A feasible method for organic fertilization of greenhouse tomatoes through drip irrigation
FNE 05-556

Project Contact Information

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Goals

The overall goal of our project was to increase our agricultural sustainability by reducing labor costs, increasing farm income, and conserving and protecting soil and water resources. To achieve this goal, we developed a feasible method of fertilizing our greenhouse tomato crop by applying liquid, organic fertilizer through a drip irrigation system. Due to the globular nature of organic fertilizers, they can clog drip irrigation systems. This is well documented by us as well as by other growers and agricultural researchers. Through changes to the drip irrigation system and the fertilizer dilution, we developed a feasible fertilization method, improving our sustainability and that of other growers who adopt our methods.

Farm Profile

We have run a vegetable farm full-time for the past 3 years in Little Compton, Rhode Island. The farm is 15 acres in size, including a 3000 square-foot greenhouse. We also have other farmland under lease elsewhere in the area that is not part of this project.

Participants

Our technical advisor for the project was Thomas Sandham of the Eastern RI Conservation District. Tom was in an advisory role on our soil and water conservation practices. He also reaches a wide network of vegetable farmers in the area, and was involved in the outreach portion of our project. Our two project collaborators are Dr. Douglas Cox, Floriculture Extension Specialist at the University of Massachusetts at Amherst, and Dr. Mary Peet, North Carolina State University. Dr. Cox has had a lot of experience with greenhouse drip irrigation, as well as with agricultural research in general. He assisted with our experimental design and our data analysis. He also spoke at our grower twilight meeting, held on July 13, 2006. He will be incorporating our results in an extension publication, which reaches many growers in the region. Dr. Peet has done extensive research on organic fertilizers and drip irrigation. She provided valuable guidance during the planning stages of the project.

Project Activities

In the spring of 2005, tomatoes, grown by us from organic seed, were planted in soilless mix in 3-gallon pots, spaced 18 inches apart in rows in the greenhouse. We used the paired comparison experimental design for our project. The treatments were as follows: (1) Treatment A, 1% dilution fish emulsion applied through the drip system at every watering and (2) Treatment B, 3% dilution fish emulsion applied through the drip system at every other watering. Each treatment included 100 single-plant replicates. Our control was hand application of the fish emulsion fertilizer, with hand watering. Watering for both treatments and the control was done as needed, approximately 3 times per week. As part of the project, we made some modifications to our existing drip irrigation system. We switched to a new, ½ horsepower, 40 pounds per square inch (psi) transfer pump. We also switched to larger, nonstop, 2 gallons per hour (gph) emitters. We diluted the fertilizer by putting the appropriate amount of fertilizer into a 300-gallon tank of water, agitating it with a large stake, then using the irrigation pump to pump the mixture to the drip system. The whole process, from setup to finish, took about one hour.

Our first try did not yield the results we expected. We believe this difference was not due to the treatments, but rather to other conditions. Once the plants were set up in the greenhouse for the experiment, we had to wait longer than we expected for the new drip irrigation system to come in before fertilizing the plants. Therefore, the plants went without fertilizer for longer than planned. At the start of the fertilizer treatments, the plants were already showing some signs of stress. Shortly thereafter, we had a fungus problem, which affected the whole greenhouse, including the experimental block. The experimental plants, already stressed, ended up losing several leaves. At this point, about 1 month into the project, we decided to end the experiment and try again at a later time.

We ran the experiment again starting in the spring of 2006. We used the same experimental design and treatments as in the first trial. This time around, the plants were very healthy and did not experience the stress and pest problems that the plants in the first trial had.

Results

A key result for the project, and a favorable one, is that we were able to pass the diluted fish emulsion through the drip irrigation system without clogging it up. The combination of the larger emitters used for the project and diluting the fertilizer with water helped to make this happen. Once we knew we could successfully get the fertilizer through the drip system to the plants, the next thing to focus on was which treatment produced the best plant growth and largest fruit.

