SECTION I

General Information

DEC 0 1 1997

1. **Project Number:** LNE92-32
   Grant Number: 92-16-01
   Funding Period: 1 January 1993 to 31 December 1997

2. **Project Title:** A 'Living Laboratory/Classroom' for the Integration of Research and Education Efforts on Alternative Vegetable Production Systems

3. **Project Coordinator:** William J. Lamont, Associate Professor of Vegetable Crops, The Pennsylvania State University, University Park, PA 16802; Phone: 814-865-7118; FAX: 814-863-6139; E-mail: wjl1@psu.edu

4. **Type of Report:** Final

5. **Date of Report:** 24 November 1997

6. **Reporting Period:** 1 January 1997 to 1 December 1997

7. **Major Participants:** William Lamont replaces Michael Orzolek as Project Coordinator

8. **Cooperators:** no changes

9. **Project Status:** Continuation

10. **Statement of Expenditures:** See accompanying document.

SECTION II

1. Objectives:

1) To evaluate the ecological, agricultural, and economic performance of alternative vegetable production systems, comprised of generally tested and newly developing practices, as well as single-component variations of these systems;
2) To investigate, using a focused team approach, complex biological processes and their economic implications in high-value, vegetable production systems in order to develop more resource efficient and environmentally sound management systems;
3) To involve the general public (rural and urban dwellers, legislators, growers, extension agents, students, other researchers) in agricultural research as an integrative, interactive process.

2. Abstract

Collection of comprehensive baseline data continued for a fifth year on crop growth and development, soil properties and fertility, disease incidence and damage, insect pressure and damage, produce yield and quality, and costs of agricultural inputs from four different, high-value, vegetable crops in five different production systems. The systems differ in their approach to soil management and pest control strategies. Research data from this season indicate the following:
1) We found significant differences in soil nutrients between the organic and other main systems. Improvement in soil tilth was observed with the incorporation of rye or hairy vetch winter cover crops. Greater soil friability was evident throughout the experiment in the treatments that were compost amended. Water infiltration was greater in the ORG soil treatments. Growth and yield responses accompanied these differences.
2) Analysis of plant nutrients and root architecture not available at this time.
3) The effects of companion cover crops on the growth and development of cabbage were studied for their effect on weed control. Ryegrass controlled weeds but inhibited the growth and development of the cabbage plants. Treatments using white clover provided the highest yields of marketable cabbage and appeared to be compatible with cabbage production, but could not be recommended over the use of herbicides or cultivation when considering yield.
4) Weather conditions favored early blight which provided good conditions for testing the effects of the soil treatments and the low impact compounds. No correlation was observed between disease severity and production. Comparing the data on the percent of culls lost from each SARE treatment over the past five growing seasons suggests that the loss is fairly close between the treatments depending on the growing conditions. Analysis of the severity of the blight two weeks before harvest and the number of #1 fruit supports common knowledge that blight affects the quality of the fruit.
5) Insect populations were monitored weekly in tomatoes, snap beans, and cucumbers. Pheromone and blacklight trap data were used to monitor activity of sweet corn pests. Monitoring data were used to time pest management activities. In tomatoes, we evaluated the effect of a very low rate of imidacloprid on the early establishment of Colorado potato beetle.
6) Analysis of economic returns not available at this time.

Educational and outreach activities accounted for a large part of our effort. Approximately 2000 people visited our SARE field plots during Penn State's annual Ag Progress Days, as well as tours by individual growers and researchers. A home page for the SARE project continues on the World Wide Web with monthly updates about the project, a calendar of events and announcements, and links to other sources of information on sustainable agriculture. The page receives about 8-10 hits each day. Through exposure from the newsletters and the Internet, the project has become a clearinghouse for information on sustainable agriculture. The project continues to be a classroom for several field biology courses.

3. Specific Project Results

3A. Findings & Accomplishments

Description of Main Treatments:

Treatment	Fertility Source	Pest Control
ORG-OCIA 1 (organic)	composted cattle manure	Organic Crop Improvement Assn. guidelines
ORG-CHEM 3	composted cattle manure	agrichemical
ICM-IPM 4 (intermediate)	hairy vetch + agrichemical	OCIA and agrichemical (higher pest threshold)
CON-CHEM 6 (conventional)	agrichemical	agrichemical (lower pest threshold)
CON-OCIA 8	agrichemical	Organic Crop Improvement Assn. guidelines

Objective 1. We collected baseline data to evaluate each of the production systems in 1997.
a) amounts and costs of labor, equipment, and materials: see Objective 2.6
b) official weather station data: used to determine nutrient/weather relationships
c) plant growth and development: see Operational Recommendations (5B)
d) soil properties and nutrient analyses: see Objective 2.1
e) arthropod density and damage: see Objective 2.5
f) pathogen epidemiology and plant damage: see Objective 2.4
g) plant tissue analysis: see Objective 2.2
h) yield and grade of produce (see Appendix, Figures 1-1--1-4):
    tomato: highest yields in organic soil treatment with chemical pest control
    snap bean: highest yields in organic soil treatments (1 and 3)
    sweet corn: highest yields in organic soil treatment with chemical pest control,
        no marketable yield in organic soil and pest control
    cucumber: comparable yields in each treatment
i) produce nutritional quality: not determined this year
j) consumer acceptance of produce: not determined this year
k) postharvest storability: no significant differences between treatments
l) economic returns: see section 3D

Objective 2.1 Vegetable crops planted to the same field year after year break down soil structure and make tillage and planting practices difficult. As of 1997, the silt loam soil found in the SARE plots was planted to vegetable crops for at least five years. Cloddy and puddled soil characteristics were observed over the five project years regardless of the experimental soil treatment. Improvement in soil tilth, however, was observed upon the incorporation of rye (*Secale cereale*) or hairy vetch (*Vicia villosa*) winter cover crops. This was especially noticeable when the rye cover crop was incorporated at a relatively mature stage of growth--ripening stage in early summer. Ample biomass accumulation of both root and shoot may be responsible for this improvement. Soil particles adhered together in granular structures and permitted fine seedbed preparation.

Greater soil friability was evident throughout the five year experiment in the treatments that were compost amended (ORG) (years 1993 through 1995) compared to those which were unamended. Soil friability is essential for mechanical weed control. Those treatments which received compost lend themselves well to mechanical weed control through increased soil granulation. Cultivation within a crop requires soil which will break up easily and "flow" around equipment discs, sweeps, tines, etc. In many circumstances, soil is used as a "mulch" and directed within a row to smother small weed seedlings. Increased cultivation proficiency was observed in the amended treatments (ORG). On the other hand, the amended treatment with OCIA pesticide practices (ORG-OCIA) had a greater number of weed species (including perennials) than the unamended soil treatments (CON).

Water infiltration is an important characteristic for any crop-producing soil. Double ring infiltrometer measurements were taken over a 30-minute period in the 1997 snap bean subplot. Average organic soil (ORG) infiltration rates were well over 1.5 times those of the conventional (CON) soil treatments.

Objective 2.2 Analysis of plant nutrients and root architecture not available at this time.

Objective 2.3 For a second year a larger study was performed outside of the SARE platform to better observe the effects of companion cover crops on the growth and development of cabbage. Cover crops were planted on April 18, 1996 into plots according to Figure 3-1. Plots with annual ryegrass (20 lbs/A), white clover (4 lbs/A), and a mixture of white clover (2 lbs/A) and annual ryegrass (10 lbs/A) were left to overwinter in 1997 and replanted with four week old cabbage transplants on May 13, 1997. A 12" strip was tilled into the cover crops prior to planting using a two row multivator. The crop was fertigated using the drip irrigation system.

The purpose of this study was to see if established covercrops could provide adequate weed control for the production of cabbage. The previous years data indicated that cover crops were ineffective at controlling weeds. Clover plots, however, were not well established that year due to the slow initial growth of clover during summer months. By late in the Fall of 1996, clover plots were well established due to the cool-wet weather common in Pennsylvania during that time. We were curious to see if these well established plots could overwinter and provide a competitive living mulch for cabbage. The results of this study are summarized in Table 3-1. Ryegrass controlled weeds, but inhibited the growth and development of the cabbage plants. Treatments using white clover provided the highest yields of marketable cabbage and appeared to be compatible with cabbage production. It should be noted that the bare ground plots received no weed control during the second year of this study and thus had reduced yields. Commercial yields of spring cabbage grown in bare ground with herbicides has averaged 20 T/A at Rock Springs, which is 30-40% more than was harvested from the clover plots. In summary, white clover performed satisfactorily as a living mulch, but could not be recommended over the use of herbicides or cultivation when considering yield.

Objective 2.4 The middle and later parts of the growing season of 1997 were characterized by moderate weather. These conditions favored disease development but with intensive control measures tomato production was maintained.

