placed on the host crop due to differences in precipitation and daytime temperatures were probably more important. Fourthly, large population densities of root-knot nematodes can develop on the crop even when the nematode is not found in early or preseason soil samples. In 1979, zero *M. incognita* (Table 3) were found in the treatment 5 block, yet 627 larvae/100 cm^3 soil were present at harvest.

Based on our data, there is little doubt that over the long term, nematode control in NEF is worth the investment in time and dollars. Although an actual dollar loss can be experienced by the grower during certain seasons such as in 1980 when plant stress and yield losses due to nematode injury were minimal, potentially disastrous yields such as those occurring in 1977, 1979, and 1981 in Treatment 6 (Table 5), can be prevented with nematode control. The data also suggest that the economics of the combined use of a nonvolatile nematicide and a soil fumigant, especially if the crop is destined for the chip market, may over the long term be questionable. Our data, however, have not been corrected for defects in tuber quality associated with CRS and other soil borne problems which are controlled with the combined treatment (5, 6, 8, 9) and which may effect the dollar value of the crop for table stock.

There is some indication in our data that nematode control following use of T + A may be sufficient to increase potato yields for two seasons. In 1979 and 1981 Treatment 4, which was nontreated during those seasons, produced, respectively, 118 and 145 cwt/acre > the nontreated Treatment 6 (Table 5). Even with this, however, there would be little economic gain over using A or T each season as in Treatments 2 and 5. In fact, the variations in yield in Treatments 2 and 5 were the least of any treatments; suggesting a more consistent performance and return to the grower than the other nematicide combinations.

In conclusion, our data support the following statements: 1. use of nematicides should be an integral part of NEF potato production. Any field with sting nematode should be treated since comparable population densities of *B. longicaudatus* can have drastically different, and unpredictable, affects on potato yields. 2. use of A + T may have effectively reduced populations of *B. longicaudatus* for two seasons, however, growers should very carefully analyze the economics of combined nonvolatile nematicide and soil fumigant treatments before using them. 3. No undesired effects on the crop, incidence of disease or population densities of the target nematodes have been observed following perennial use of nematicides in our research plots.

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Proc. Fla. State Hort. Soc. 94:144-146. 1981.

REDUCING CELERY LEAFMINER DAMAGE WITH PLANT GROWTH REGULATORS[1]

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Additional index words. Apium graveolens, Liriomyza trifolii, yield, pest management.

Abstract. **Two plant growth regulators, gibberellic acid (GA_3), 6-benzyladenine (BA), and combinations thereof were used as root dips before transplanting or applied as foliage sprays on celery two weeks before harvest. The combination of 25 ppm of GA_3 and 25 ppm of BA used as a root dip restricted early root growth, reduced transplant survival, and restricted marketable weight. The use of GA_3 and BA did not increase marketable yield or average stalk weight, but some treatments did increase plant height. The per cent leaves infested with leafminer (*Liriomyza trifolli*) was somewhat reduced by trimming the taller GA_3, BA, and GA_3 + BA sprayed plants.**

Gibberellin is one of a number of growth-promoting substances produced by the fungus, *Gibberella fujikuroi*, or is found in plant extracts. The physiological and morphological processes of gibberellins on plant growth and development have been studied in depth (8, 10). Gibberellic acid or gibberellin A_3 (GA_3) can be synthesized in a laboratory. Although much emphasis has been placed on commercial use of synthetic or exogenous GA_3 in fruit production (2, 4), GA_3 can be used to advantage in other stages of plant growth including stimulation and ripening of seeds (3, 7, 11), promotion of root initiation (5), reversal of induced dormancy (6), increasing yields (1, 2, 9, 10, 15), and promotion of flowering in certain conifers and ornamentals (12, 13).

GA_3 promotes growth of celery by increasing plant

[1]Florida Agricultural Experiment Stations Journal Series No. 3457.

height, fresh weight, and dry weight (10, 14, 15). Some undesirable effects in celery of excessive concentrations of GA_3 include lighter green color, more susceptible to wilting in hot dry weather, blackheart, and bolting (14). Generally, 10 to 100 ppm of GA_3 increased growth and yield (14, 15). One manufacturer's spray guide for GA_3 suggests using 25 to 50 ppm one to four weeks prior to harvest to increase plant height and yield, overcome stress due to cold weather, and to obtain earlier maturity.

The purpose of this study was to determine if GA_3 and BA would increase celery plant height enough so that normal trimming for market would remove leaves infested with leafminer (*Liriomyza trifolii*). If the infested leaves could be removed without reducing the yield or average weight, growers would have a management tool which could be used in an integrated pest management (IPM) system. Fewer insecticide sprays would be required since more leafminer damage could be tolerated.