Treatment B (3% fertilizer dilution at every other watering) resulted in the largest plants as measured by average plant height (See Figure 1, Average Plant Height and Pictures, IMG_2553.JPG). Treatment A (1% fertilizer dilution at every watering) and the Control (hand fertilizer application with hand watering) ended up just about the same with regard to plant size, although the Treatment A plants were smaller to start with (Figure 1).

Treatment A (1% dilution, every watering) resulted in the largest fruit as measured by average fruit diameter (Figure 2, Average Fruit Diameter). The control (hand application, hand watering) was next, while Treatment B (3% dilution, every watering) finished last for fruit size. Pictures of the fruit from the first harvest from each treatment are included as follows: Treatment A, IMG_2558.JPG, Treatment B, IMG_2559.JPG, Control, IMG_2560.JPG. The inside quality of the fruit when sliced is shown in picture IMG_2562.JPG.

Conditions

Although our greenhouse is a controlled environment, weather conditions did play a part in our project. The humid conditions during the spring of 2005 contributed to the fungus problems in the greenhouse, which eventually stopped our project and resulted in us running the experiment again during the 2006 season. We also had a slight difference in growth in plants that were sitting directly on the dirt floor of the greenhouse versus on a raised bed (see Pictures, IMG_2557.JPG). The plants on the floor grew larger, presumably because they were receiving extra moisture through the ground. This difference was slight, however, and did not skew the overall results of the treatments.

Economics

We found that being able to use the drip irrigation system to water and feed our tomatoes saved us money over the hand application and watering method we had used previously. For one, we used less water, and there was less water wasted from overspill onto the greenhouse floor. We use water from our own well for watering, so we did not have to pay for water. Each feeding using the drip irrigation system used approximately 300 gallons of water. Each feeding using hand application and hand watering used approximately 600 gallons of water. For farmers who pay for municipal water for their irrigation, they will cut their water costs in half using drip irrigation vs. hand watering. Secondly, the labor was cut in one third by using the drip system rather than manually feeding and watering the whole crop, one plant at a time. Feeding or watering with the drip system took 1 hour; feeding and watering by hand took 3 hours. Comparing either of the treatments to the control, with labor at $15/hour, there was a $30.00 savings per feeding or watering using the drip system. The plants were fed or watered approximately 3 times per week. The cost savings per week was $90.00. The plants were fed over a period of six months (from planting in April to final harvest in September). Therefore, our cost savings for the season is $810.00. Farmers using municipal water would add their water cost savings for the season to this figure. Considering this, there is definitely an economic benefit to using the drip system for organic fertilization of greenhouse tomatoes over hand application with hand watering.

Assessment

Given the results above, we would recommend using Treatment A, 1% dilution, every watering. Although this treatment did not result in the largest plants, it did result in the largest fruit. Since fruit size is a key marketability trait, we think it will be most beneficial to growers to use Treatment A. Again, the larger emitter size, fertilizer dilution amount, and dilution procedure were very effective in getting the fertilizer to the plants without clogging up the drip system. In addition to more efficiently feeding our greenhouse tomato crop, this system improved our sustainability by conserving water, time, and labor, and by reducing soil erosion.

Adoption

We plan to adopt the fertilization practice used in this project, using Treatment A, 1% dilution, every watering. The savings in time, labor, and money make it an economical practice for us. The increase in agricultural sustainability makes it beneficial for our operation as well as the environment.

Outreach

On July 13, 2006, we hosted a twilight meeting at our greenhouse. Farmers from all over the region were invited; several attended. Also in attendance were Dr. Douglas Cox, project collaborator, Walter Elwell of the Eastern RI Conservation District, and Whitney Langone, Sustainable Agriculture Specialist from URI. We held a tour of the greenhouse and presented the project and our results so far at that point. Photographs and graphs of the project progress were provided in a handout to illustrate our presentation. We then opened the meeting up to questions and discussion. A brief paper detailing the completed project will be sent to growers by Dr. Douglas Cox, Extension Specialist at the University of Massachusetts, and by Thomas Sandham of the Eastern RI Conservation District, as part of regular Extension and District mailings this growing season.