The incidence of these blights was visually assessed by determining the percentage of leaves diseased in a plot row. Assessments were made at one meter intervals using a standard scale. Each assessment was made by two individuals. There were 80 observations made on each treatment at the time of assessment. These evaluations were made six different times as the fruit matured and was being harvested. An ANOVA analysis was completed each time and only significance greater than 95% using the Fisher PLSD Test was noted.

Blight was first observed on August 7 and continued to develop until the experiment was terminated Sept. 8 (Figure 4-1). Early blight of tomato was severe but did not occur as early as last year. The severity was significantly lower in the treatments receiving Bravo sprays (ORG-CHEM) and ICM-IPM). The highest incidence occurred in the CON-OCIA treatment. This observation is the same as observed for the 1994, 1995, and 1996 growing seasons (Figure 4-2). Except for 1996 which had conditions that favored disease development to the point that even with the intensive control measures tomato production was severely reduced, the ORG-CHEM treatment significantly reduced the blight incidence compared to the other treatments except the ICM-IPM treatment. This suggest that the ORG soil treatment helps suppress the incidence of leaf blight.

Regression analysis between blight incidence and fruit production and quality were completed for each SARE plot and all of the plots summarized together. There was no relation between the blight incidence and quality of fruit comparing each plot except for ICM-IPM. The kilograms of #2 fruit were significantly affected by the incidence of blight on the last three readings. There were significant relations among the last three readings and the number of kilograms of #1 fruit and trend with the kilograms of culls produced (Table 4-1).

Fruit discarded as culls were examined for specific causes and possible effects of the soil treatments on these causes (Table 4-1). Differences were analyzed via an ANOVA program and only significance greater than 95% using the Fisher PLSD Test were noted. The only significant difference in the cull breakdown was the percentage of cull lost due to diseases was less in the ICM-IPM treatment than the others and the same treatment had less lost due to "Other" than the CON-CHEM.

Work using different low impact compounds and extracts for tomato disease control was continued in Plots ICMs-ICMp2. These materials were copper sulfate, hydrogen peroxide (30%), Trilogy, Bravo, seaweed extract, and water. (For more detail please see Table 4-2.)

Bravo 720 and Cu_2SO_4 were the most effective in reducing the incidence of leaf blight (Figure 4-3). While there were significant differences between some of the treatments to control the selected disease, only Trilogy was significantly different that the other treatments in the percentage culls, kilograms of #1 and 2 fruit. The Trilogy treatment had more culls that Bravo.

In conclusion, the weather conditions favored early blight which provided good conditions for testing the effects of the soil treatments and the low impact compounds. However, there was no correlation between disease severity and production. Visually comparing the data on the percent of culls lost from each SARE treatment over the past five growing seasons suggests that the loss is fairly close between the treatments depending on the growing conditions (Figure 4-4). Analysis of the severity of the blight two weeks before harvest and the number of #1 fruit supports common knowledge that blight affects the quality of the fruit.

Objective 2.5 *Tomatoes.* Colorado potato beetle was the only pest that warranted monitoring in 1997. In the tomato crop, we tested the use of transplant applications of imidacloprid. Imidacloprid is a unique type of chemistry (a nicotinic cholinergic agonist) that has recently gained registration in many vegetable crops, and whose registration is expected to expand. It is generally recognized as having a good worker-safety profile, but can be expensive. In 1997, we repeated the tests of low rates (0.01 ml Admire 2F/plant) by applying directly to the transplants in the cold frames on May 30, 4 days prior to transplanting on June 3. This transplant application of imidacloprid was applied to plants placed in treatments 3 and 6. Treatment 4 had imidacloprid applied as a foliar spray (Provado, at 3.75 oz/ac) when densities exceeded threshold, which occurred on July 2. Treatments 1 and 8 had no chemical or biological controls applied. The literature suggests that straw mulch interferes with early establishment of Colorado potato beetle, and the straw mulch used in treatment 1 may be viewed as a pest management tactic.

As expected, and as in previous years, the Colorado potato beetle did invade the plots (see Fig. 5-1, 5-2, and 5-3 for densities of adults, egg masses, and larvae, respectively). Adults invaded young transplants by the middle of June (about 10 days to 2 weeks after transplanting), and remained in the plots for about 25 days (Fig. 5-1). Eggmasses were deposited by these adults (Fig. 5-2), and development of these egg masses resulted in a population of larvae during late June and early July (Fig. 5-3). Use of imidacloprid on the transplants (treatments 3 and 6) prevented any population development, which was consistent with the 1996 data. In contrast, treatments 1 and 4 showed a well-defined sequence of development of the life stages. Foliar application of the Provado formulation of imidacloprid (treatment 4) was delayed until July 2 (calendar day 183) because of relatively low densities, and thus adults and eggmasses became established. Larval populations collapsed after the spray on July 2. This collapse may not have been due entirely to the spray, as larval populations were declining concurrently in treatment 1, where no spray was applied. In treatment 1 (with straw mulch), all life stages also established. However, even without any insecticide, population establishment in the treatment with straw mulch was lower than that in treatment 4 (compare top and bottom of Fig. 5-4). Thus, we have now seen a system that uses straw mulch to result in less beetle pressure for two years.

Cucumbers. Striped cucumber beetles invaded within days after transplanting on June 13 (calendar day 164) (Fig. 5-4). Mean densities exceeded 1 per 5 plants within days after transplanting. Row covers were applied in treatments 1 and 8 on calendar day 168 (five days after planting) for pest control, and removed 16 days later (calendar day 184) to allow for pollination. Monitoring data from these plots, which started at removal of the row covers, suggests that some beetles were trapped under the row covers. However, row covers were effective at keeping invading populations low. Esfenvalerate applied soon after transplanting on June 20 (calendar day 171) plus Thiodan applied on July 18 (day 199) to treatments 3 and 6 kept populations low in uncovered plots. By late July (day 207) populations in all plots were low, probably reflecting the end of the first generation. Data were not necessary for the second generation, as the crop was harvested.

Snap beans. Potato leafhopper densities were high in 1997. Treatments 3 and 6 used acephate (a systemic carbamate) on two dates (calendar day 183 and 199) to reduce these densities, and also in response to the European corn borer densities collected from pheromone traps. In contrast, insecticide treatments were delayed until calendar day 189 for treatments 1 and 8, and used rotenone and pyrellin (a tank mix of botanicals). The leafhopper densities were more often higher in the plots treated with the botanicals. Leafhoppers may have reduced yield and quality of snap beans in treatments 1 and 8.

Sweet corn. Sweet corn insect management was based on pheromone trap catch. This was part of a transition to an IPM program based entirely on pheromone trap catches conducted throughout the state of Pennsylvania. Previously to this year, the sweet corn IPM program relied upon blacklight trap captures for monitoring European corn borer and pheromone traps for corn earworm and fall armyworm. Moving entirely to pheromone traps (using a separate trap for the Z-race and the E-race of the European corn borer) will allow much wider on-farm adoption. Extension agents in 16 locations throughout the state helped in demonstration of the pheromone based IPM program. Treatment 4 based sprays upon trap capture, which resulted in 3 sprays. In contrast, treatments 3 and 6 received scheduled sprays during silking, resulting in 5 silk sprays. In all cases, the spray was Warrior II. Treatments 1 and 8 did not receive any sprays.

Most damage was caused by poor pollination, probably due to feeding by adult Western corn rootworm. Additional damage resulted from ear infestation by the European corn borer. Ear ratings for poor pollination was significantly greater ($P < 0.0001$) in the two treatments without any insecticide (1 and 8) than the three treatments with any insecticide application (3, 4, and 6), regardless of the frequency of application. This was the most important source of ear damage associated with insects in 1997. In addition, although densities of corn borer larvae were low, there were significant differences in these numbers among treatments. Densities of larvae was highest in treatment 8 (4.2 larvae/100 ears), followed by treatment 1 (2 larvae per 100 ears), and then followed by treatments where insecticides were applied (mean of 0/100 ears in treatments 3, 4, and 6). Fall armyworm was present during late whorl stage, but did not result in appreciable numbers of larvae in the ears (means were < 0.25 larvae per 100 ears), and differences in the mean number of larva in the ears were not significant ($P > 0.57$). Corn earworm pheromone trap captures were very low, did not result in any measurable larvae in the ears, and there were no significant differences among treatments in the mean number of ears with tip damage ($P > 0.15$).

Objective 2.6 see section 3D.

