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GROWTH CHARACTERISTICS OF CELERY '2-14' IN CENTRAL FLORIDA[1]

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Abstract. **Individually tagged petioles of celery '2-14' were examined weekly from 29 September 1976 through 6 January 1977 in each of two 0.17 ha fields at Zellwood, Florida. No significant differences between plots treated with fungicides or fungicides plus insecticides were observed with respect to petiole production rate (ca. 2/week), petiole longevity (ca. 5-6 weeks) or marketable weights (ca. 0.5 kg/plant). Vegetable leafminer (*Liriomyza sativae* Blanchard; Diptera: Agromyzidae) maggot and adult populations were significantly lower in insecticide protected plots than in those treated only with fungicides. Numbers of mines on marketable plants (0.2-0.3/plant, average) did not differ significantly between fields after stripping and trimming. Studies on insecticide treated celery '2-14' plants grown in bins of muck soil at Sanford (February-May 1977) confirmed that approximately 50% of the petioles produced by plants, 17 out of 34, were actually marketed.**

Since 1975, an interdisciplinary team of University of Florida researchers has been systematically assembling data on a variety of horticultural, pathological and entomological problems associated with Florida celery production. The ultimate goal of this team effort is development of a feasible pest management program for celery such that crop maintenance decisions can be evaluated objectively while yield is optimized. One outcome of this joint research is an accumulation of data necessary for a plant growth model, a prerequisite for most management decisions. In addition, we have gathered data for certain variables, such as insect pests, that interact with the celery plant and affect yield in some manner. Although considerable work still is needed to translate these plant and insect data into a mathematical format, the work described below represents some of our progress on the preliminary stages of developing interacting models for celery and selected insect pests. Since vegetable leafminer, *Liriomyza sativae* Blanchard (Diptera: Agromyzidae), is of prime concern to celery producers, data pertinent to their population dynamics were taken in conjunction with plant growth studies.

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Materials and Methods

Growth of individual celery '2-14' transplants was observed in muck soil during both fall 1976 and spring 1977 crops. In the fall study two 0.17 ha fields were transplanted on 23 September 1976 at Zellwood, Florida in 3-row, flat beds using 17.8 cm row spacing with 0.9 m between beds. Both fields were treated weekly with selected fungicides: chlorothalonil at 2.3 liters/ha; copper hydroxide at 2.2 kg/ha; benomyl at 0.28 kg/ha to 0.56 kg/ha and mancozeb at 0.56 kg/ha to 1.68 kg/ha. One field was not treated with insecticides while the other was treated 1-2x per week with selected combinations of oxamyl (1.1 liter/ha), *Bacillus thuringiensis* (1.03 kg/ha), dimethoate (1.1 liter/ha), parathion (0.5 liter/ha), or toxaphene (1.1 kg/ha to 2.3 kg/ha).

Each field was subdivided into a 4 x 5 array of 20 study sites, each 7.6 m (long) x 3.7 m. One plant in a center row of each site was selected for the growth study. Individual petioles were labeled with flexible plastic strips as soon as they grew ca. 1 cm long. Petioles were numbered consecutively on each transplant, beginning with the outermost, oldest one. Dates of initiation and death or destruction were recorded for each petiole on each plant. At harvest, fates of individual petioles (i.e. senescent, stripped or marketable) were determined along with fresh weights of marketable celery plants.

Numbers of leaf mines, both empty and active (i.e. containing maggots and/or their parasites), were counted weekly on each labeled petiole of all 40 plants in both blocks from 29 September 1976 until harvest on 6 January 1977. Maggot counts and leafminer parasite activity also were monitored weekly from samples of 20 "trifoliates" (i.e. the terminal 3 leaflets of 20 mature petioles, each on a different plant) taken from each plot. After counting the maggots and mines on fresh leaflets, samples were retained in labeled paper, pint cartons for 3 weeks. Leafminers and their parasites reared from these samples were identified and counted. Mine counts on individual petioles and petiole fates were tabulated through harvest.

