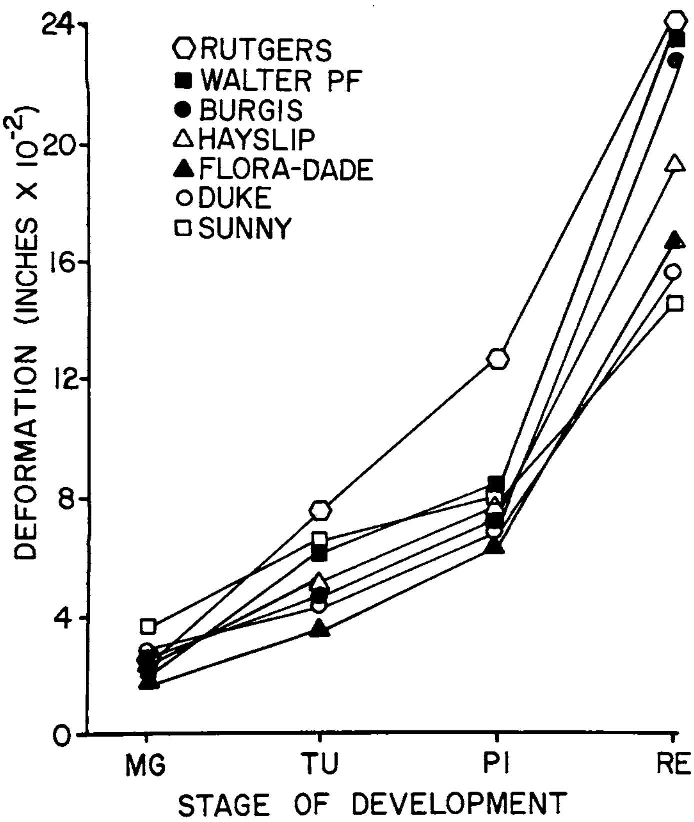

Fig. 2. Firmness evaluation of tomatoes at selected stages of development (MG = mature-green, TU = turning, PI = pink, RE = red).

and we suggest that these measurements may be incorporated into existing programs that emphasize quality evaluation.

Acknowledgements

The authors wish to thank Dr. S. J. Locascio and Dr. D. D. Gull for their cooperation.

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Proc. Fla. State Hort. Soc. 96:109-113. 1983.

INFLUENCE OF POLLINATION AND CHLORFLURENOL ON FRUIT DEVELOPMENT IN SQUASH[1]

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Additional index words. Cucurbita pepo, Curbiset, Ethrel, ethephon, fruit set.

Abstract. **Yellow crookneck (cv. Dixie) and/or straightneck (cv. Seneca Prolific) summer squash** (Cucurbita pepo **L.) were grown in greenhouse and field experiments at Gainesville. In the greenhouse, 50 ppm methyl-2-chloro-9 hydroxyfluorene-[9]-carboxylate (chlorflurenol) increased fruit set of 'Dixie' when the flowers were not pollinated. When pollination occurred or at a 100 ppm concentartion, chlorflurenol was without effect on fruit set. Fruit shapes from chlorflurenol treated plants were significantly improved when the flowers were not pollinated. In the field 0 to 200 ppm chlorflurenol was applied when 4 to 6 female flowers were visible. Early yields were increased by 25 to 50 ppm chlorflurenol regardless of cultivar. Individual fruit weights were generally less in the chlorflurenol treatments, however more fruit per plant were produced leading to similar total yields in the chlorflurenol treatments as the control. To improve the effectiveness of chlorflurenol, plants were sprayed twice in the seedling stage with 250 ppm 2-chloroethyl phosphonic acid (ethephon) to increase femaleness. Ethephon did not improve the effectiveness of chlorflurenol but did increase overall yields of 'Dixie' squash.**

Parthenocarpy can be induced chemically in cucumber (*Cucumis sativus* L.) by several growth regulators. Most notably, auxin transport inhibitors such as TIBA (2) and chlorflurenol (7) are highly active inducers of multiple fruit set in cucumber. Chlorflurenol effectively induces parthenocarpy in muskmelon (*Cucumis melo* L.) (4) and improves fruit set in tomato (8).