Objective 3. We accomplished the following objectives involving general outreach:

- A home page for the SARE project continues on the World Wide Web (URL: http://hortweb.cas.psu.edu/sustag/) with monthly updates about the project, a calendar of events and announcements, and links to other sources of information on sustainable agriculture. Over 10000 people have accessed the page since its inception in December 1995.
- Through exposure from the newsletter and the Internet, the project has become a clearinghouse for information on sustainable agriculture.
- We modified research on some cultural practices to better reflect growers' needs as suggested in our grower's survey from last year.
- Several field biology and ag courses at Penn State continue to integrate the SARE project into their curriculum.
- A large number of growers or those closely linked to agriculture visited the field plots this year including over 2000 people during Penn State's Ag Progress Days in August.
- A formal advisory board was created.
- An advisor was hired to consult on organic treatment practices.

3B. Dissemination of Findings

In addition to the accomplishments presented in section 3A, we have planned the following:

- monthly updates of project news through web site, news releases.
- results that can be applied on farms are being incorporated into Vegetable Winter Extension Meetings or are under discussion with Extension agents. For Colorado potato beetle management in tomatoes, results on using either straw mulch or transplant treatments of imidacloprid are being discussed.
- pheromone trap data were reported weekly using toll-free telephone access. Close to 1000 calls were made to this hot-line.

3C. Site Information

Information about site soil characteristics was detailed in the first year's report.

3D. Economic Analysis

Analysis of economic returns not available at this time.

4. Potential contributions and practical applications

4A. Impacts

As in 1995, the potential of using biocontrols for immature stages of diabroticite larvae was advanced. The potential of using very low rates of imidacloprid applied to tomato transplants to control CPB was again demonstrated.

The adaptation of a pheromone based program for sweet corn IPM in Pennsylvania was demonstrated via Extension (previously this program relied upon a combination of pheromone traps and light traps). This creates the base for much wider adoption of monitoring of pests of sweet corn in the state.

4B. Pesticide reduction

When widespread presence of Colorado potato beetle on transplant tomatoes is anticipated, either low rates of imidacloprid applied to transplants or straw mulch appear to be good control options for this pest. No-till planting can be expected to give the same effect as straw mulch. When presence is not anticipated, or is spotty, scouting and foliar applications work well. Although this pest has significant pesticide resistance to all other classes of insecticides, foliar applications of imidacloprid or rotenone, or well-timed applications of the biological control *Bacillus thuringiensis* var. *tenebrionis* (B.t.), are effective options. This is based on this year's work, plus previous years where B.t. was applied based on scouting data.

4C. New hypotheses

5. Farmer Adoption and Direct Impact

Rotary Hoe in Sweet Corn and Snap Beans

The rotary hoe is a three-point hitch-mounted cultivation tool that disrupts soil within and between rows of large seeded crops. Steel wheels designed with spoon-billed teeth penetrate the soil surface as the implement is pulled across the field. Manufacturer recommendations specify hoe operation between eight and twelve miles per hour. Proper speed of the rotary hoe is necessary for effective weed control. Greater numbers of weed seedlings were observed at the edge of the field where the hoe had not achieved recommended ground speed. The rotary hoe demonstrated effective weed control when used in the non-herbicide sweet corn and snap bean crops. After using the hoe in the SARE plots at eight miles per hour, evidence of weed seedlings in the white root stage were brought to the soil surface. Desiccation of the weed seedlings after soil disruption was further observed. Some sweet corn and snap bean crop seeds were brought to the surface as a result of rotary hoe cultivation. Damage was estimated at less than ten percent.

Observations in Tomato

Black plastic mulch was applied to the four main tomato systems in the 1997 season. Growth of tomato plants in all systems was excellent. Shoot development, flowering, and fruit development was slower in the organic soil treatments (ORG) compared to the conventional soil treatment (CON). Later in the season, tomato shoot development in the organic treatment was comparable to the conventional treatment. Where organic soil practices are combined with synthetic chemical pesticide application (ORG-CHEM), yield and quality were highest. Where conventional soil practices are combined with Organic Crop Improvement Association pest control guidelines (CON-OCIA), yield and quality were lowest.

Straw mulch used in tomato culture may have a deleterious effect on production. Where straw mulch was used, in some years, stunted growth and poor yield was evident. Insufficient availability of nitrogen to the crop may be a significant factor. Also, volunteer grain found in straw bales may germinate causing unwanted competition.

Where napropamide (Devrinol) was used as a preemergent herbicide in combination with straw mulch on the organic soil treatment (ORG-CHEM), weedy volunteer grain growth was inhibited. Of the four main treatments, this had the highest degree of weed control. The herbicide mulch combination was also very effective in suppressing weed species such as common lambsquarters and redroot pigweed. Competition from these species along with the volunteer grain was observed in the organic soil, straw mulched treatment receiving no herbicide (ORG-OCIA).

Observations in Snap Beans

Potato leafhopper infestation in the snap beans was greatest in 1997 compared to 1993-1996. Where treatments received insecticide (CHEM), leaf hopper counts were reduced. Under the OCIA treatments, leafhopper devastation was evident. Snap bean foliar damage occurred in all treatments in 1997 but was greatest in those treatments where no insecticides (OCIA) were applied.

Observations in Cucumbers

Black plastic mulch was applied to the four main cucumber systems in the 1997 season. Conventional soil treatment (CON) exhibited faster establishment, earlier flowering, and fruit set than the organic soil treatment (ORG). Crop row covers were effective in excluding striped cucumber beetle. Infestation was severe in uncovered treatments prior to insecticide application. Row cover used in combination with the conventional soil treatment (CON-OCIA) returned the highest yields in 1997.

Observations in Sweet Corn

In 1997, drought conditions prevailed during the initial stages of sweet corn development. Also, western corn rootworm adults infested all sweet corn treatments and damaged the exposed silk of the corn ears. Pollination and consequent yield on these damaged ears was poor. Only where the organic soil treatment received insecticide applications (ORG-CON) was a reliable marketable yield obtained. Conventional soil treatment in combination with synthetic insecticide application (CON-CHEM) failed to produce a reliable marketable yield. Soil amendment (composted dairy manure), applied in 1993-1995, favorably affected sweet corn crop response. Compost, as part of a vegetable production system, contributed to greater crop yields in the years following actual application.

General Observations of Crop Growth

Vegetable systems differing in soil management have affected crop canopy growth response and development. Where pest numbers were low or controlled adequately and the mulch variable was held constant, mature plant canopy development in the organic soil (ORG) system was larger than that of the conventional soil system (CON). In the nonirrigated sweet corn and snap bean crops, plant growth response in both height and canopy width was larger than that of the conventional soil treatment (CON). This was especially true in times of drought or water stress. Conventionally fertilized soil treatments exhibited rapid early growth. As maturity of the crop approached, canopy width and plant height stabilized. The organic soil treatment (ORG) appeared to have a delayed growth response different from the conventional soil treatment (CON). Established plants grew slowly at first but exhibited sustained vigor in the later stages of development. Fruit development and ripening of tomato and cucumber was found to be delayed in the organic soil treatment (ORG). Side by side comparison of the two soil systems enabled observations of differing growth rates.

5C. Farmer Evaluations

6. Producer Involvement

Concluded last year.