Summary

The purpose of this project was to increase our agricultural sustainability by finding a feasible method for organic fertilization of greenhouse tomatoes through drip irrigation. Prior attempts to fertilize through our drip system using fish emulsion had resulted in clogging up the system. We found out that many other farmers had had the same problem. To conduct our project, we modified our drip system by using larger emitters. We diluted the fish emulsion prior to sending it through the drip system, using 2 treatments, which differed in dilution rate, and watering frequency. Our control was hand application of the fertilizer with hand watering. A key result was that the combination of larger emitters and diluting the fertilizer enabled us to fertilize through the drip system without clogging it up. We found the best treatment, and the one we would recommend to other farmers, was a 1% fertilizer dilution at every watering. This resulted in the largest fruit, an important marketability trait. In addition to more efficiently feeding our greenhouse tomato crop, this method improved our sustainability by conserving water,

time, and labor, and by reducing soil erosion. We shared our project progress with other farmers during a twilight meeting at our greenhouse on July 13, 2006 and will share our project results in brief papers which will reach regional farmers during the 2007 growing season.

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4. IMG_2558.JPG- 6/24/06- First harvest Group A (1%)
5. IMG_2559.JPG- 6/24/06- First harvest Group B (3%)
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8. IMG_2606.JPG- 7/13/06- Twilight Meeting