Nitsch et al. (6) reported that the flowering and fruit set patterns of summer squash and cucumber are similar and that both species are capable of setting fruit parthenocarpically. The induction of uniform fruit set promotes earliness, easier harvesting, and, in the case of cucumber, allows the crop to be mechanically harvested.

The objective of this study was to determine the effects of chlorflurenol on fruit set, yield, and fruit size in summer squash.

Materials and Methods

Greenhouse experiments 1 and 2. Effect of chlorflurenol on fruit set in squash. Summer squash (cv. Dixie) seeds were

[1]Florida Agricultural Experiment Stations Journal Series No. 5214.

planted in 3-gal pots containing a vermiculite-peat mix (1:1 v/v). The pots were placed in a greenhouse maintained at 80°F (day) and 65°F (night) under natural light conditions. The plants were seeded in October and grown for approximately 3 months. Insects were excluded to prevent random pollination. At the onset of flowering the plants were divided into 2 groups, 1 which was hand-pollinated on the day of anthesis, the other which was not. At approximately 1 to 2 days before anthesis of the first female flower, one-half of each group of plants were sprayed with 50 ppm of chlorflurenol. Each female flower that opened was tagged, and at the termination of the experiment, all the fruit which developed were removed and measured. A second experiment was initiated in January and conducted in the same manner as the first except that chlorflurenol was applied at 100 ppm.

Field experiment 1. Effect of chlorflurenol on yield. Squash seeds, 'Seneca Prolific' and 'Dixie' were planted on April 3, 15 inches apart in a fine sandy soil at the Horticultural Unit in Gainesville on beds with 4-ft centers covered with black plastic mulch. Individual plots were 25 ft long and each treatment was replicated 4 times. Cultural practices, including disease and insect control were those recommended for Florida (5). Pollination was encouraged by the use of bees.

Chlorflurenol was applied at 0, 25, 50, 100, or 200 ppm to runoff when 4 to 6 female flowers were visible and after approximately 2 reached anthesis but before any male flowers opened. The fruit were harvested from 10 plants in the center of each plot 7 times beginning on May 12 and ending May 27.

Field experiment 2. Effect of ethephon and chlorflurenol on yield. 'Dixie' squash was planted and grown in the spring of the following year in the same manner as described above. Ethephon was applied at 0 or 200 ppm in a single application when the plants were at the 2 to 3 leaf stage in order to induce femaleness. Chlorflurenol was applied as described above.

Results and Discussion

In the greenhouse, pollination significantly reduced the number of female flowers which opened (Table 1). Approximately 50% fewer female flowers opened when chlorflurenol was applied to nonpollinated plants. The number of fruit which developed was doubled when chlorflurenol was applied to nonpollinated plants, while all other treatments had approximately one fruit per plant set and develop. The average node at which the fruits set was unaffected by treatment.

At maturity pollinated fruits were larger than nonpollinated fruit (Table 1). Nonpollinated fruit were long and narrow and the seed cavity was undeveloped unless chlorflurenol was applied, wherein the fruits had undeveloped seed and were enlarged at the base (Fig. 1 and 2).

Increasing the rate of chlorflurenol to 100 ppm or pollination had no effect on fruit development of squash grown in the greenhouse in the winter (Table 2). As previously reported by Nitsch et al. (6) seasonal effects probably led to a more conducive environment for parthenocarpy to occur in the nonpollinated control plants. Fruit size was less affected by pollination than in the previous experiment, however, the circumference of nonpollinated control fruits were still significantly narrower than fruit from all the other treatments.

Patterns of floral opening in many summer squash hybrids such as 'Dixie' and 'Seneca Prolific' are such that several female flowers reach anthesis before the first male flower opens (Cantliffe, personal observation). This gives rise to inadequate pollination of the early female flowers and thus, a high percentage of off-type fruits. The use of chlorflurenol might greatly increase the potential for promoting earliness in squash by providing for more marketable fruits from these first female flowers (Fig. 1 and 2). This idea was next tested in the field.