Marketable Tomato Yield 1993-1997

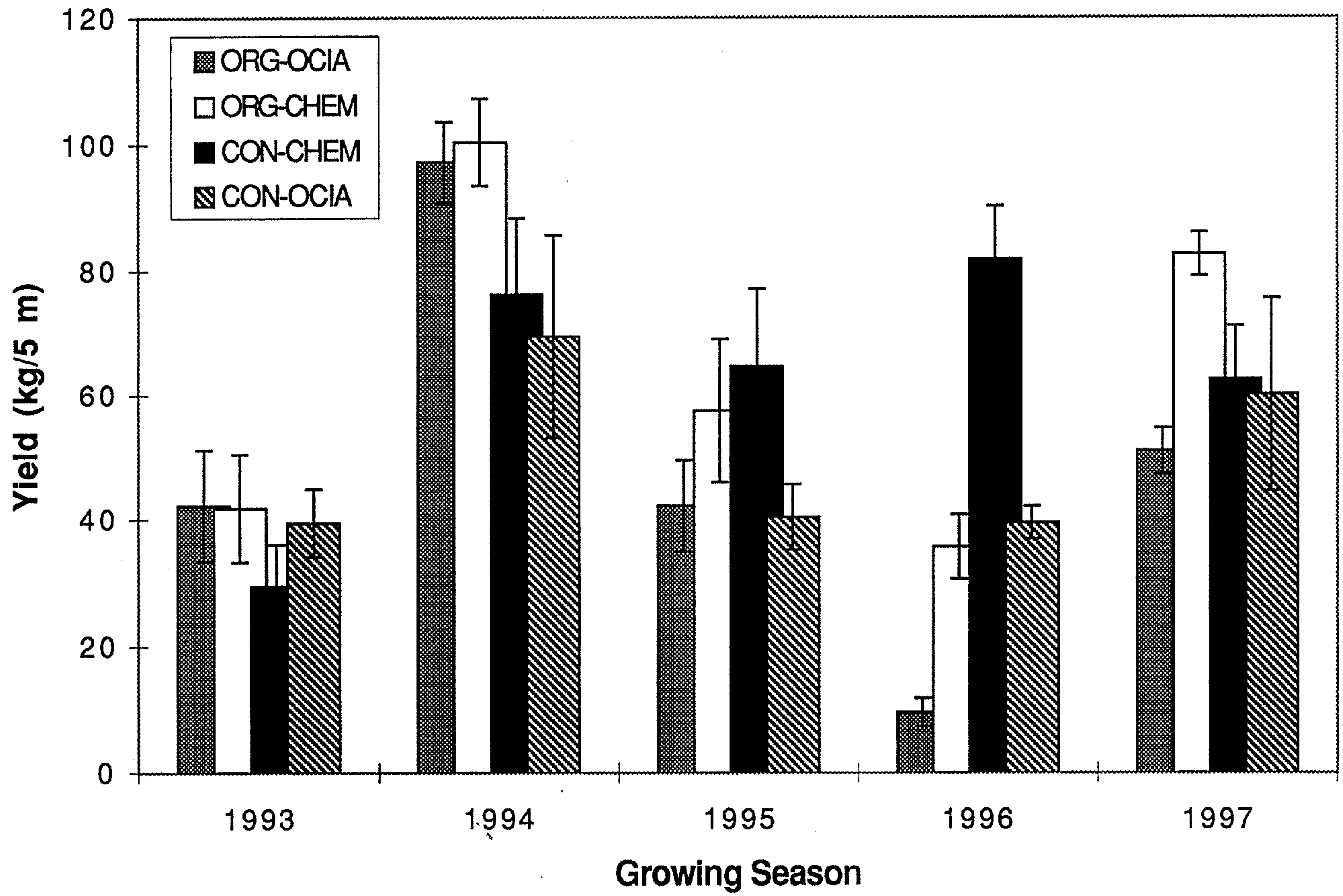


FIGURE 1-1

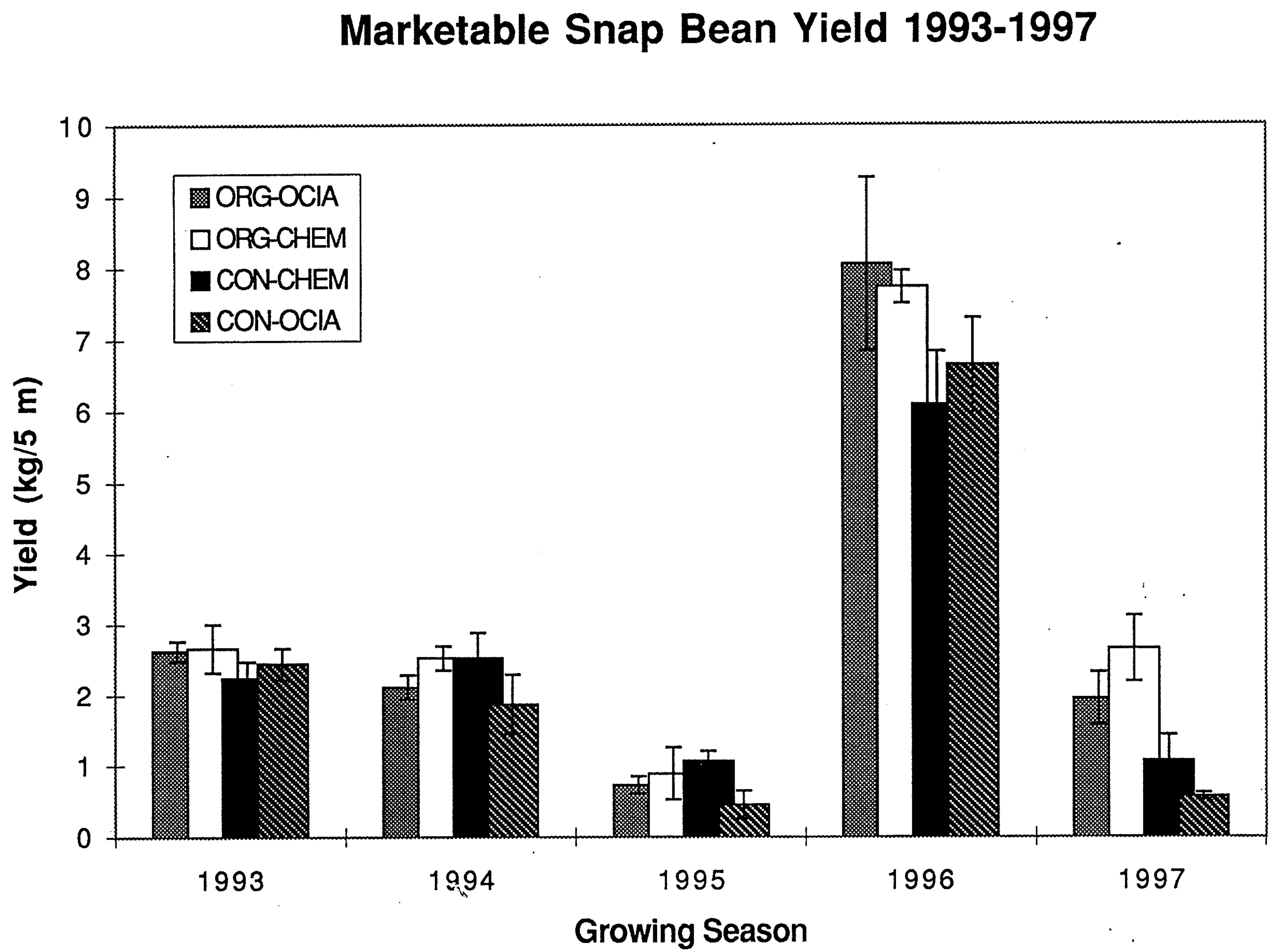

Marketable Snap Bean Yield 1993-1997
Yield (kg/5 m)
0
1
2
3
4
5
6
7
8
9
10
ORG-OCIA
ORG-CHEM
CON-CHEM
CON-OCIA
1993
1994
1995
1996
1997
Growing Season