Arthur Mello
April 29, 2007

Figure 1. **AVERAGE PLANT HEIGHT**

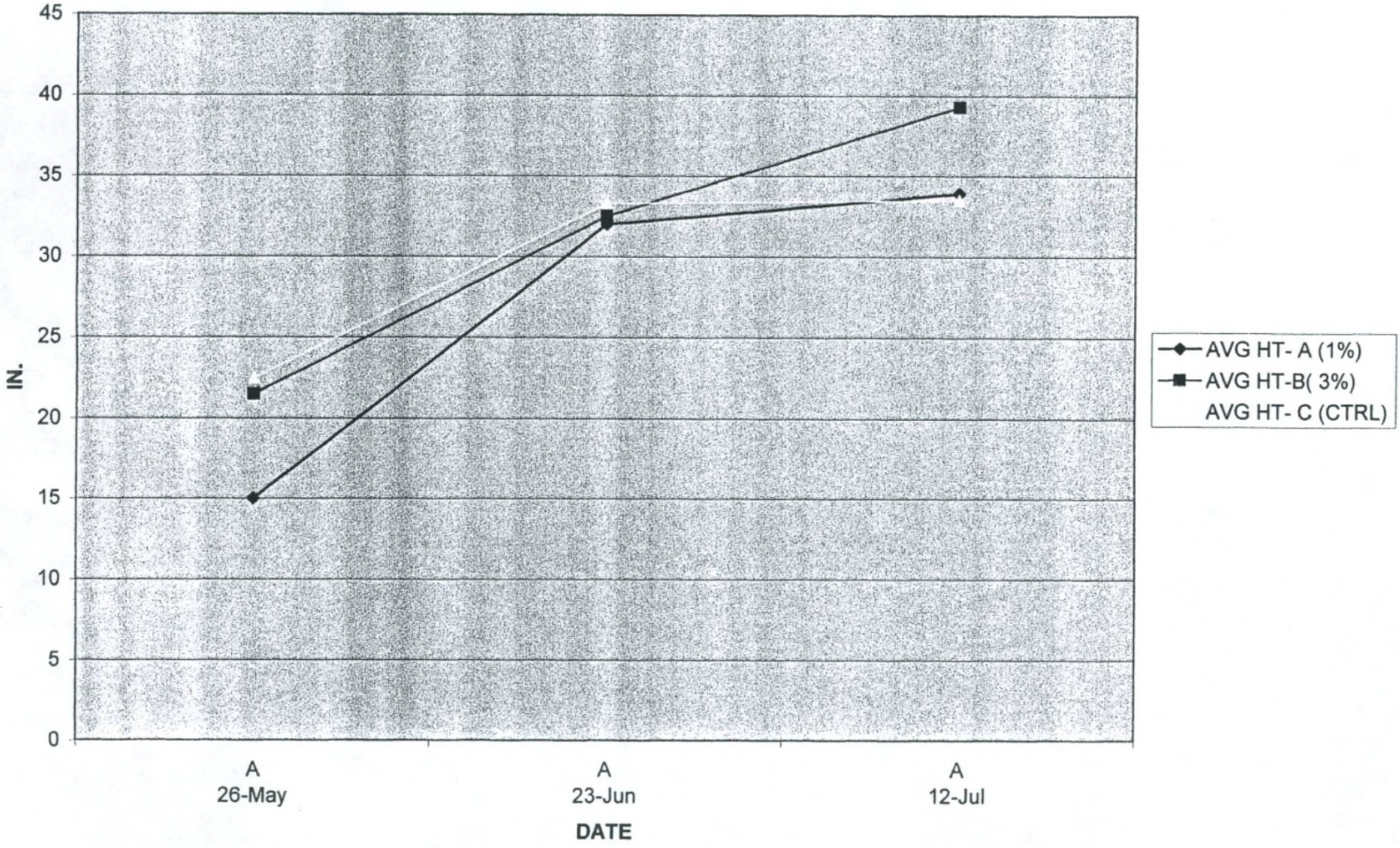
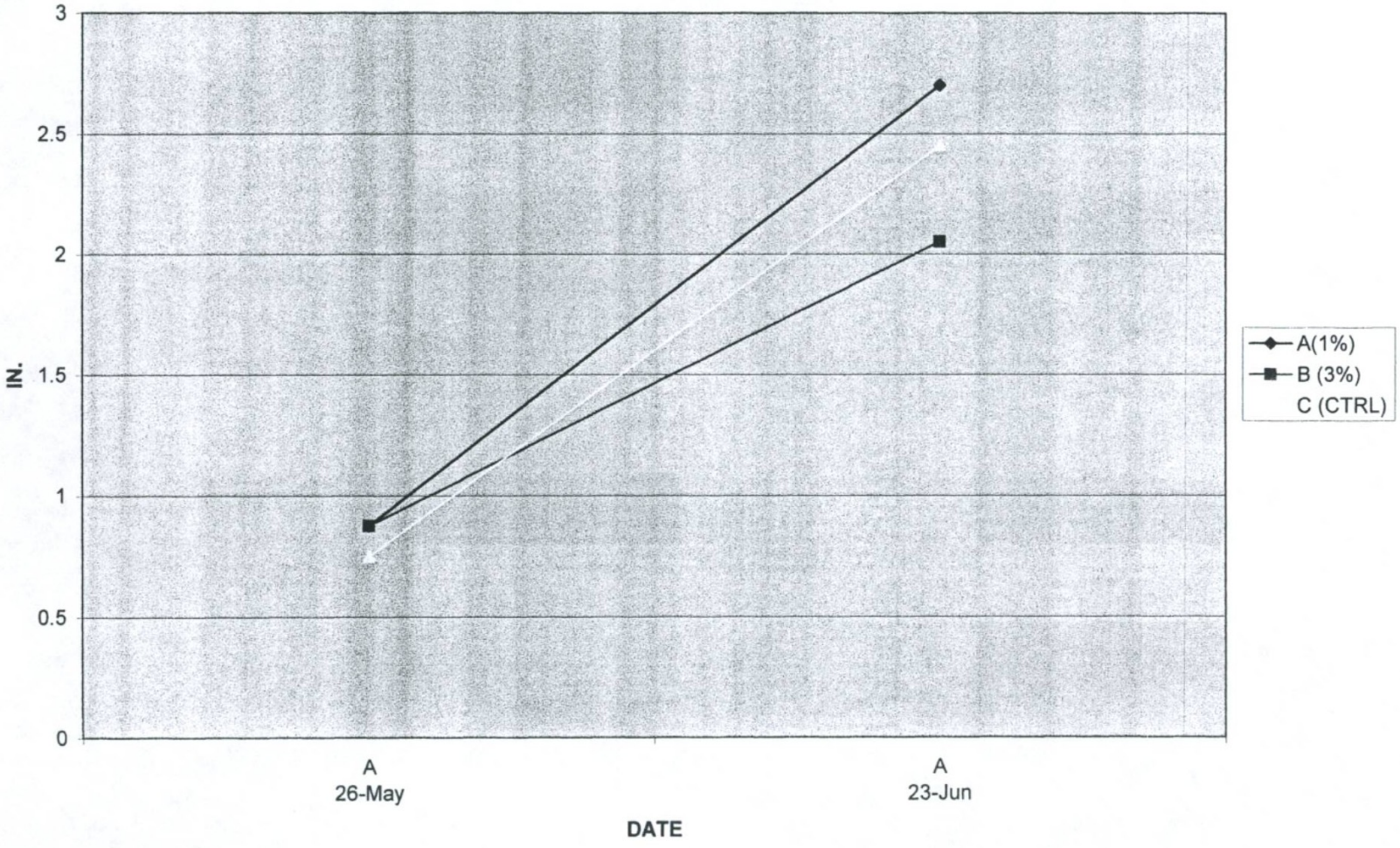