The data for both cultivars were combined since there were no significant interactions. The harvest data were divided into early, late, and total yields for a clearer indication of the action of the chemical on fruit maturity. Chlorflurenol at all rates tested significantly increased the yields of fruit harvested at the first picking (Table 3). When averaged over the first 3 harvest dates, yields were greater than the control at only the 25 and 50 ppm rates of chlorflurenol. Yields at the late harvest were lower than the control except at the 25 ppm rate. This gave rise to total yields which were lower than the control at the 100 and 200 ppm chlorflurenol concentration. These yield differences were reflected by a higher number of fruit set per plant and lower fruit weights (Table 4) due to the chlorflurenol treatment. In treatments from chlorflurenol concentrations of 50 to 200 ppm, individual fruit weights were significantly lower than the control in the late harvests. There appeared to be strong advantage to chlorflurenol usage for better control of fruit sizing as the plants became older. This is extremely important to saleability of the product, i.e. the smaller the size the more marketable the fruit.

Cantliffe and Phatak (1) reported that when ethephon was used to induce femaleness in pickling cucumbers before chlorflurenol was applied, as high as a 68% yield increase was recorded. Cantliffe and Woods (3) increased early and total yields in 'Dixie' summer squash by application of ethephon. Thus, another experiment was designed to increase the numbers of female flowers by ethephon application, a procedure which might then increase the potential effectiveness of chlorflurenol. Ethephon significantly increased early and total yields of squash fruit (Table 5). The

Table 1. Effect of 50 ppm chlorflurenol on fruit set and development of 'Dixie' squash grown in the greenhouse.

Chlorflurenol (ppm)	Fruit set			Fruit characteristics			
	No. female flowers/plant	No. fruit/plant	Avg node of fruit set	Weight (oz)	Length (inches)	Circumference (inches)	Immature seed (no.)
Not pollinated							
0	10.8c[z]	0.8a	8.3a	5.2a	3.8a	3.3a	78a
50	5.8b	2.0b	9.8b	10.2b	6.7b	6.6ab	104a
Pollinated							
0	3.5a	1.0a	8.3a	15.8b	9.4b	10.0bc	244b
50	2.5a	1.3a	7.3a	18.3c	9.3b	10.4c	234b

[z]Mean separation in columns by Duncan's multiple range test, 5% level.

