remove these covers as the first seedling emerges. A growing mix kept at 75 to 85 degrees F will sprout seeds in three to five days. When most plants have sprouted, move them to full sun exposure. Transplants grow best at 70 to 80 degrees F day temperatures with night temperatures about 60 to 65 degrees F. Under cool, cloudy conditions, drop temperatures to 70 to 75 degrees F days and 60 degrees F nights.

Fertilize plants each week or two with a soluble complete fertilizer made to half strength. A good transplant (Figure 1) has a sturdy stem and is about as wide as it is tall.

Transplanting

Set transplants in the soil 1 inch deeper than they were previously grown. If transplants are tall and spindly, set them on their sides in a shallow trench, allowing 6 to 8 inches of the shoot to extend above the soil.

Figure 1

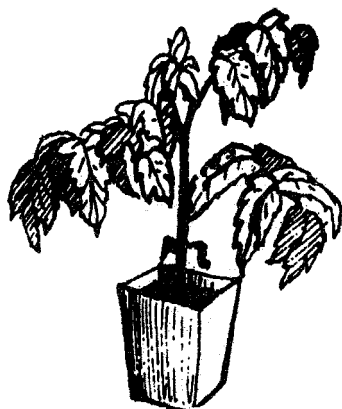
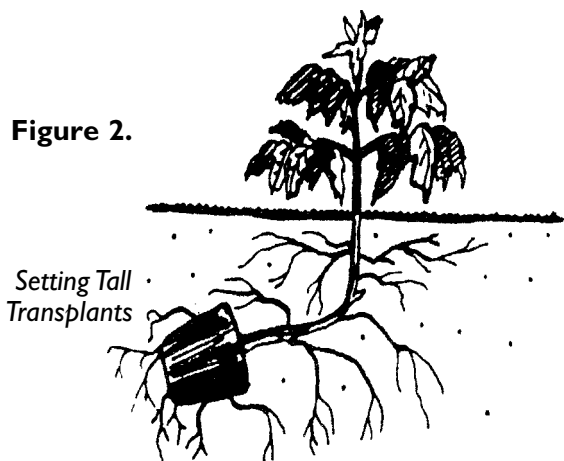


Figure 2.



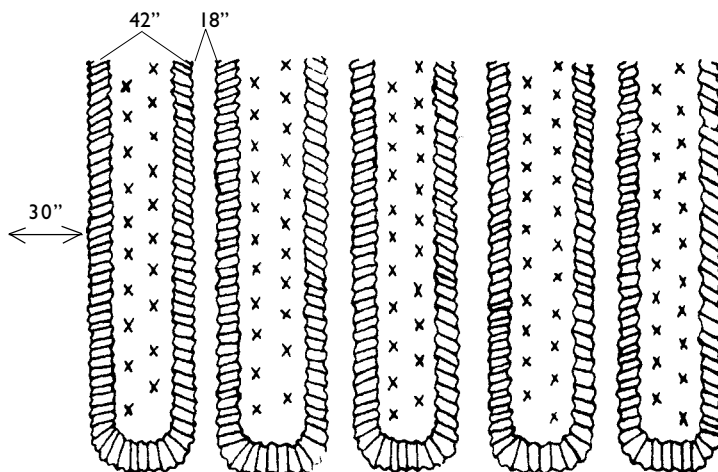
The number of plants needed will depend on row and plant spacing. A recommended plant spacing in soils is 18 inches between plants and about 36 inches between rows. This allows 4.1 square feet per plant. Plants may grow as close as 3 1/2 square feet per plant. In an average 30 x 100 house using the recommended plant spacing and beginning the first row 3 feet away from the side, about 540 plants will be required (9,680 plants/acre). The plant spacing in the row for various row widths to provide about 10,000 plants per acre follows.

Plant Spacing in Row (Inches)	Row Width (Inches)
21	30
19.5	32
18.5	34
17.5	36
16.5	38
15.5	40
16	39
18	35
20	31
22	28.5

To use the table for variable row spacings, average the row widths and use this average for determining the plant spacing in the row. For example, many growers prefer an average row spacing of 36 inches by alternating 40-inch rows with 32-inch rows. The plant spacing from the table for 36-inch rows is 17.5 inches for about 10,000 plants per acre (actually 9,956 plants per acre). A fall crop population should run 9,500 to 10,000 plants per acre. The spring crop population could be boosted by about 10%. Remember that higher population means greater risk from plant pests and more attention needed by plants.

Another scheme (Figure 3) allows an extra row of plants by using five double-row beds for this same size house. Each bed is 42 inches wide with 18-inch service aisles. Planting 18 inches within the row and staggering or offsetting rows within a bed will require about 590 plants (11,422 plants per acre). Rows should be about 20 inches apart in bed.

Figure 3



The scheme in Figure 3 is a high density population and should be considered only by an experienced grower. Fertilizer should be increased accordingly.

Training and Pruning

The plants are trained to a single main stem by removing all side shoots (called suckers) as they develop where a leaf joins the stem (Figure 4). All but the topmost sucker should be removed weekly while they are still small (3 to 4 inches long). If the plant top is lost, train this sucker as a replacement.

Figure 4



The plants are usually supported by plastic or binder twine. One end of this twine is secured to the base of the plant with a loose non-slip loop or clasp. The other end of the twine is attached to overhead wires that run above the rows about 7 feet high and are attached to support structures. When first tying the young plant, slope the twine in the direction the plants are to be dropped. As the plant grows, the twine is wrapped clockwise around the plant with one complete spiral between each fruit truss or about every three leaves. Always wrap the twine in the same direction. You'll need clips or tape to keep the plant from slipping down the twine. You may clip without wrapping also.

When the plants reach the wire supporting the string, carefully lower the plants about 2 feet with tomato hooks or by loosening the twine and retying it. (The string is always cut about 4 to 5 feet longer than is necessary so the plants can be lowered.) Remove all leaves that lie on the soil.