FIGURE 1-2

Marketable Sweet Corn Yield 1993-1997

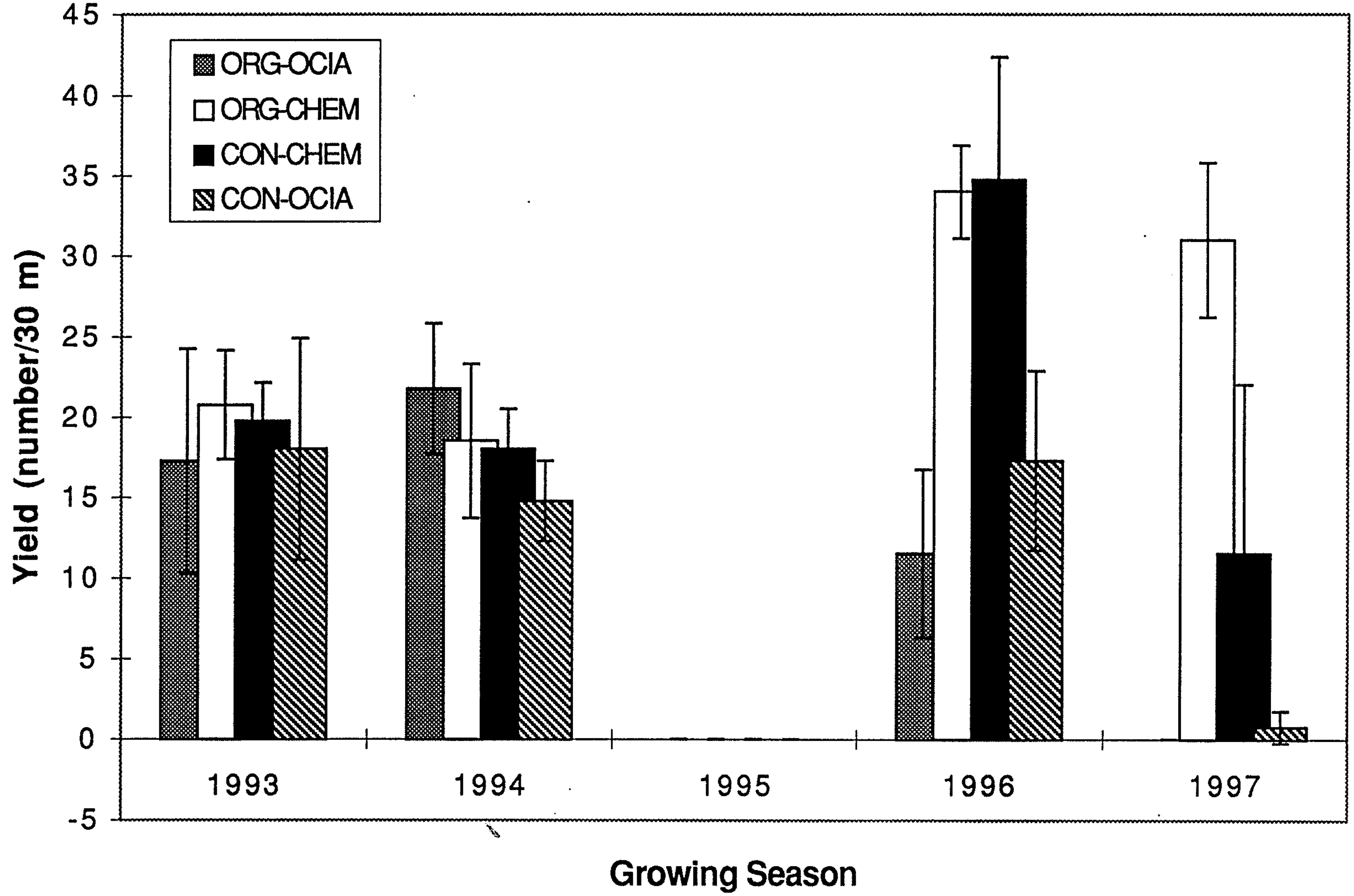


FIGURE 1-3

Table 3-1. Effect of alternative weed control methods on cabbage yield.

Treatment	T/A	Marketable No.	Marketable lbs.	Cull No.
Bare Ground	8.5	30	46.8	10
Rye Grass	4.4	22	24.0	18
Rye+Clover	11.4	35	62.5	5
White Clover	13.7	34	75.0	6

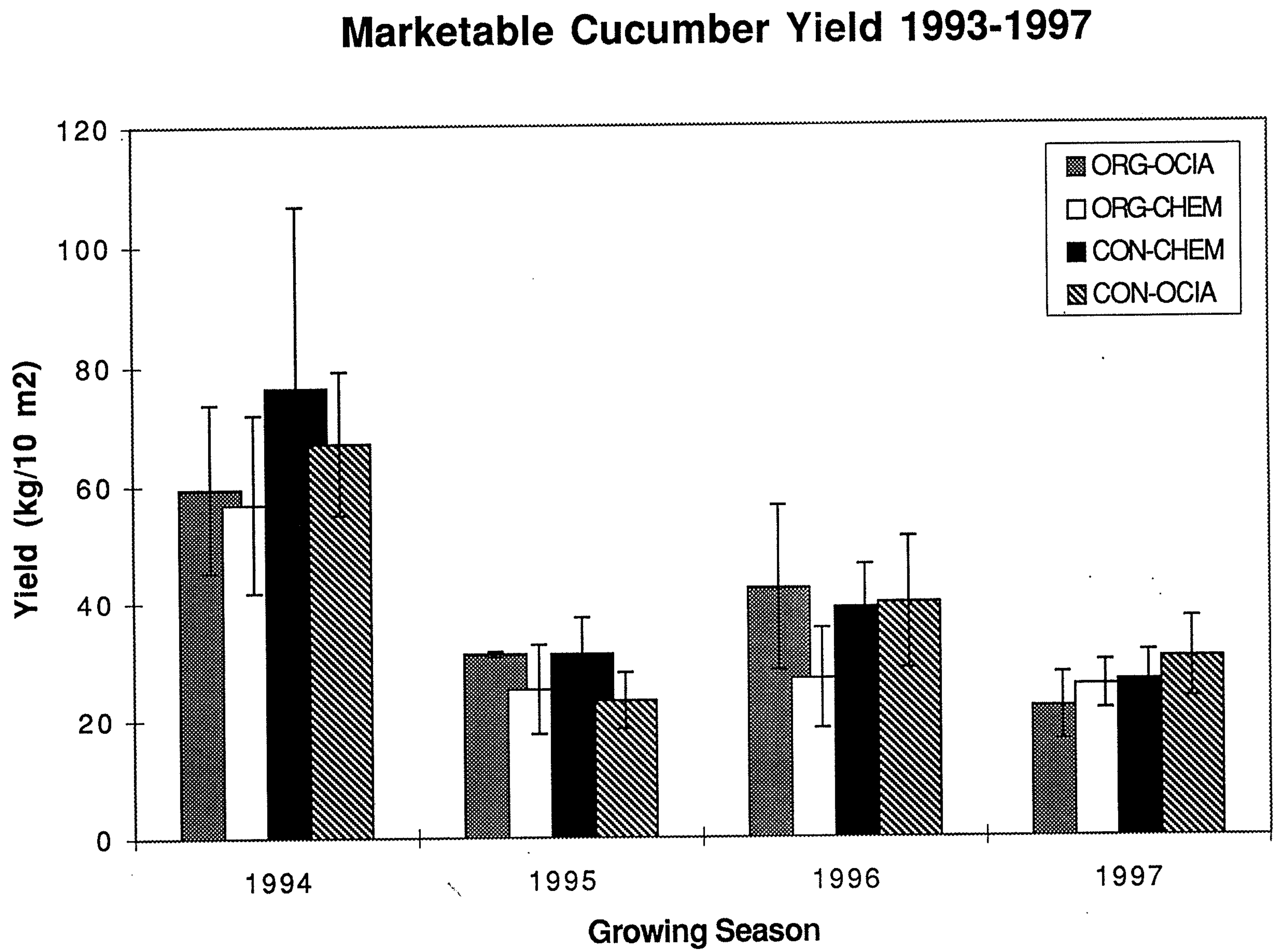
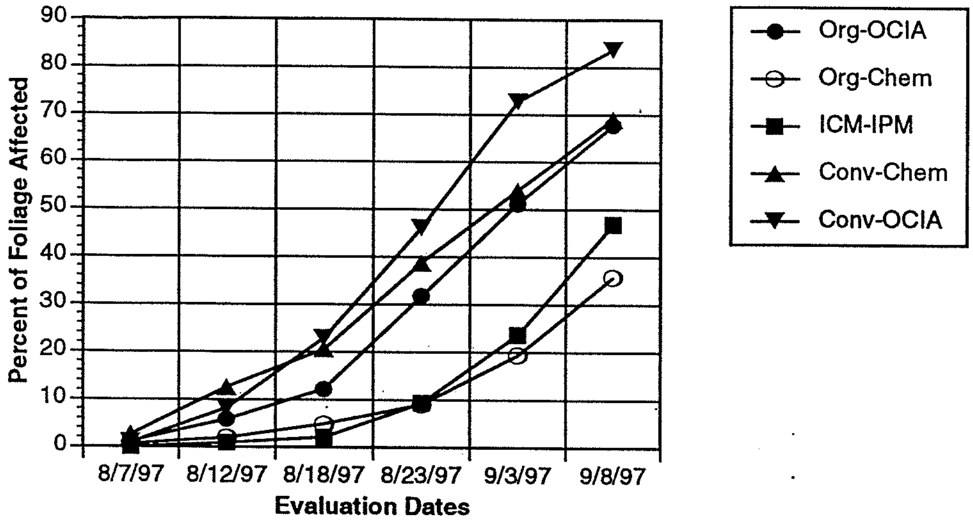

Marketable Cucumber Yield 1993-1997
Yield (kg/10 m2)
0
20
40
60
80
100
120
ORG-OCIA
ORG-CHEM
CON-CHEM
CON-OCIA
1994
1995
1996
1997
Growing Season

FIGURE 1-4



~~Table 1.~~ **Effect of SARE Treatments on Early Blight Development on Tomato.**

FIGURE 4-1.