Materials and Methods

Celery plants were obtained from local growers and transplanted into a Lauderhill muck soil at Zellwood, Florida. Plots were 1.8 m wide by 12.8 m long. This gave three rows per plot with a 61 cm row spacing. Plants were spaced 17 cm within each row. Growth measurement, leafminer, and yield data were taken from the middle row of each plot (61 cm wide X 549 cm long). The plots were arranged in a randomized block design with six replications. Data taken at harvest were: plant height, number of plants, number of marketable stalks, marketable stalk weight, and petiole length. The area of petiole leaves which were infested with one or more leafminers was visually estimated before harvest and after trimming the marketable stalks to a standard length of 39 cm. Removal of several outer petioles and trimming to a uniform length is a standard practice in preparation of celery for market. The plant height was measured from the base of the crown (heart) to the tip of the tallest petiole leaf. The petiole length was measured from the base of the crown to the first node of the longest outside petiole. A sample of ten plants per replication was measured.

Experiment 1.—Plants of 'Florida 683' were transplanted on October 3, 1978. Three treatments consisted of plants dipped bare root for one minute in either 25 ppm of 6-benzyladenine (BA), 13 ppm of GA_3 + 12 ppm BA, or 25 ppm GA_3 + 25 ppm BA prior to transplanting. Four other treatments were applied as an over-the-row broadcast spray 79 days after transplanting and an estimated two weeks before harvest. These four treatments were 25 ppm GA_3, 25 ppm BA, 25 ppm GA_3 + 25 ppm BA, and 30 ppm GA_3 + 5 ppm BA. Harvest was delayed four days until January 8, 1979, due to a freeze (−1.3°C) the day before the planned harvest.

Experiment 2.—Plants of 'Florida 1622' were transplanted on September 26, 1979. The treatments were the same as in Experiment 1. Foliage sprays were applied two weeks before harvest. Plots were harvested on December 18, 1979.

Experiment 3.—Plants of 'Florida 1622' were transplanted on March 26, 1980. Five treatments were applied to the foliage two weeks before harvest. The treatments were 25 ppm GA_3, 50 ppm GA_3, 100 ppm GA_3 25 ppm BA, and 25 ppm GA_3 + 25 ppm BA. Plots were harvested on June 17, 1980.

Experiment 4.—Plants of 'Florida 1622' were transplanted on April 23, 1980. Treatments were the same as in Experiment 3. Foliage sprays were applied two weeks before harvest. Plots were harvested on July 11, 1980.

Experiment 5.—Plants of 'Florida 1622' were transplanted on August 29, 1980. Treatments were the same as in Experiments 3 and 4. Foliage sprays were applied two weeks before harvest. Plots were harvested on December 15, 1980.

Results and Discussion

Experiment 1.—Two spray treatments (25 ppm GA_3 + 25 ppm BA and 30 ppm GA_3 + 5 ppm BA) had a significantly higher number of plants than the 25 ppm GA_3 + 25 ppm BA root dip treatment (Table 1). No treatment was significantly different in number of plants than the check. The root dip treatment, 25 ppm GA_3 + 25 ppm BA, restricted early root growth after transplanting with a shorter plant height and petiole length at harvest (Table 2). Sprayed plants with 25 ppm GA_3 + 25 ppm BA had a significantly greater plant height (Table 2), but significantly less average marketable stalk weight (Table 1) than the check. The petiole lengths were not significantly different (Table 2). No treatment significantly increased the yield or petiole length. Significantly taller plants resulted from three of the four spray treatments (Table 2). There was

Table 1. Yield and average weight of celery as affected by a pretransplant dip treatment or foliage sprays two weeks before harvest with gibberellic acid (GA_3) and 6-benzyladenine (BA). Experiment 1.

Treatment	Conc. (ppm)	No. plants	Marketable stalks No.	Wt. (kg)	Avg./stalk (g)
Root dip					
BA	25	160 ab[z]	154 ab	98 ab	638 abc
GA_3 + BA	13 + 12	160 ab	151 ab	101 a	677 ab
GA_3 + BA	25 + 25	150 b	138 b	82 b	600 bc
Spray					
GA_3	25	159 ab	156 ab	101 a	645 abc
BA	25	161 ab	159 a	97 ab	610 abc
GA_3 + BA	25 + 25	166 a	163 a	95 ab	586 c
GA_3 + BA	30 + 5	164 a	160 a	102 a	637 abc
Check		163 ab	161 a	109 a	680 a

[z]Mean separation within columns by Duncan's Multiple Range Test, 5% level.

Table 2. Plant height, petiole length, and damaged celery leaves infested with leafminers (*Liriomyza trifolli*) as affected by a pretransplant dip treatment or foliage sprays two weeks before harvest with gibberellic acid (GA_3) and 6-benzyladenine (BA). Experiment 1.