Wood or metal stakes may also be used to support the tomato plants as is done with field-grown tomatoes.

About 40 to 45 days before end of harvesting, plants should be "topped" (top pinched out) so the food manufactured by the plant can mature the fruit already present. Continue to remove suckers.

Leaf Pruning

As the lower clusters of fruit approach maturity, prune off older leaves up to these clusters. This provides for better air circulation, helps to reduce the incidence of disease and facilitates harvesting and spraying. Snap leaves off where they join the stem.

Fruit Pruning

Continually observe newly set fruit and remove any that are deformed since these will be culls or third rate fruit when mature. The food produced by the plant can then be used to mature the well-shaped fruit. If clusters

set too many fruit, their chances of breakage are greater. Therefore, you may want to leave only a maximum of three or four perfect fruit on a cluster.

Pollination

Because of little air movement and high humidity inside greenhouses, tomatoes grown indoors require mechanical pollination to get a good set and high yield of number 1 fruit. The general shape, size and smoothness of the fruit are largely determined by the thoroughness of pollination. Artificial pollination is accomplished by touching the flower stalks with a rapidly moving electric vibrator. The vibration releases the pollen necessary for pollination. This should be done once between 10 a.m. and 3 p.m. every other day or every day when the skies are cloudy or overcast. On rainy days, raise the house temperature to 75 degrees F, pollinate and then drop back to 70 degrees F.

The electric vibrator is the most effective method of pollination. Blowers also can be effective, but tapping strings may lead to plant damage or fruit drop.

Some use special bumble bees for pollination. They are effective but expensive. The hive must be maintained and protected from harmful pesticides. High temperatures limit the longevity of the hive.

The time required for a tomato to develop and ripen after pollination varies with the season: in winter, about 60 days; in late fall and early spring, about 55 days; and in the hot months, 40 to 45 days. A house kept too cool will lengthen these periods.

Factors responsible for poor fruit set are:

- 1) Extremes in temperature - daytime temperature over 90 degrees F, nighttime temperature below 60 or above 70 degrees F
- 2) High humidity - causing pollen to stick
- 3) Low light intensity - several days of overcast or cloudy skies; poor light transmission through the material covering the greenhouse
- 4) Imbalance of nutrients - especially boron, iron and manganese or high nitrogen
- 5) Diseases - especially Botrytis when found on flowers
- 6) Starvation
- 7) Drought
- 8) High total salts

Temperature and Humidity Control

Controlling temperature is one of the most effective ways to control plant growth. Ideally the temperature should be determined to some extent by the light conditions on the outside. When light is limited by overcast skies, the daytime temperature of the greenhouse should be lowered to about 70 degrees F. With low light intensity and high temperatures, the rate of food manufacture (photosynthesis) is less than the rate of respiration or food use. On clear days the temperature ideally should range around 76 degrees F. It may go as high as 85 degrees F on clear days without affecting fruit set or development. The temperature around the flowers should never go

below 60 degrees F because this can result in poor pollination and thus fewer fruit, or misshapen fruit will set. The nighttime temperature should be maintained about 60 to 62 degrees F after a cloudy day and 62 to 64 degrees F after a sunny day. Some mixing of outside air after sunrise is beneficial to recharge carbon dioxide and control humidity.

Proper ventilation is necessary to help control certain diseases, maintain proper temperature and to keep a sufficient supply of the carbon dioxide that plants need for photosynthesis. The relative humidity inside the greenhouse should always be held below 90% to keep leaf mold under control. With cool, cloudy weather it's a good idea to ventilate in the morning to dry the plants. One can also periodically heat or ventilate to dry the air and recharge the carbon dioxide.

Typical Two-crop System Operating Schedule for Louisiana:

	Fall	Spring
Plant seeds in plant beds or flats	Late July - early August	Nov. 25-30
Set plants in greenhouse	Sept. 1-10	Jan. 2-10
Spray plants for disease and insects (as directed on label)	- Every 7 to 10 days -	
Begin vibrating flower clusters 4 times per week	- When blossoms appear -	
Begin harvesting about	November	March
End of harvest	Dec. 30	June 1-10
Yield per plant (average)	7 to 9 lbs.	11 to 14 lbs.

Harvesting

The fruit must remain on the vine as long as possible to be of highest quality. Tomatoes increase in size, flavor and weight after they first begin to turn red. Fruit grown for local markets can stay on the vine one day longer than those to be shipped. Plants are harvested two to three times a week.

The stage of maturity at which the fruit is picked may depend on the market requirements. Normally greenhouse fruit should be at the "light red" stage. At this stage more than 60% of the surface shows pinkish-red or red, but not more than 90% of the surface is red. Markets may require "pink" (30% to 60% color) or "red" (more than 90% color) fruit. Group fruit by size and color. If cracking skin is a problem, harvest at 10% to 30% color.

All ripe fruit heading directly for market should be cooled to 55 degrees F directly after picking. Fruit treated this way will have maximum shelf life, yet maintain high quality. Market storage should be 60 degrees F and never drop below 50 degrees F. If fruit are picked a little early, do not cool. Hold at about 70 degrees F until the desired color has developed before cooling for shipment. When washing, use water as warm as or warmer than the fruit to reduce post-harvest cracking.

Marketing

Your marketing skills can mean 20 cents to 30 cents per pound more for your fruit. Moving produce is seldom a problem, but getting a premium price requires marketing skills and the ambition to cultivate marketing outlets. This publication provides basic production techniques but does not cover market development in detail.

Greenhouse tomatoes are a specialty product and should be sold as such. Growers should separate produce into two to three grades and base sales on these grades. The market outlet often designates what grades and standards it will accept. The USDA standards for greenhouse tomatoes can be obtained from a copy of "United States Standards for Grades of Greenhouse Tomatoes," (31 F. R. 5939) effective April 19, 1966; located at the following Web site: www.ams.usda.gov/standards/tomatogr.pdf.