Numbers of adult leafminers were also monitored weekly in each plot by using: 1) sweep net samples (10 sweeps taken over the length of the plot using a 37.5 cm diameter sweep net with a canvas bag); 2) sticky traps (one 7.6 cm x 12.7 cm yellow railroad board card, thinly covered with Tack-Trap®; and 3) D-Vac® samples (10 dips of the vacuum hose over the length of the plot) with samples taken weekly from alternate plots beginning 19 November 1977 and ending on 6 January 1977.

In the spring study at Sanford, Florida, an outdoor soil bin, ca. 3.6 m x 3.6 m x 46 cm deep, was filled with muck soil from Zellwood. Fifteen celery '2-14' plants were transplanted on 24 February; individual petioles on each plant were labeled as described previously. New growth was tagged weekly; observations on growth and senescence were made bi-weekly until harvest on 13 May 1977. Plants were watered as necessary; 3 applications of 10-4-10 fertilizer at 673 kg/ha, 3 treatments with methamidophos (2.3 liter/ha) and weekly treatments of chlorothalonil (4.6 liter/ha) were made during the study to maintain plant vigor and control insects and pathogens. At harvest, remaining petioles were removed if they were senescent, damaged or irregular in form. Stripped and marketable petioles were counted on a per plant basis.

Results and Discussion

Observations on plant growth during both fall and spring seasons produced similar results with respect to plant growth parameters (Table 1; Fig. 1). After 15 weeks of growth in the fall, plants in the fungicide only plots had grown 27.3 petioles while plants from the insecticide plus fungicide plots produced an average of 26.6 petioles (Table 1). From 10-11 of these petioles in both treatments were lost naturally before harvest; their average longevity was 5-6 weeks. From 6-8 petioles were stripped from plants in both treatments leaving approximately 9 petioles for market (Table 1). Differences in the 2 blocks with respect to petiole production, loss, longevity and stripping were not significantly different. Only 33-35% of the petioles ever produced by plants in these 2 treatments were marketable. Weights of individual marketable plants from both plots were not significantly different.

In the spring the average plant produced 34 petioles by the end of 11 weeks (Fig. 1). Approximately 10-11 petioles were lost naturally by the plant at some time during the season. For those petioles initiated and lost prior to harvest, longevity ranged from 7.5-9 weeks. One mature petiole and 5-6 senescent petioles were stripped at harvest leaving 17 (50%) petioles for market.

In the fall studies, new petioles were added at the rate of ca. 2/week in both treatments until the last 2 weeks of the season when some plants added as many as 6 new petioles per week (Table 1). The first marketable petioles were added during the 8th-10th weeks of growth in the fall crop; this was 1/2-2/3 of the way through the *growing* season. In the spring, growing conditions were more optimal than the fall; new petioles were added at the rate of ca. 3/week and the first marketable petioles appeared again about half way through the growing season, after 5 weeks of growth (Fig. 1). These celery growth results are generally comparable with those reported by Stone *et al* (2); in this earlier paper on Florida celery, plants added an average of 2 petioles per week during a 14 week growing season. Marketable petioles began appearing after 9 weeks in the field. At the end of the growing time, fall crop plants had produced 38 petioles of which 14 died before harvest, 7 were stripped and the remaining 17 were marketed.