Figure 2. **AVERAGE FRUIT DIAMETER**

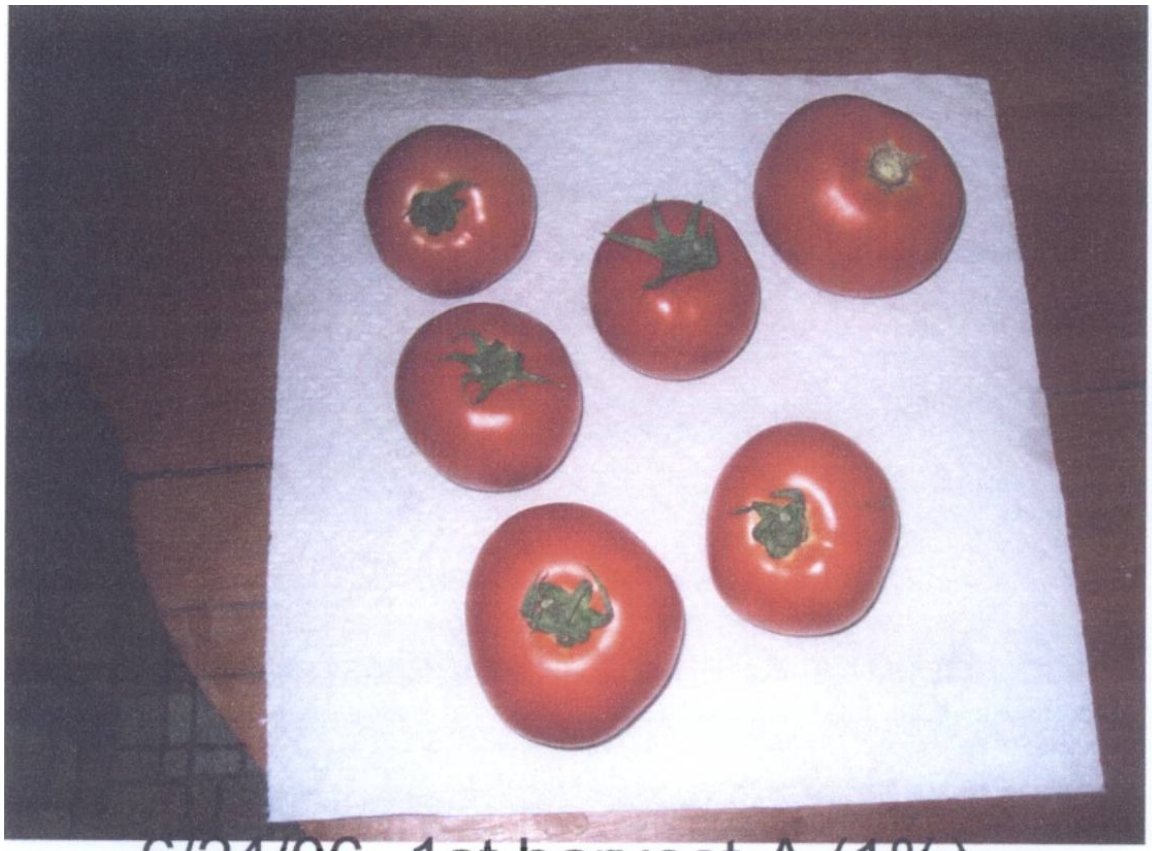


Organic Fertilization of Greenhouse tomatoes using Drip Irrigation

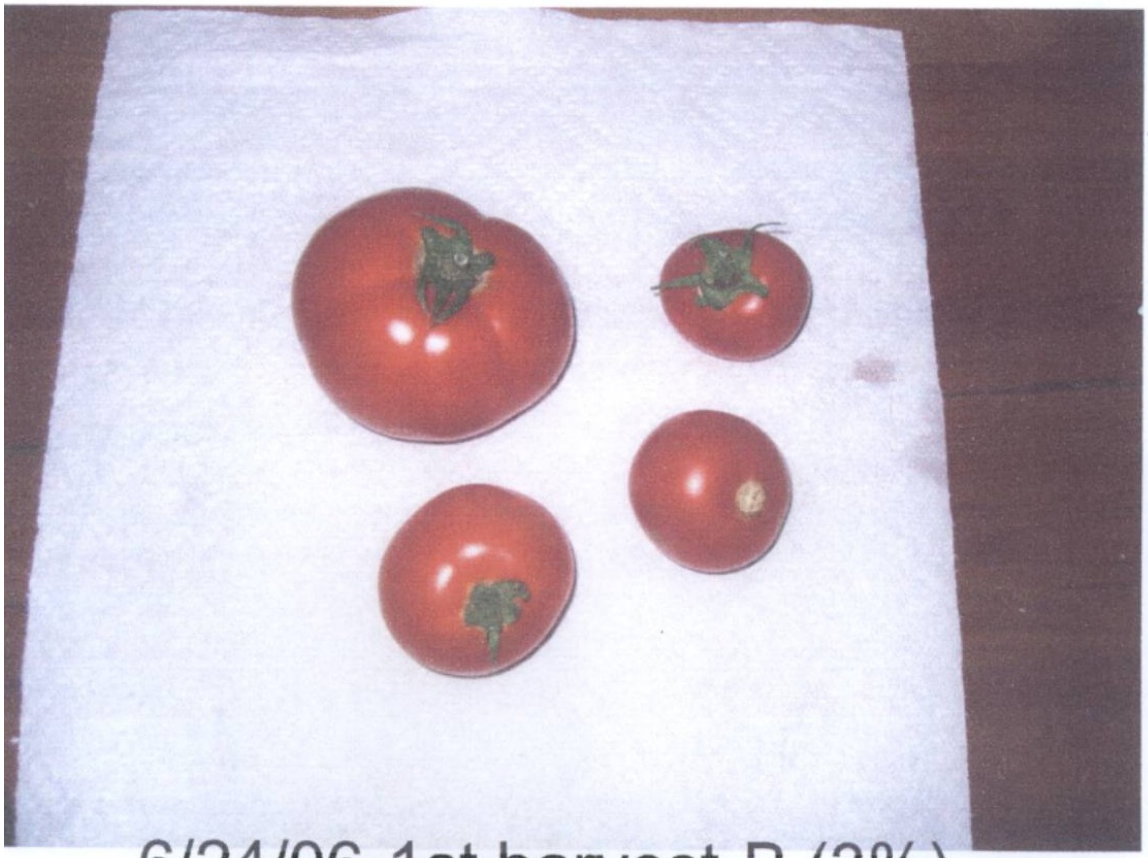
6/23/06-Gp. B (3%)

6/23/06- first ripe fruit

6/23/06- View from Gp.A to Gp. B



6/24/06- 1st harvest-A (1%)



6/24/06-1st harvest-B (3%)

6/24/06-1st harvest- C(cntrl)

6/24/06-sliced fruit