Some growers place personal labels on the blossom end of each fruit. This identifies the product as produced in a greenhouse. Flats or shipping cartons of 8 or 10 pounds have been used. Some containers have two layers and will hold 16 or 20 pounds. The containers must be sturdy enough to prevent mechanical damage from compression and vibration, yet be well ventilated for rapid cooling. A 6-inch toss can cause a moderate-to-severe bruise on a pink tomato. Ripe, warm fruit are most susceptible to mechanical damage.

At delivery, make the retailer aware of proper holding temperatures and the importance of advertising the display. To be a dependable outlet, the outlet must be guaranteed of a dependable source. During cloudy periods in mid-winter, the failure of blossoms to set fruit will result in low yields beginning about seven weeks later. The grower may warn the outlets of the upcoming shortage or pool with other growers to try to meet quotas for specific grades.

Average wholesale prices for field-grown tomatoes at New Orleans markets show two peak periods: a winter high from mid-October through January, and a spring high for April and May. Greenhouse growers should harvest heavily during these high price months to compete better in the market.

Profits

Producing greenhouse tomatoes is an exciting concept that offers an opportunity for some people to increase their net income. It is, however, not a get-rich-quick operation. Considerable labor, knowledge and attention are required to make even a modest profit.

The cost of producing and marketing greenhouse tomatoes will vary from operation to operation. Structural costs for one grower may be triple those of another, and it does not follow that the more expensive house will produce that much more. For greatest profits, start small with inexpensive structures and then grow into the type of structure and size of operation that meet the demand of the available markets.

Estimated costs and returns per greenhouse. Fall greenhouse tomatoes (660 plants in grow bags), 1998.

Item	Unit	Price	Quantity	Amount	Your Farm
		dollars		dollars	
Direct Expenses (non-labor)					
Fertilizer	greenhouse	345.00	1.0000	345.00	_____
Fungicides	greenhouse	162.00	1.0000	162.00	_____
Insecticides	greenhouse	21.95	1.0000	21.95	_____
Pack and Harvest Items	greenhouse	321.60	1.0000	321.60	_____
Stakes and Twine	greenhouse	146.34	1.0000	146.34	_____
Plants	greenhouse	509.85	1.0000	509.85	_____
Custom	greenhouse	250.00	1.0000	250.00	_____
Diesel Fuel	gal	0.85	300.0000	255.00	_____
Electricity	kWh	0.09	687.2000	151.85	_____
Repair and Maintenance	greenhouse	128.97	1.0000	128.97	_____
Interest on Op. Cap.	greenhouse	175.18	1.0000	175.18	_____
Direct Expense (Labor)					
Hired Labor	greenhouse	2152.50	1.0000	2152.50	_____
Harvest Labor	greenhouse	990.00	1.0000	990.00	_____
Operator Labor	hour	7.50	50.0000	375.00	_____
Total Direct Expenses				5985.24	_____
Total Fixed Expenses				1987.50	_____
Total Specified Expenses				7972.74	_____

Estimated costs per greenhouse. Spring greenhouse tomatoes (660 plants in grow bags).

Item	Unit	Price	Quantity	Amount	Your Farm
		dollars		dollars	
Direct Expenses (non-labor)					
Fertilizer	greenhouse	575.00	1.0000	575.00	_____
Fungicides	greenhouse	178.20	1.0000	178.20	_____
Insecticides	greenhouse	24.14	1.0000	24.14	_____
Pack and Harvest Items	greenhouse	691.20	1.0000	691.20	_____
Stakes and Twine	greenhouse	77.40	1.0000	77.40	_____
Plants	greenhouse	231.00	1.0000	231.00	_____
Custom	greenhouse	250.00	1.0000	250.00	_____
Diesel Fuel	gal	0.85	701.1000	595.94	_____
Electricity	kWh	0.09	1603.2000	144.29	_____
Repair and Maintenance	greenhouse	88.82	1.0000	88.82	_____
Interest on Op. Cap.	greenhouse	177.70	1.0000	177.70	_____
Direct Expense (Labor)					
Hired Labor	greenhouse	2415.00	1.0000	2415.00	_____
Harvest Labor	greenhouse	900.00	1.0000	900.00	_____
Operator Labor	hour	7.50	51.0000	382.50	_____
Total Direct Expenses				6731.18	_____
Total Fixed Expenses				650.50	_____
Total Specified Expenses				7381.68	_____

Effects of yields and prices on net returns per tomato greenhouse above total direct expenses.

Yield (boxes)	Price per 20 lb. Box				
	\$18	\$20	\$22	\$24	\$26
Net Returns Per Acre					
500	-3126.42	-2126.42	-1126.42	-126.42	873.58
600	-1571.42	-371.42	828.58	2028.58	3228.58
700	-16.42	1383.58	2783.58	4183.58	5583.58
800	1538.58	3138.58	4738.58	6338.58	7938.58
900	3093.58	4893.58	6693.58	8493.58	10293.58

Troubleshooting Greenhouse Tomatoes

A. Plants wilt - Wilting plants usually indicate a root problem or broken stem. Excessive moisture and low oxygen will inhibit root functions. High soluble salts withhold moisture from roots and slow root growth. Excessive ammonium salts in the soil are toxic to tomato roots and can lead to root and stem degeneration. A temporary wilt may appear when the evaporative demand exceeds the moisture supply. Although this is not destructive to the plant, it delays new growth.

Wilts may indicate a root system damaged by pathogens such as nematodes, bacteria or fungi. Nematodes cause galls or knots to form on the roots and interfere with nutrient and water uptake. Bacterial wilt usually appears quickly, and the plants often wilt overnight. Fungal wilts are usually slower. Discoloration in the vascular system in the lower stem may indicate the presence of a disease pathogen. Several fungal wilts occur in greenhouse tomatoes, including *Fusarium* wilt, *Fusarium* crown rot and sclerotial blight (*Sclerotinia* sp.)