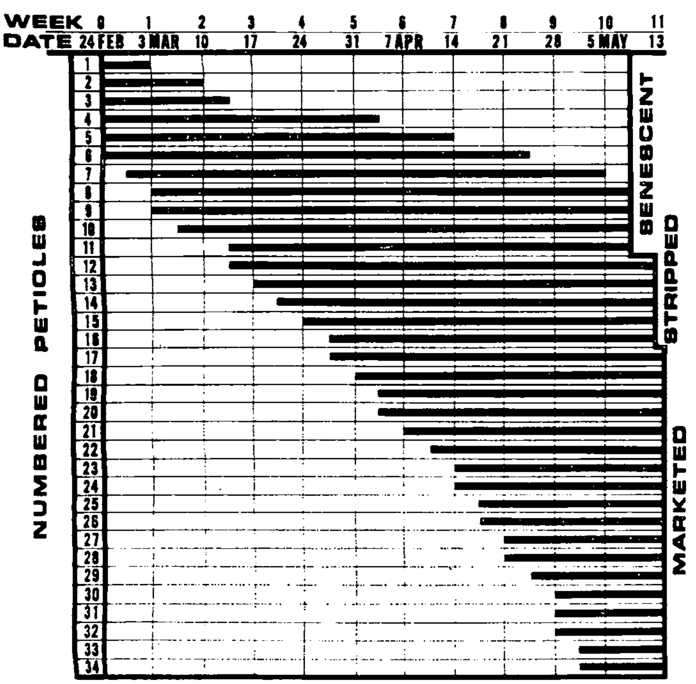

Fig. 1. Average dates for petiole initiation, longevity and disposition for celery '2-14' grown in bins of muck soil at Sanford, Florida in spring 1977 (February-May; averages for 15 plants).

Table 1. Average values for plant growth rates, yields and numbers of vegetable leafminers (*Liriomyza sativae* Blanchard) on celery '2-14' grown in muck soil at Zellwood, Florida from 23 September 1976 to 6 January 1977.

Average values for: (n = 20 plants/treatment)	Insecticides[z] plus fungicides[y]		Fungicides[y] only
New petioles added/week	1.5	—N.S.—[x]	1.6
Old petioles lost/week	0.8	—N.S.—	0.7
Total petioles after 15 weeks	26.6	—N.S.—	27.3
Petioles lost before harvest	11.2	—N.S.—	10.4
Petioles removed at harvest	6.2	—N.S.—	8.0
Total marketable petioles	9.2	—N.S.—	8.9
Marketable fresh weight (kg)[w]	0.49	—N.S.—	0.52
Active mines-marketable stripped plant	0.15	—N.S.—	0.26
Total mines-marketable stripped plant	3.15	—N.S.—	2.58

[z]Insecticides used weekly on a per hectare basis included: oxamyl and dimethoate (1.1 liters each), *Bacillus thuringiensis* (1.03 kg), parathion (0.5 liters) and toxaphene (1.1 kg to 2.3 kg).
[y]Fungicides used weekly on a per hectare basis included: benomyl(0.28 kg to 0.56 kg), mancozeb (0.56 kg to 1.68 kg), copper hydroxide (2.2 kg), and chlorothalonil (2.3 liters).
[x]Means in same rows were not significantly different at $p < 0.05$ in Student's t-test.
[w]Yield data taken from six 6.1 m sections (ca. 40 plants) of row.

Most of the data from the fall 1976 leafminer studies (Table 2) indicated that leafminers and their parasites were significantly less active in insecticide treated plots than in those receiving fungicides only. Average values for sweeping, rearing, mine counts in leaflets and D-Vac samples in the insecticide plus fungicide plots ranged from 3% (reared parasites) to 69% (swept leafminers) of the values reported for the fungicide only plots. However, roughly comparable numbers of adult leafminers were trapped on sticky cards in both treatments. We assume that these latter results are due to a combination of factors including time invested per sample (24h for each card *vs* 5 minutes or less for each of the other techniques) and the mobility of flies such that they can readily reinfest a sampled site even though it may be protected by insecticides.

According to active and total mine data, oviposition was markedly less in insecticide protected plots even though potentially damaging leafminer populations were present, as demonstrated by values associated with the variables, D-Vac flies and swept flies (Table 2). Perhaps beneficial insects were killed directly or weakened by succeeding insecticide treatments prior to oviposition; alternatively, they may not have preferred to oviposit in insecticide treated leafminers since rearing results in these latter plots were only 3% of the value observed for parasites reared from fungicide treated plots.

Table 2. *Statistical comparison of vegetable leafminer (Liriomyza sativae* Blanchard) infestation indices taken from two 0.17 ha celery '2-14' fields at Zellwood, Florida (September 1976-January 1977); one field was treated with fungicides only and the second was treated with insecticides plus fungicides.