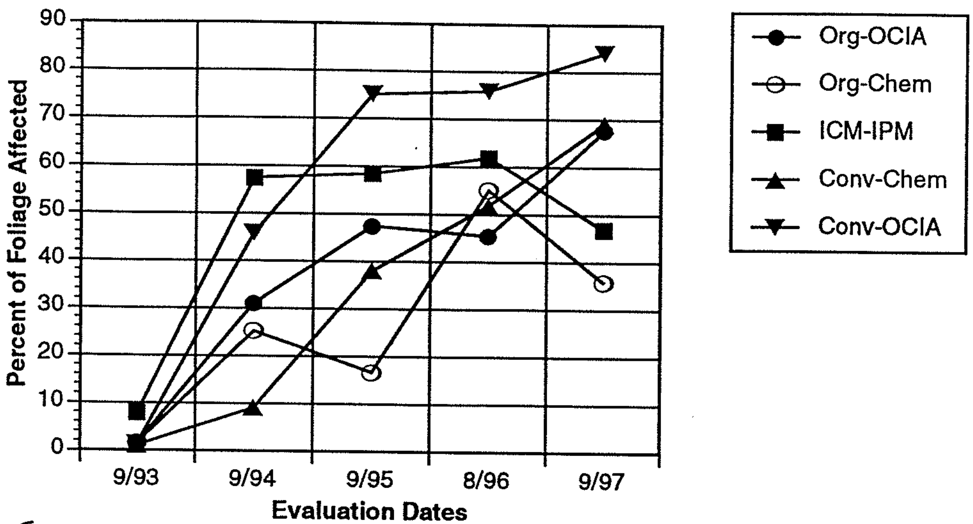


FIGURE 4-2
~~Figure 2~~. **Effect of the SARE Treatments on the Development of Leaf Blight of Tomato over Five Growing Season.**

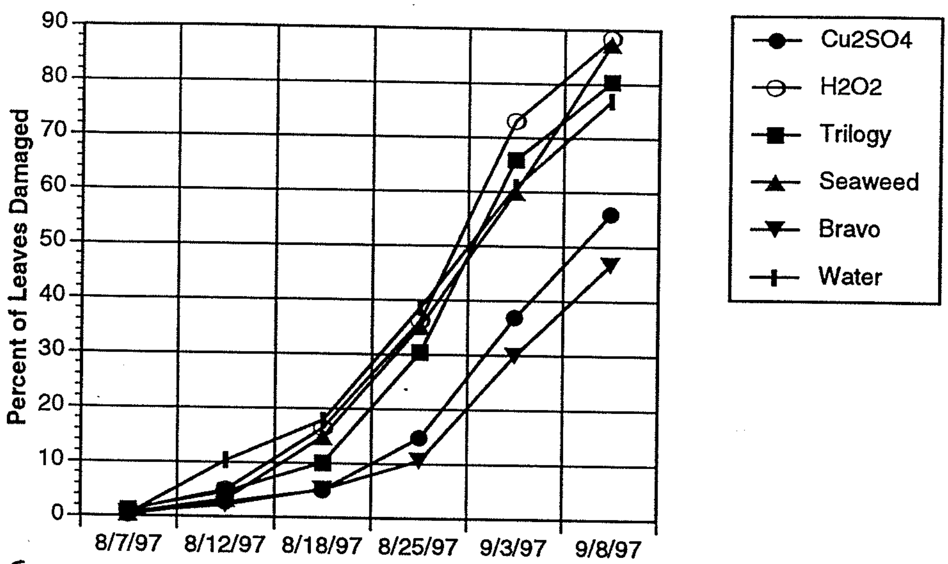


FIGURE 4-3

~~Figure 3~~ **Effect of Treatments in Plot 5 on Early Blight Development on Tomato Plants.**

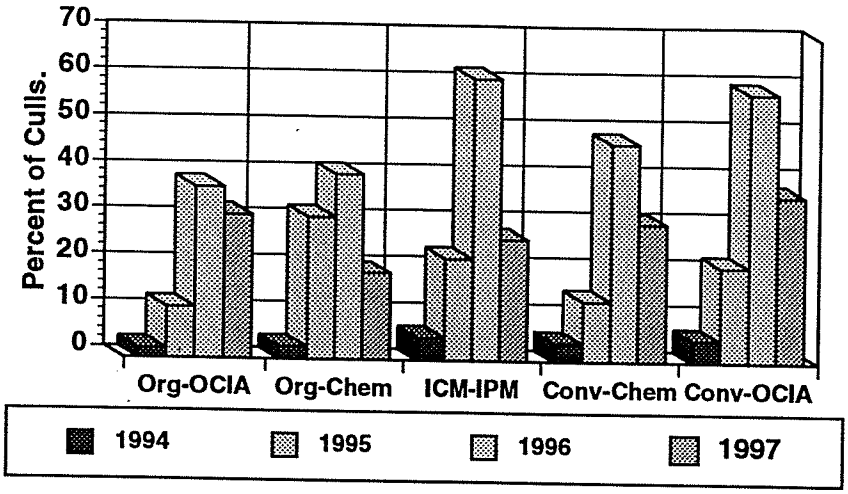


FIGURE 4-4

~~Figure 4.~~ **Effect of SARE Treatments on the Percent of Culls Lost that were Due to Diseases During the 94, 95, 96 and 97 Seasons.**

Table 4-1. The regression analysis of the date of blight evaluation and fruit production and quality of all of the SARE treatments.

Yield measured	Date	y=	r^2	SS-<MS	F Test
Kg. of #1 Fruit					
	8/18	-1X+46.8	.5	1406.3	16.7
	8/23	-.5X+48.2	.5	1543.6	20.2
	9/03	-5X+53.4	.7	1968.1	37.3
	9/08	-.4X+58.5	.6	1653.4	23.5
Kg. of #2 Fruit					
	8/18	.2X+31.6	.1	41.2	1.1
	8/23	-9,1E-4X+3	E-6	45 e3	1.2 E4
	9/03	-3.2E-3X-3	1.2E	.1	2.5E3
	9/08	2.2E-2X-2X	6.E-3	4.4	0.1
Kg of Culls					
	8/18	.2X+13.7	.2	76.8	4.8
	8/23	.2X+12.2	.4	150.8	12.7
	9/03	.1X+11.9	.3	118.4	8.7
	9/08	.1X+99	.3	126.3	9.6

Table 4-2. The means of the percentage of all of the tomato fruit culled from the main Soil Building plots during the 1997 season due to the specific listed causes. The total cull loss for each treatment was calculated as the percentage of the yield (kilograms/meter) to eliminate variations between the treatment yield.

Treatment	Diseases[1]	Pests	Other
Org-OCIA	31.1[2]	30	36.2
Org-Chem	18.7	22.8	50.1
ICM-IPM1	26.2	26.5	32.5
Conv-Chem	29.7	11.1	42.3
Conv-OCIA	35.9	18.4	39.9

[1]Diseases: Anthracnose, Early Blight, Late Blight, Blossom end rot, Buckeye, and bacterial canker. Pests:Rodent, Insects. Other:Size, Shape, Growth cracks, Sunscald

[2] Means of the percent of the percent of culls from four harvests of four replicates of each treatment.

Table 4-3: Sub-Treatments of SARE Treatments ICMs-ICMp-2 for the 1997 Growing Season.

1. Cu_2SO_4-- will be applied at the rate to 1.67 T/gal every 5-7 days or as called for by Blightcast.
2. Hydrogen Peroxide--will be applied at the rate of 1.9 T/gal as called for by Blightcast, or on the leaves every 7 days.
3. Trilogy 90EC (2.56 T/gal of water) will be applied as called for by Blightcast, or every 7 days.
4. Seaweed Extract--Will be applied at the rate of 2T/gal as called for by Blightcast, or every 5-7 days as needed. Do not apply in the heat of the day.
5. Bravo 720--application rates listed in the 1993 Commercial Vegetable Production Recommendations will be followed (0.8 T/gal of water).
6. Control--water with 1/2 teaspoon of wetting agent/gallon will be used as a control..