B. Leaf symptoms - Leaf discoloration without necrosis may be caused by a nutrient deficiency or disease. A general purplish color on the underside of dark leaves indicates a phosphorus deficiency. Lower leaves with mottled (blotchy) or spotty dead areas along the leaf margins and veins may indicate a potassium deficiency or fungal leaf spot. Lower leaves whose interveinal tissue is becoming chlorotic while veins remain dark green indicate a lack of magnesium. Upper leaves appearing netted because of chlorotic leaf tissue and small veins remaining green indicate manganese deficiency. Uppermost leaves becoming chlorotic from the leaflet bases toward the tips (veins remaining green in the early stages) with little or no necrotic (dead) areas indicate iron deficiency. Mid-range and lower leaves with chlorotic areas associated with veins and necrotic areas indicate a manganese toxicity (usually associated with soil steaming or low pH). Upper leaves turning a very dark green with shoot tops that are stunted and curled down (inward) and bushy indicate a boron deficiency (also check for splits in upper stem). When plants stop growing and develop small, pale leaves that exhibit a variety of nutrient deficiencies, the plants

may be underfed.

Numerous viral diseases can affect tomatoes, but only a few occur in greenhouses. The most common viruses are probably tomato spotted wilt virus, cucumber mosaic and tomato mosaic virus. Symptoms of spotted wilt disease can be varied but typically include brown to purplish spots on young leaves, abnormal growth pattern with part of plant more stunted than the rest, leaves curled to give a wilted appearance and death of the top of the plant. Infected fruit usually is mottled yellowish-red with ring spots. The virus is transmitted with thrips. Control depends on keeping thrips out of the greenhouse. A plant-free zone around the greenhouse is useful for this as well as using insect barrier screens over vents and other openings. Infected plants must be removed from the greenhouse area to reduce spread. Insecticides used to control thrips do little to prevent spread of the virus.

Cucumber mosaic can usually be identified by leaves that are much narrower than is typical. This is often referred to as a "shoe-stringing" of the foliage. The affected leaves also often have a mosaic pattern of uneven green coloration. Infected plants will produce less yield. This virus is transmitted by aphids. Insect barrier screens can help to reduce aphid movement into greenhouses. Remove plants with symptoms.

Tomato mosaic virus was once common in greenhouse tomatoes, but using varieties with resistance to the virus eliminates this problem. The virus can cause mosaic patterns with different intensity of color on the foliage. Leaves can be misshapened and plants stunted. Fruit yield may be reduced, and some of the fruit may be deformed.

Gray mold (*botrytis*) causes brown, necrotic (dead) spots on leaves. A gray fuzzy mold growth is often evident on dead leaves which had been infected with the gray mold. Gray mold can occur on foliage, stems and fruit. The disease is most easily identified when the fungus produces spores that give the infected tissue a fuzzy graying brown appearance. Infections often begin to develop on the older tissue of plants, particularly foliage and flower parts, and at pruning wounds. In a greenhouse, the disease can spread rapidly and cause severe crop loss from dead plants and rotted fruit.

The pathogen needs either moisture on the plants or a relative humidity level of 90% or higher for infection to occur. Temperatures that favor infection range from the low 60s to the mid 70s.

Early blight is not common on greenhouse tomatoes, but occurs occasionally. In such cases the leaves exhibit dead spots which have a ring or bull's-eye pattern. This begins on older leaves first and gives a "fired" appearance to the plant.

If lower leaves begin to turn yellow (especially if only one side of the plant or one side of a leaf) and wilt sets in, suspect *Fusarium* wilt. To be sure of this wilt, check for a dark-brown discoloration of the woody tissue in the lower stem. No soft decay of central pith is generally found. Irregularly shaped leaves (straplike, mottled or puckered) may indicate a virus or herbicide damage (especially 2,4-D or phenoxy chemicals). If most plants

show this symptom and plants with minor symptoms seem to grow out of it, it probably is an herbicide injury. Leaves with a sooty-black, sticky covering may indicate a sooty mold disease brought on by whiteflies or aphids.

If tunnels appear in the leaves (between the upper and lower surfaces), a thin tunnel indicates a leaf miner and a larger tunneled area is either a pinworm (dark larva) or a potato tuberworm (cream larva). Leaves that look grayish, light and hazy upon closer inspection may show tiny silk threads with spider mites infesting the surface.

C. Stem symptoms - A thickened stem with a vertical split or crease indicates a boron deficiency. The collapse of young seedlings may indicate an attack by damping off fungi. Brown decay of mature stems at the soil line accompanied by a white fungal growth in which is found light brown sclerotia bodies (size of cabbage seeds) is southern blight. This blight first shows as a general wilting of leaves. A mature plant which has a rotten lesion or collar on the lower stem may have stem rot. Plants with stem rot wilt slowly and, when older lesions are cut open, large (1/4 inch) hard, black, sclerotia bodies are found. Slowly enlarging stem lesions which form a gray or brown, powdery growth during cool, damp periods are probably botrytis stem rot.

D. Fusarium Crown and Root Rot - The fungus that causes this disease, *Fusarium oxysporum*, is a soil organism that invades the roots and ground level stem of tomato plants. The obvious symptom is wilting of plants; plants may also be stunted. Some infected plants die; others may continue to wilt until the season is nearly complete. The most effective control for this disease is to use resistant varieties. Once this organism is established within the greenhouse, it's difficult to eliminate.