Treatment	Conc. (ppm)	Plant height (cm)	Petiole length (cm)	Leafminer damage Before trim	After trim	Change (%)
Root dip						
BA	25	67.8 b[z]	22.0 a	41.3 a	11.2 ab	72.9
GA_3 + BA	13 + 12	68.2 b	22.6 a	40.0 a	13.0 a	67.5
GA_3 + BA	25 + 25	65.9 b	19.2 b	42.6 a	18.8 a	55.9
Spray						
GA_3	25	72.7 a	23.8 a	39.7 a	6.7 ab	83.1
BA	25	70.1 ab	23.5 a	38.4 a	3.3 b	91.4
GA_3 + BA	25 + 25	73.8 a	23.2 a	39.9 a	5.4 b	86.5
GA_3 + BA	30 + 5	75.1 a	22.7 a	41.0 a	8.0 ab	80.5
Check		68.5 b	23.0 a	41.5 a	7.8 ab	81.2

[z]Mean separation within columns by Duncan's Multiple Range Test, 5% level.

no significant correlation (r = 0.6373) between plant height and petiole length.

There were no significant differences among the treatments for leafminer damaged area before trimming the celery tops (Table 2). After trimming, the area of leafminer infested foliage was not significantly different for any treatment from the check, but two root dip treatments had significantly higher leafminers than two foliage treatments. The freeze before harvest may be responsible for the lack of correlation between plant height and leafminer damage after trimming. Plants from the root dip treatments had slightly shorter petioles and more leaves after trimming. With more leaf area, they received a high leafminer rating.

Experiment 2.—Plants of 'Florida 1622' were harvested 83 days after transplanting. Yield and plant height data were taken and generally followed the same results as in Experiment 1. Leafminer damage was low and no differences could be measured before or after trimming.

Experiment 3.—This experiment was terminated without harvest data on June 17, 1980, 83 days after transplanting. There were few leafminers, but a serious early blight (*Cercospora apii*) problem had developed.

Experiment 4.—Few leafminers were found when the spray treatments were applied on June 27, 1980. Due to the hot weather (above 35°C), there was no response to the treatments.

Experiment 5.—There were no significant differences for number of plants, marketable number, weight, or average stalk weight (Table 3). Plant height was increased over the check significantly for all GA_3 treatments (Table 4). Petiole length was increased over the check for three of the four GA_3 treatments. Leafminer damage was the same on all treatments before trimming (Table 5). Two treatments (25 ppm GA_3 and 25 ppm GA_3 + 25 ppm BA) had significantly less leafminers on the foliage after trimming (Table 5). These treatments also had taller plants than the check. The 50 and 100 ppm GA_3 treatments were taller than the check, had fewer leafminers after trimming, but not significantly fewer.

Table 3. Yield and average weight of celery as affected by foliage sprays two weeks before harvest with gibberellic acid (GA_3) and 6-benzyladenine (BA). Experiment 5.

Treatment	Conc. (ppm)	No. plants	Marketable stalks No.	Marketable stalks Wt. (kg)	Marketable stalks Avg./stalk (g)
GA_3	25	192	180	88.3	444.9
GA_3	50	190	183	80.1	469.0
GA_3	100	203	188	85.8	444.9
BA	25	198	189	83.5	469.0
GA_3 + BA	25 + 25	200	190	88.6	469.4
Check		197	192	89.3	459.9
		NS	NS	NS	NS

Table 4. Plant height and petiole length of celery as affected by foliage sprays two weeks before harvest with gibberellic acid (GA_3) and 6-benzyladenine (BA). Experiment 5.

Treatment	Conc. (ppm)	Plant height (cm) Dec. 1	Plant height (cm) Dec. 8	Plant height (cm) Dec. 15	Petiole length (cm)
GA_3	25	65.8	71.5 b[z]	77.2 b	30.8 b
GA_3	50	64.2	69.7 ab	76.1 b	30.4 ab
GA_3	100	64.1	71.1 b	78.2 b	30.9 b
BA	25	64.4	67.6 a	73.3 a	30.3 ab
GA_3 + BA	25 + 25	65.7	71.1 b	77.0 b	31.0 b
Check		66.7	67.9 a	72.8 a	29.8 a
		NS			

[z]Mean separation within columns by Duncan's Multiple Range Test, 5% level.

Table 5. Celery leaves infested with leafminers (*Liriomyza trifolli*) before and after trimming as affected by foliage sprays two weeks before harvest with gibberellic acid (GA_3) and 6-benzyladenine (BA). Experiment 5.

Treatment	Conc. (ppm)	Leafminer damage Before trim	Leafminer damage After trim	Leafminer damage Change (%)
GA_3	25	46.8	3.2 b[z]	93.2
GA_3	50	44.7	7.0 ab	84.3
GA_3	100	43.8	6.8 ab	84.4
BA	25	48.0	9.8 a	79.6
GA_3 + BA	25 + 25	45.8	4.6 b	90.0
Check		45.3	10.1 a	77.7
		NS		

[z]Mean separation within columns by Duncan's Multiple Range Test, 5% level.

This study indicates growth regulators, under proper growing conditions, may be of benefit in a celery IPM program. In summary, under certain growing conditions, growth regulators can be used to stimulate celery plant height. More leafminer infested foliage is removed from taller plants by the normal trimming process. Therefore, a higher level of leafminer damage can be tolerated which could indicate fewer insecticide sprays for the control of leafminer. Celery growth, weather, and leafminer conditions will be factors in the success of this practice.

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