Average values for: (n=20 except for D-Vac where n=10)	Field treatments		Significance
	Insecticides[z] plus fungicides[y]	Fungicides[y] only	
Leafminers on sticky traps	23.8	32.4	N.S.
Leafminers in sweeps	14.1	20.5	0.01
Leafminers in D-Vac	134.2	198.3	0.01
Parasites in D-Vac	9.5	92.3	0.01
Active mines—leaflets	3.9	58.3	0.01
Leafminers reared—leaflets	18.8	83.8	0.01
Parasites reared—leaflets	0.5	15.9	0.01
Active mines—whole plant at harvest	2.7	15.0	0.01
Total mines—leaflets	33.5	167.4	0.01

[z]Insecticides used weekly on a per hectare basis included: oxamyl and dimethoate (1.1 liters each), *Bacillus thuringiensis* (1.03 kg), parathion (0.5 liters) and toxaphene (1.1 kg to 2.3 kg).
[y]Fungicides used weekly on a per hectare basis included: benomyl (0.28 kg to 0.56 kg), mancozeb (0.56 kg to 1.68 kg), copper hydroxide (2.2 kg), and chlorothalonil (2.3 liters).

The species of parasites reared from both treatments were the same; *Opius dimidiatus* (Ashmead) (Hymenoptera: Braconidae) was the most common species, followed by the chalcids, *Diglyphus intermedius* (Girault) and *Achrysocharella formosa* Westwood. Parasitism in the insecticide treated plots reached a peak in the 2 December 1976 samples at 7% (or 17 parasites/249 total reared); in the fungicide only plots the peak parasitism, 41% (690 parasites/1702 total reared), occurred during week 10 (2 December 1977). The peak of adult leafminer activity in both fall blocks occurred just prior to or during the time interval that marketable petioles were being added by the plants.

Statistically significant effects of insecticide treatments also were observed in all previously mentioned variables when data were analyzed on a weekly basis from transplant through harvest, although differences between the 2 treatments in terms of marketable, fresh weights and mine counts disappeared once the plants were stripped and trimmed (Table 1). These pre-harvest and harvest results on leafminer infestation are thus comparable to those reported earlier (1). An average of ca. 0.3 mines/plant remained in ready-to-crate celery from the fungicide treatment while 0.2 mines/plant remained on insecticide treated celery.

In conclusion, celery '2-15' naturally lost nearly half of the petioles that it produced during the growing season. An additional 18-29% of the total petioles were stripped at harvest. Regular insecticide applications in addition to fungicides significantly reduced numbers of leafminers and their parasites in treated fields. Vegetable leafminers seemed to have little effect on crop production in our fields at Zellwood in fall 1976 since plants in both treatments grew as comparable rates; further, yields for both fields were similar in terms of sizes, weights of plants, and numbers of leaf mines remaining on marketable plants. The added expense of insecticidal crop protection appeared excessive for a pest population of the light to moderate magnitude seen in that area at that point in time. Obviously, treatment thresholds and economic injury levels are needed for celery and other high value vegetable crops especially when they have pests that are very difficult to control chemically. Determining these pest thresholds becomes complicated in view of the natural losses of petioles during growth and at harvest. However, when useful threshold levels are determined and when the interactions of leafminer parasites and potent pesticides are more completely understood, researchers hopefully can help the grower make sound management decisions to achieve his goals of high yields and good quality.

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EVALUATION OF THE IFAS CELERY SEEDLING HARVESTER USING PRECISION SEEDED PLANTS[1,2]

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Abstract. **The IFAS celery seedling harvester was tested for damage of transplants and for effect on yields. Two seedbeds were used, one seeded by the grower's conventional method using raw seed and the other seeded with coated seed by a precision seeder. Plants were pulled by using the seedling harvester or by hand. A pulling rate of up to 117 boxes/hr. using the seedling harvester with three workers was measured. An average of 12% of the plants pulled by the harvester were damaged. The marketable yield responses were highest for the hand pulled plants and lowest for the damaged machine pulled plants. The yield of undamaged plants pulled by the harvester from the precision seeded bed was higher than plants from the conventional seeding. Precision seeded plants with more uniform spacing were more effectively pulled by the seedling harvester and more effectively transplanted. Yield losses were due to loss in plant stand and the loss of stand could be reduced by improved irrigation techniques and improved harvester adjustment.**

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[2]Acknowledgment is given to the Florida Celery Exchange, South Bay Growers, and A. Duda and Sons for their support and contributions to this study.

A machine to harvest celery seedlings from the seedbed has been developed by IFAS (1, 3). Mechanically the harvester performs very well and it is believed that using the principles developed, a successful commercial machine can be constructed.