Pythium Root Rot: In tomato greenhouses in the South, root rot disease is often caused by *Pythium* fungus. This soil fungus can be introduced into greenhouses in non-sterile media and spread quickly through an irrigation system. The disease usually develops on plants grown in poorly drained media. The pathogen attacks the root system, causing the foliage to become yellowish and the plants to wilt. Diseased plants should be removed quickly and carefully from the greenhouse to avoid spreading soil or growth media that contain the fungus. Do not reuse growth media that contained *Pythium* infected plants.

E. Fruit symptoms - If the blossom end of the fruit develops a dry, leathery, black, sunken area, then the plant has blossom-end rot. Irregular watering, low soil calcium and high N fertilization may have brought this on. Tomatoes with malformation and scarring at the blossom end (catfaced) have undergone some disturbance during blossoming and pollination, and the tissues of the pistil have developed abnormally. A zipper-like running from top to bottom is an anther scar. This scar is caused by failure of the anther to detach after pollination is complete. Small, dark green specks 1/8 inch in diameter that may become corky are fruit pox.

Streaking, sunken lesions and malformations may be caused by one of several viruses that attack tomatoes. Cracks radiating from the stem end or circling the shoulder are growth cracks. An irregular split in the side or

bottom that looks as though someone dragged a razor over the surface is a fruit burst. It is caused by excessive soil moisture. A wash in cool water may do this also. Large, whitish-yellow patches on the fruit which may have firm or shrunken skin are sunscald injuries. Gray-brown blotches on and in the fruit's wall indicate either graywall, internal browning or blotchy-ripening. Green shoulders or calloused shoulders result from high temperatures.

If fruit are light in weight with slightly flattened sides, the internal seed cavities may be somewhat hollow; this symptom is called puffiness or pockets. It is caused by lack of good seed development. Fruit which develop irregularly with bulges, pointed bottoms or spurs are classified as misshapen. Holes chewed into the fruit wall indicate tomato fruitworms. Small holes found in the fruit and under the sepals indicate pinworms.

F. Failure of flowers to set fruit - see Pollination

Note: This list of symptoms includes the most common problems. Others may arise also. No attempt is made here to identify the potential causes or cures. Consider each situation individually. For insect and disease control, see the appropriate sections in this publication or contact your county agent. The publication "Tomato Diseases and Their Control," ARS, USDA Agriculture Handbook #203 is available from the U.S. Government Printing Office. It is a more complete review of tomato diseases and disorders.

Disease Control

Consider these points in your disease control program:

1. Select a sunny site that is well drained.
2. Sterilize soil with one of the soil sterilants or fumigants listed (Vapam or Volex).
3. Provide good air circulation with exhaust fan (provide one air change per minute minimum). Use this to dry the house.
4. The watering system should keep the soil moist, but not water logged. Foliage and stem must not remain wet.
5. Spraying equipment should be efficient enough to cover all plant surfaces. A 3-gallon hand sprayer is a poor sprayer to use because of the lack of pressure it maintains.
6. Keep a supply of recommended fungicides on hand, and spray weekly. Check plants daily for diseases. The recommended fungicides are in the disease control table.
7. Take soil sample for soluble salts, nutrition, pH and nematodes.
8. Do not permit tobacco in the greenhouse. Viruses can be easily transmitted. Have tobacco users wash their hands before working.
9. Immediately after final harvest is completed, remove and burn all plant material.
10. Keep tomato refuse and weeds away from the area near fan intakes and doorways.

Below is a list of fungicides and bactericides. Rates are listed as amount of product per acre as on the labels. This of course is difficult to translate into actual greenhouse use. In general, use an estimate of 100 gallons per acre as a dilution rate for greenhouses. This list may not be complete, but it is a group of labeled fungicides that should include the most commonly used materials.

Fungicide	Disease	Rate
Exotherm Thermil	Gray Mold and Other Fungal Diseases	1 Can / 1000 sq. ft.; 2 -3 Cans / Bay.
Botran 75W	Gray Mold	1 lb / acre; 14-day pre-harvest interval
Quadris 2.08F	Early Blight, Target Spot, Powdery Mildew	6 oz / acre; do not use more than twice / crop; injury may occur on small plants.
Sulfur Fungicides	Powdery Mildew	Follow label.
Armcarb 100	Powdery Mildew	Follow label.
Nova 40W	Powdery Mildew	4.8 oz / acre; maximum 2 application / year; 3-day pre-harvest interval.
Kocide DF	Bacterial Diseases	2-4 lb / acre.
Agri-Strep	Bacterial Diseases	Follow label.
Agri-mycin 17	Bacterial Diseases	Follow label.
Dithane F-45	Bacterial & Fungal Diseases	Follow label; 5-day pre-harvest interval

Insect Control

Insects are perpetual pests on tomatoes, whether they be in the field, home garden or greenhouse. In addition to a host of sucking and chewing insects, many other arthropods feed on greenhouse tomatoes. Some begin feeding as soon as the seedlings emerge from the soil, and others feed on the mature plant and its fruit.

Effective control of greenhouse pests must be maintained for maximum production of quality fruit. Effective pest control can be achieved with certain cultural and chemical practices.

Inspect plants frequently to detect insect infestations before they cause severe injury. Any plant or group of plants with abnormal appearance should be examined immediately for insect pests.

Light infestations of some pests may be tolerated with no economic loss. Be sure an insecticide is needed before you apply one. Spot treatment may be effective when a pest is in only one part of the greenhouse.

Soil-associated Pests

Cutworms of several species may attack greenhouse tomatoes. About 1 ½ - 2 inches long when full-grown, cutworms can be gray, greenish or yellowish and usually have darker markings. They are nocturnal, hiding in the soil during the day and feeding at night. Most cutworms feed by cutting off plant stems at or slightly below the soil level. Climbing cutworms may climb the plant and feed on the fruit, lower stem or leaves.