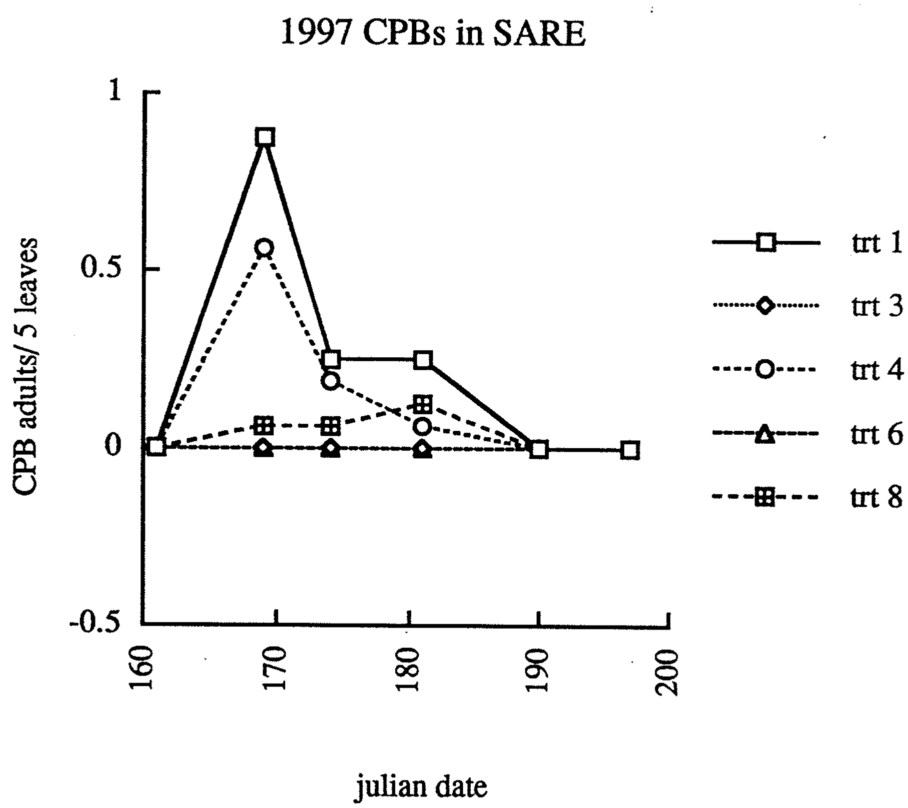
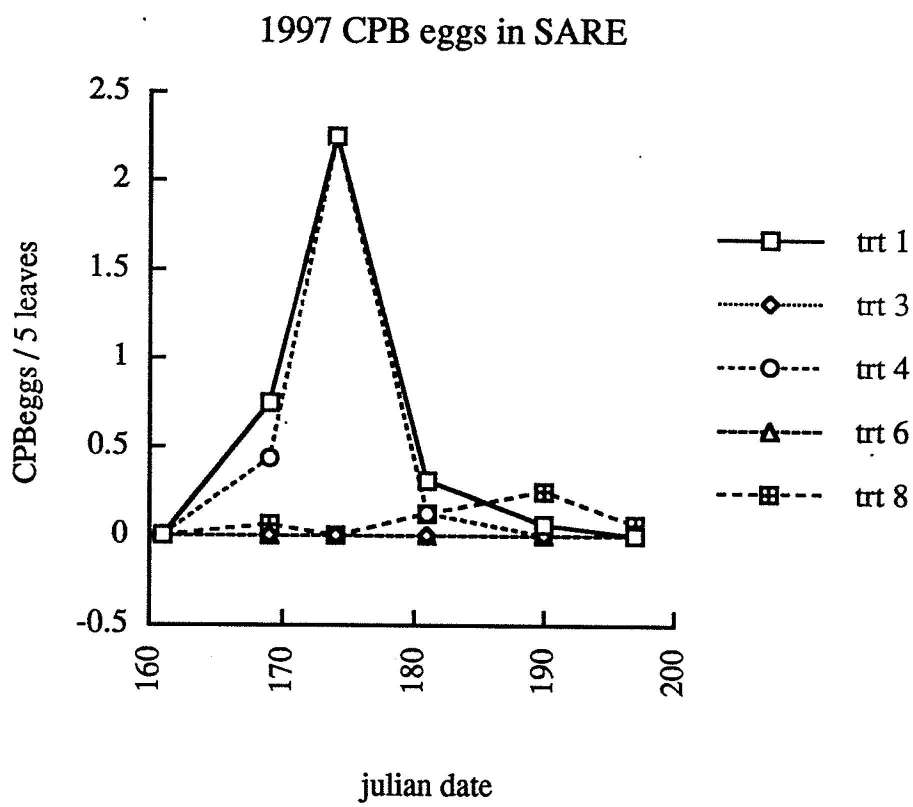

1997 CPBs in SARE
CPB adults/ 5 leaves
1
0.5
0
-0.5
160
170
180
190
200
julian date
trt 1
trt 3
trt 4
trt 6
trt 8

FIGURE 5-1



1997 CPB eggs in SARE
CPBeggs / 5 leaves
2.5
2
1.5
1
0.5
0
-0.5
160
170
180
190
200
julian date
trt 1
trt 3
trt 4
trt 6
trt 8

FIGURE 5-2

1997 CPB larvae in SARE

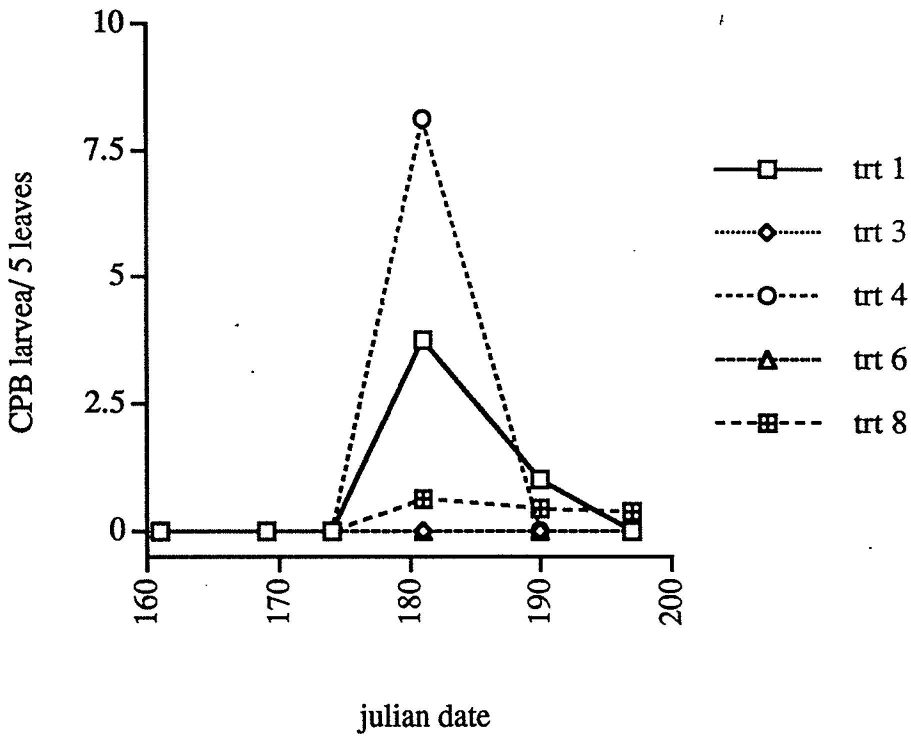


FIGURE 5-3

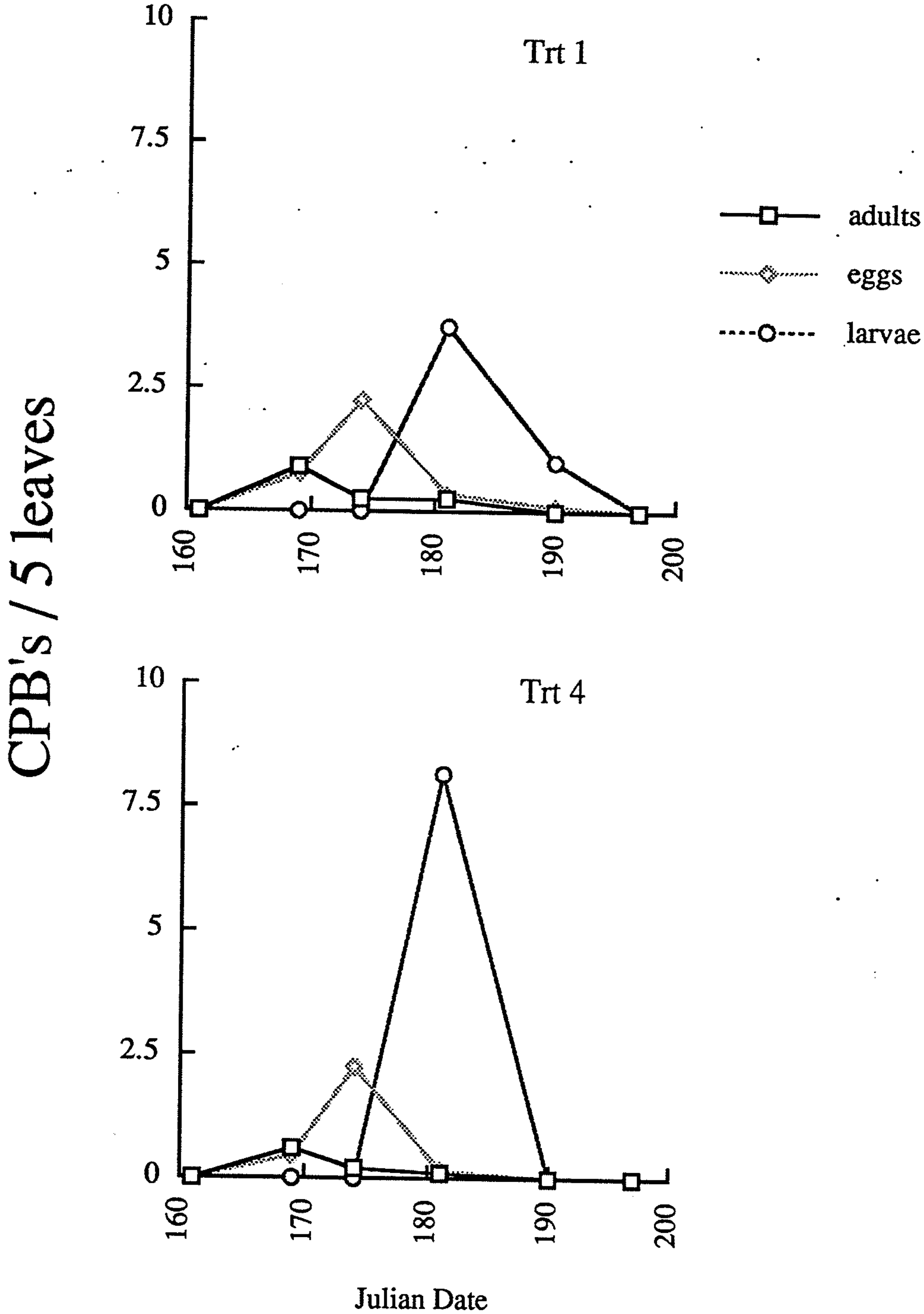

CPB's / 5 leaves
Trt 1
10
7.5
5
2.5
0
160
170
180
190
200
adults
eggs
larvae
Trt 4
10
7.5
5
2.5
0
160
170
180
190
200
Julian Date