Earwigs are elongated insects with prominent forceplike projections on their posterior

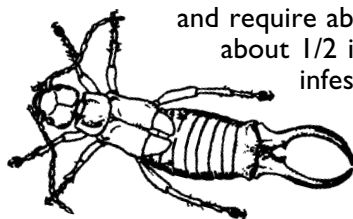
ends. They are from 1/2 - 1 1/4 inches long and are brown to black. When disturbed or mashed, they give off a disagreeable odor. Generally, earwigs are only a nuisance, but some species may become economic pests, feeding on tender vegetation and damaging the plants. They also feed on many small insects and are beneficial.

Springtails can occur in fantastically large numbers and still go unnoticed. They are minute insects that commonly occur in moist soils rich in organic matter. Seldom are springtails a major pest, but they may become so when they feed on young tomato seedlings.

Fungus gnats are small flies. Their larvae often attack stressed greenhouse plants. They are normally organic feeders. The adults are tiny grayish to black gnats with long legs. The larvae are nearly transparent maggots with black heads and are about 1/4 inch long when grown. In high numbers, larvae injure plants by feeding on the roots and root hairs. Their feeding causes a lack of plant vigor and yellowing of the leaves.

Sowbugs and **pill bugs** are not insects, but they are often grouped with insects in regard to their control. These are robust and distinctly segmented arthropods with several pairs of legs. They are light gray to slate colored and often roll up into a ball. They feed on the roots and tender parts of plants. Injury is usually observed near the soil level. The young resemble the adults and require about one year to reach their full growth of about 1/2 inch. All sizes usually can be found in an infested greenhouse.

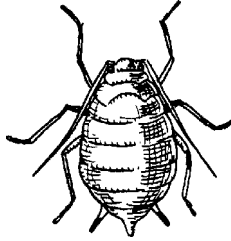
Snails and slugs can become economic pests in greenhouses. They feed on the fruit, flowers and tender parts of the plants and often cause severe injury to



seedlings. They prefer high humidity and are usually found in damper parts of the greenhouse. Both snails and slugs leave a trail of mucus where they crawl. This mucus is a silvery trail when it dries.

Sucking Insect Pests

Aphids are small, soft-bodied insects that insert their beaks into a plant and extract the plant juices. They can build to high numbers rapidly and can cause extensive leaf curling if not controlled. They also transmit serious diseases to greenhouse tomatoes. Aphid infestations may be detected by the presence of sticky honeydew on plants or by the black sooty mold that grows in the honeydew. Control measures should be applied before sooty mold is observed.



Whiteflies are common pests of greenhouse tomatoes. The adults are small white insects about 1/16 of an inch long. The larvae suck juices from the plants. Like aphids, whiteflies produce honeydew. Infestations are often located by finding honeydew or a black sooty mold on the plants. They also may be detected by shaking the plants and watching for them to fly from the plants. Yellow sticky traps are excellent for pest management.

Mealybugs often become pests on greenhouse tomatoes. The infestation can often be traced to ornamental plants brought into the greenhouse. They are recognized by the cottony masses on the stems and leaves. Mealybugs cause injury by sucking juices from the plant. Controlling these insects may be difficult.

Chewing Insect Pests

Leaf miners are the larvae of small flies or moths that feed between the upper and lower surfaces of leaves. They leave narrow, winding paths through the leaves. When abundant, they can reduce yields by defoliating the plants.

Thrips of several species attack greenhouse tomatoes. They are extremely small insects that feed by rasping away plant tissue and lapping up the exuding juices. Thrips can transmit spotted wilt and cause premature blossom drop. Heavily infested plants may show a silvery on the underside of the leaves. Flowers are one of their favorite foods.

Hornworms are large, green larvae that may reach a length of 4 inches. They are foliage feeders and can destroy a large quantity of foliage. In small greenhouses, they may be controlled by hand picking them from the plants.

Cabbage loopers are pale green larvae with whitish stripes running the length of the body. They move with a looping action. These pests are foliage feeders and can damage young plants severely, but large numbers on older plants will seldom reduce yields.

Tomato fruitworms are about 1 1/2 to 2 inches long when fully grown. They range from green to brown, have alternating light and dark stripes, and cause considerable injury.

Beet armyworms are indistinctly striped, green caterpillars about 1 1/2 inches long when fully grown.

They are primarily foliage feeders, but feed on fruit occasionally. At times they cause severe injury in tomato greenhouses.

Yellow-striped armyworms have two triangular spots on the back of each segment and a bright orange stripe outside these spots on each side. On each side, they have a median yellowish line. They are about 1 1/2 to 1 3/4 inches long when fully grown. They feed on foliage, but rarely do they defoliate the plants.

Tomato pinworms are one of the most serious pests of greenhouse tomatoes. Newly hatched larvae are orange, but they gradually darken to purplish-black as they mature. The larvae have a distinctive color pattern, which resembles a pair of spectacles on each segment. The full-grown larvae are about 1/4 inch long. Early feeding is on the foliage. Leaves are stuck together, and the larva feeds inside. Defoliation of the plants is possible. Later feeding is on the fruit beneath the calyx.

On young tomato plants, this insect invades the leaves and sometimes the stems. On large plants, injury consists mainly of leaf mining and folding of the lower leaves. In severe infestations, all leaves are attacked, and the plant may not set fruit. Fruit on heavily infested plants may be stunted or deformed. The greatest economic damage results from larvae boring into the fruit. They commonly enter the sides of fruit where two fruits or a fruit and leaf come in contact with each other. The primary injury occurs beneath the calyx.

Mites

Two-spotted spider mites are closely related to spiders and are not insects. This species is one of the most serious pests of greenhouse tomatoes. They feed on and injure tomato plants by sucking juices from the underside of the leaves. Infested leaves become stippled with gray and may be covered with a fine web. Heavy infestations cause extensive defoliation. The mites are yellowing to greenish and have a dark spot on each side. The life cycle is completed in about nine days, enabling an infestation to build rapidly.

Tomato russet mites in heavy infestations may give the fruit a russeted appearance and sometimes cause cracks to appear in the skin. The main stem of infested plants becomes brown, and much of the foliage dies and assumes a papery texture. These small, slender mites may be much longer than wide. They can complete their life cycle in about one week.

Cultural Control of Greenhouse Pests

Certain cultural practices play a significant role in reducing or eliminating many insect problems in greenhouses. These cultural practices will help control insect pests.

1. Spray around the greenhouse with an herbicide to keep a 3-foot area clear of weeds. Avoid running lights at night. Seal the greenhouse to prevent pests from entering. Use very fine mesh netting over ventilation fans.

2. Dispose of any trash, boards or old plant debris in the area.
3. Keep doors, screens and ventilation fan screens in good repair.
4. Use clean sterile soils, tools, flats and other equipment.
5. At the end of the season, remove all plants and any plant debris, clean greenhouse thoroughly and fumigate (see Insecticide Use Suggestions).

An ounce of prevention is worth a pound of cure.

Chemical Safety in the Greenhouse

When used as recommended on their labels, pesticides are safe and effective. All pesticides are poisonous, however, and, if misused, they may be hazardous to people and animals. They may also contribute to the pollution of the environment.

Before using any pesticide, read the label in its entirety. Note any special precautions, such as the necessity of wearing special protective clothing when applying the chemical. Follow all safety precautions on the label. The following suggestions will help you develop safe pesticide use practices in greenhouses.

1. Identify the insect to verify it is a pest.
2. Become familiar with the use of a pesticide before using it. Know its toxicity and the necessary precautions for its safe use.
3. Keep all safety equipment such as face masks, respirators and protective clothing on hand and in good working order.
4. When mixing pesticides, use a well-ventilated area or mix outdoors. Avoid contact with skin, and do not breathe vapors.
5. Do not save used pesticide containers. Dispose of old containers properly. Triple rinse and spray rinse waters.
6. Store all pesticides in a secure place away from pets, children and unknowledgeable people. Never store pesticides in unmarked containers.
7. Post caution signs during fumigation and after treatment of greenhouse to avoid contact with chemicals.
8. Apply correct dosage of the pesticide. Using less than the correct amount may result in poor control of the pest. Using more than the correct amount may result in excessive residue or damage to plants.
9. Obey specified time intervals between treatments and cut-off dates before harvest. A failure to observe these restrictions may result in excessive residue or damage to plants.
10. The use of certain chemicals may be phytotoxic to some varieties of plants. This should be checked before using a chemical.
11. Special restrictions apply to greenhouses connected to living quarters. Read label restrictions where this applies, and follow all restrictions carefully.

Table of Measures

Liquid:

- 1 level tablespoon = 3 level teaspoons = 14.8 milliliters
- 1 fluid ounce = 2 tablespoons = 29.57 milliliters
- 1 cup = 8 fluid ounces
- 1 pint = 2 cups = 16 fluid ounces
- 1 quart = 2 pints = 32 fluid ounces = 0.95 liter
- 1 gallon = 4 quarts = 128 fluid ounces
- 1 cubic yard = 202 gallons

Weight:

- 1 ounce = 28.3 grams
- 1 pound = 16 ounces = 454 grams
- degrees F = (C x 1.8) + 32
- degrees C = (F - 32) x 0.56

Dilution Tables

Wettable Powders

Number of ounces of wettable powder to use in small sprayers when amount per 100 gallons is known.

100 gals.	10 gals.	5 gals.	2 gals.	1 gal.
0.5 lbs.	0.8 oz.	0.4 oz.	0.2 oz.	0.1 oz.
1 lb.	1.6	0.8	0.3	0.2
2 lbs.	3.2	1.6	0.6	0.3
3 lbs.	4.8	2.4	1.0	0.5
4 lbs.	6.4	3.2	1.3	0.6
5 lbs.	8.0	4.0	1.6	0.8

Emulsifiable Concentrates

Number of fluid ounces of emulsifiable concentrate to use in small sprayers when amount per 100 gallons is known.

100 gals.	10 gals.	5 gals.	2 gals.	1 gal.
1 pt.	1.6 fl. oz.	0.8 fl. oz.	0.3 fl. oz.	0.2 fl. oz.
1 qt.	3.2	1.6	0.7	0.3
2 qts.	6.4	3.2	1.3	0.6
1 gal.	12.8	6.4	2.6	1.3

Mist Blower

Quantity of emulsifiable concentrate (EC) needed to make a 25X concentrate

If amount per 100 gals. for a high volume spray is	Use this amount in a mist blower:			
	25 gals.	10 gals.	2 gals.	1 gal.
1 pt.	6.25 pts.	2.50 pts.	8 fl. oz.	4 fl. oz.
1 qt.	6.25 qts.	5 pts.	1 pt.	8 fl. oz.
2 qts.	3.13 gals.	5 qts.	1 qt.	1 pt.
1 gal.	6.25 gals.	2.50 gals.	2 qts.	1 qt.

Your county agent can help you with dilutions.