FIGURE 5-4

adult PLHs in SARE beans

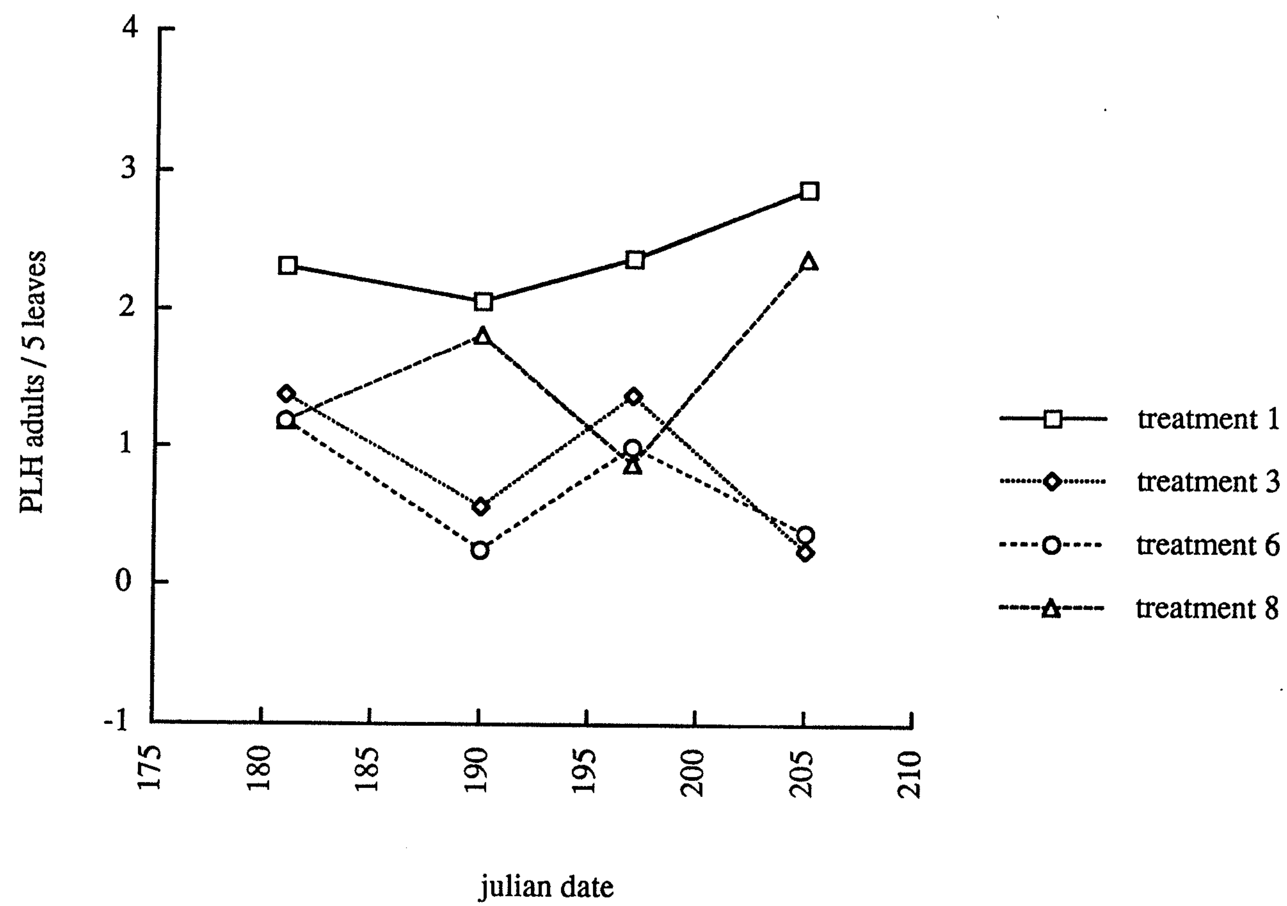
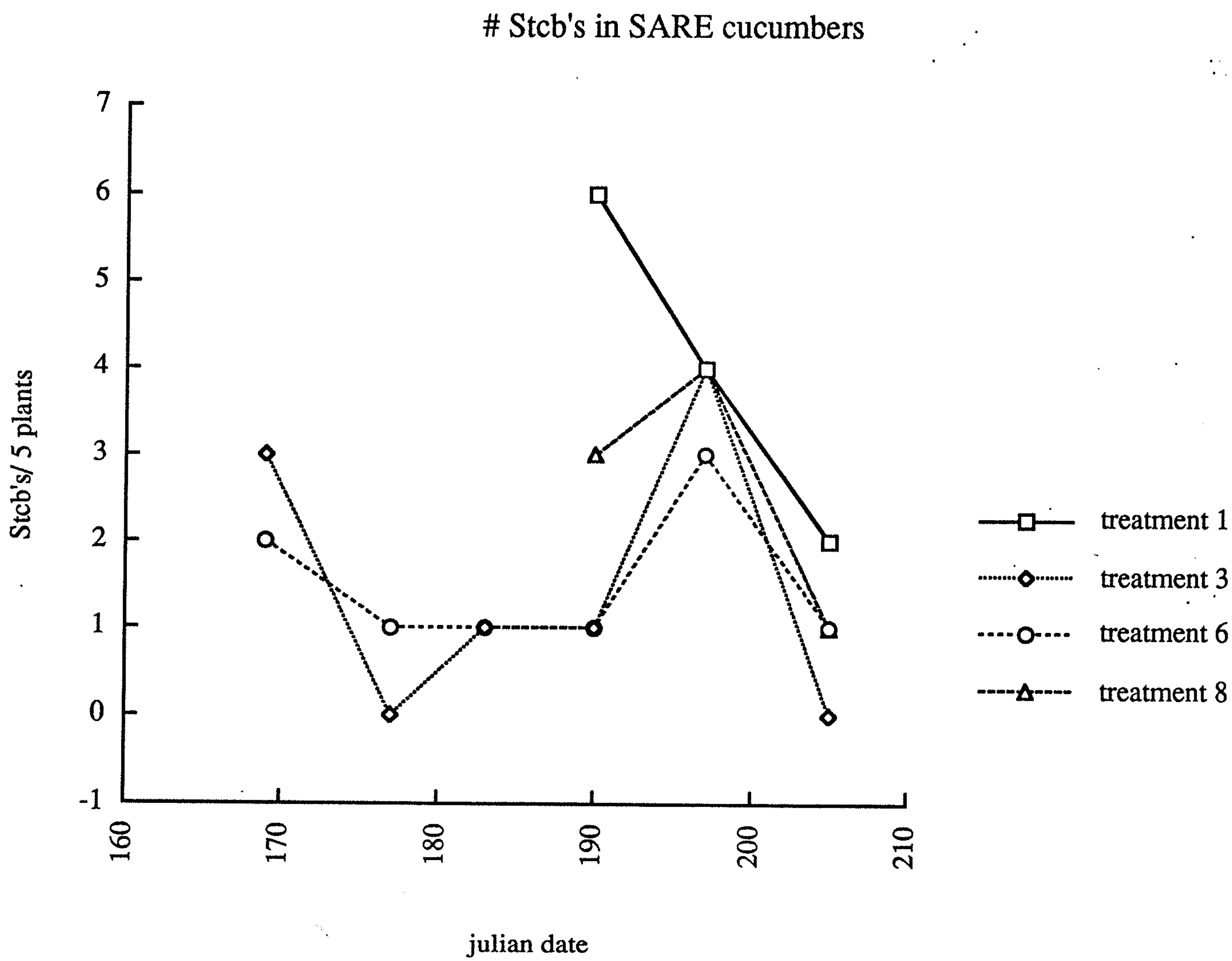


FIGURE 5-6



Stcb's in SARE cucumbers
Stcb's/ 5 plants
7
6
5
4
3
2
1
0
-1
160
170
180
190
200
210
julian date
treatment 1
treatment 3
treatment 6
treatment 8

FIGURE 5-5