Calculation of Greenhouse Volume

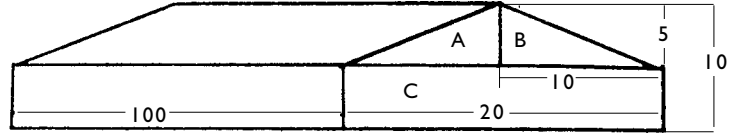
Even Span Structure

$$\text{Area A and B} = .5 (5 \times 10) = 25$$

$$\text{Area C} = 20 \times 5 = 100$$

$$\text{Total Area} = A + B + C = 100 + 25 + 25 = 150$$

$$\text{Volume} = \text{Length} \times \text{Total Area} = 100 \times 150 = 15,000 \text{ cu. ft.}$$



3/4 Span House

$$\text{Area A} = .5 (12 \times 5) = 30$$

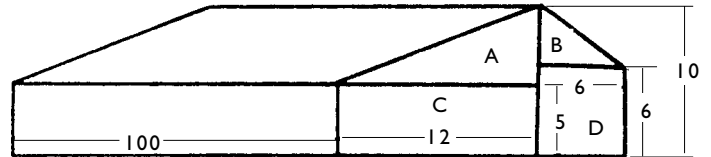
$$\text{Area B} = .5 (4 \times 6) = 12$$

$$\text{Area C} = 12 \times 5 = 60$$

$$\text{Area D} = 6 \times 6 = 36$$

$$\text{Total Area} = A + B + C + D = 30 + 12 + 60 + 36 = 138 \text{ sq. ft.}$$

$$\text{Volume} = \text{Length} \times \text{Total Area} = 100 \times 138 = 13,800 \text{ cu. ft.}$$



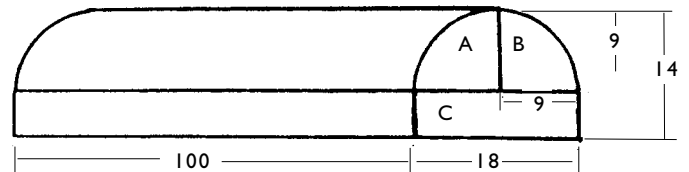
Roundtop Structure

$$\text{Area A + B} = .5 (r^2) = 127$$

$$\text{Area C} = 5 \times 18 = 90 \text{ sq. ft.}$$

$$\text{Total Area} = A + B + C = 127 + 90 = 217$$

$$\text{Volume} = \text{Length} \times \text{Total Area} = 50 \times 217 = 10,850 \text{ cu. ft.}$$



Insecticides for Greenhouse Tomatoes

Azadirachtin (aphids, whiteflies, thrips, leafminers, fungus gnats, caterpillars)

Azatin XL
Neemix
Ornazin

Bacillus thuringiensis subs. kurstaki (loopers, tomato fruitworm, other caterpillars)

Biobit HP
DiPel 2X
DiPel DF
Javelin WG

Bacillus thuringiensis subs. aizawai (loopers, tomato fruitworm, other caterpillars)

XenTari
Ketch DF

Bacillus thuringiensis subs. israelensis (fungus gnat larvae)

Gnatrol

Beauveria bassiana (whiteflies, aphids, thrips)

Botanigard WP
Botanigard ES

Cinnamaldehyde (aphids, mites)

Cinnamite

Dichlorvos (aphids, whiteflies)

DDVP
Vapona

Endosulfan (aphids, whiteflies, thrips, loopers, tomato fruitworm, other caterpillars)

Thiodan 50WP
Thiodan 3EC
Thiodan 10A
Fulex Thiodan Smoke (whiteflies and thrips only)
Phaser

Insecticidal Soap (aphids, whiteflies, mites, adult fungus gnats, thrips, caterpillars)

M-Pede 49EC
Olympic Insecticidal Soap 49.52CF

Malathion (aphids, loopers, thrips, mites)

Gowan Malathion 8EC
Gowan Malathion 8F
Malathion 10A, 57EC, 25WP (various generic brand available)

Methoxychlor (thrips)

Marlate

Neem Oil (aphids, whiteflies, mites)

Trilogy 70%

Nicotine (aphids, thrips)

Fulex Nicotine Smoke Fumigator

Paraffinic Oil (aphids, thrips, whiteflies, mites)

Prescription Treatment Ultra-Fine Oil

Pyrethrins + Piperonyl Butoxide (aphids, caterpillars, fungus gnat adults, whiteflies, thrips, mites)

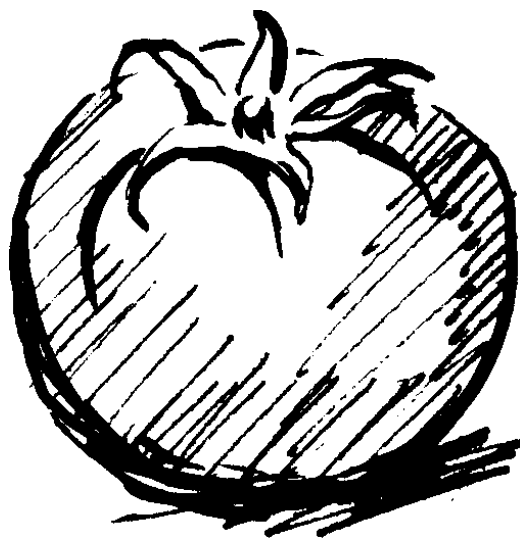
Pyronone

Pyrethrum + Rotenone (aphids, loopers, tomato fruitworm, whiteflies, thrips)

Pyrellin

Spinosad (tomato fruitworm, tomato pinworm, flower thrips)

Spintor 2SC (cannot be applied to transplants that will be used in the field)





Dr. Thomas J. Koske, Professor (Horticulture)
Dr. Mike Hall, Associate Professor (Entomology)
Dr. Roger Hinson, Professor (Agricultural Economics)
Dr. Dale Pollet, Professor (Entomology)
Dr. Randy Sanderlin, Associate Professor, Pecan Research Station (Plant Pathology)

Visit our Web site: www.lsuagcenter.com

Louisiana State University Agricultural Center

William B. Richardson, Chancellor

Louisiana Agricultural Experiment Station

David Boethel, Vice Chancellor and Director

Louisiana Cooperative Extension Service

Paul D. Coreil, Vice Chancellor and Director

Pub. 1808

(Online Only)

4/05 Rev.

Issued in furtherance of Cooperative Extension work, Acts of Congress of May 8 and June 30, 1914, in cooperation with the United States Department of Agriculture. The Louisiana Cooperative Extension Service provides equal opportunities in programs and employment.