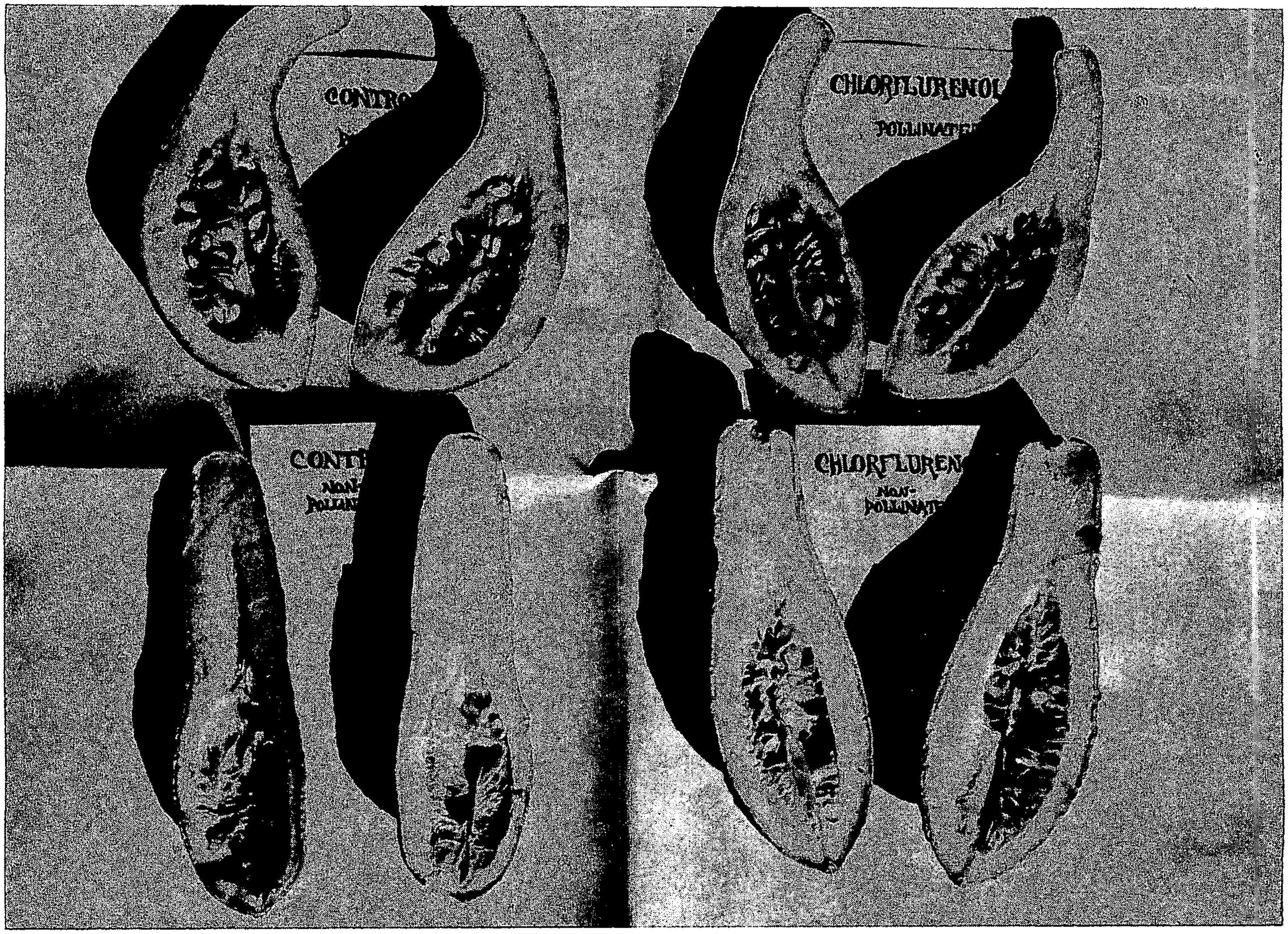

Fig. 1. Effect of chlorflurenol and pollination on fruit shape in 'Dixie' squash. The upper two fruits came from pollinated flowers, whereas the lower two were not pollinated. The two fruits on the right (upper and lower) came from plants treated with 50 ppm chlorflurenol.

Table 2. Effect of 100 ppm chlorflurenol on fruit set and development of 'Dixie' squash grown in the greenhouse.

Chlorflurenol (ppm)	Fruit set			Fruit characteristics			
	No. female flowers/plant	No. fruit/plant	Avg node of fruit set	Weight (oz)	Length (inches)	Circumference (inches)	Immature seed (no.)
Not pollinated							
0	6.4b[z]	1.4a	11.6b	21.4a	7.4a	7.0a	12a
100	4.8a	1.0a	10.7ab	22.0a	7.7a	8.7b	24a
Pollinated							
0	4.8a	1.0a	10.8ab	22.5a	8.4a	9.6b	120b
100	3.8a	1.2a	8.4a	21.8a	7.4a	8.6b	102b

[z]Mean separation in columns by Duncan's multiple range test, 5% level.

Table 3. Main effects of chlorflurenol application on yield as tons/acre or number of fruit per plant when applied to 'Seneca Prolific' and 'Dixie' squash grown in the field. The data for both cultivars were combined.

Chlorflurenol (ppm)	Yield (tons/acre)				No. fruit/plant			
	First harvest	Early harvest (picks 1-3)	Late harvest (picks 4-7)	Total	First harvest	Early harvest (picks 1-3)	Late harvest (picks 4-7)	Total
0	2.0a[z]	5.6a	9.6d	15.2bc	1.7a	5.3ab	6.3c	11.6bc
25	2.8cd	7.0c	9.3d	16.3c	2.5b	6.6c	6.6c	13.2d
50	2.8cd	6.2b	7.9c	14.1b	2.2ab	5.8b	6.5c	12.3cd
100	2.6bc	5.2a	5.4b	10.6a	1.9b	4.9a	5.4b	10.3ab
200	3.2d	5.6a	3.7a	9.3a	2.4b	5.1a	4.1a	9.2a

[z]Mean separation in columns by Duncan's multiple range test, 5% level.

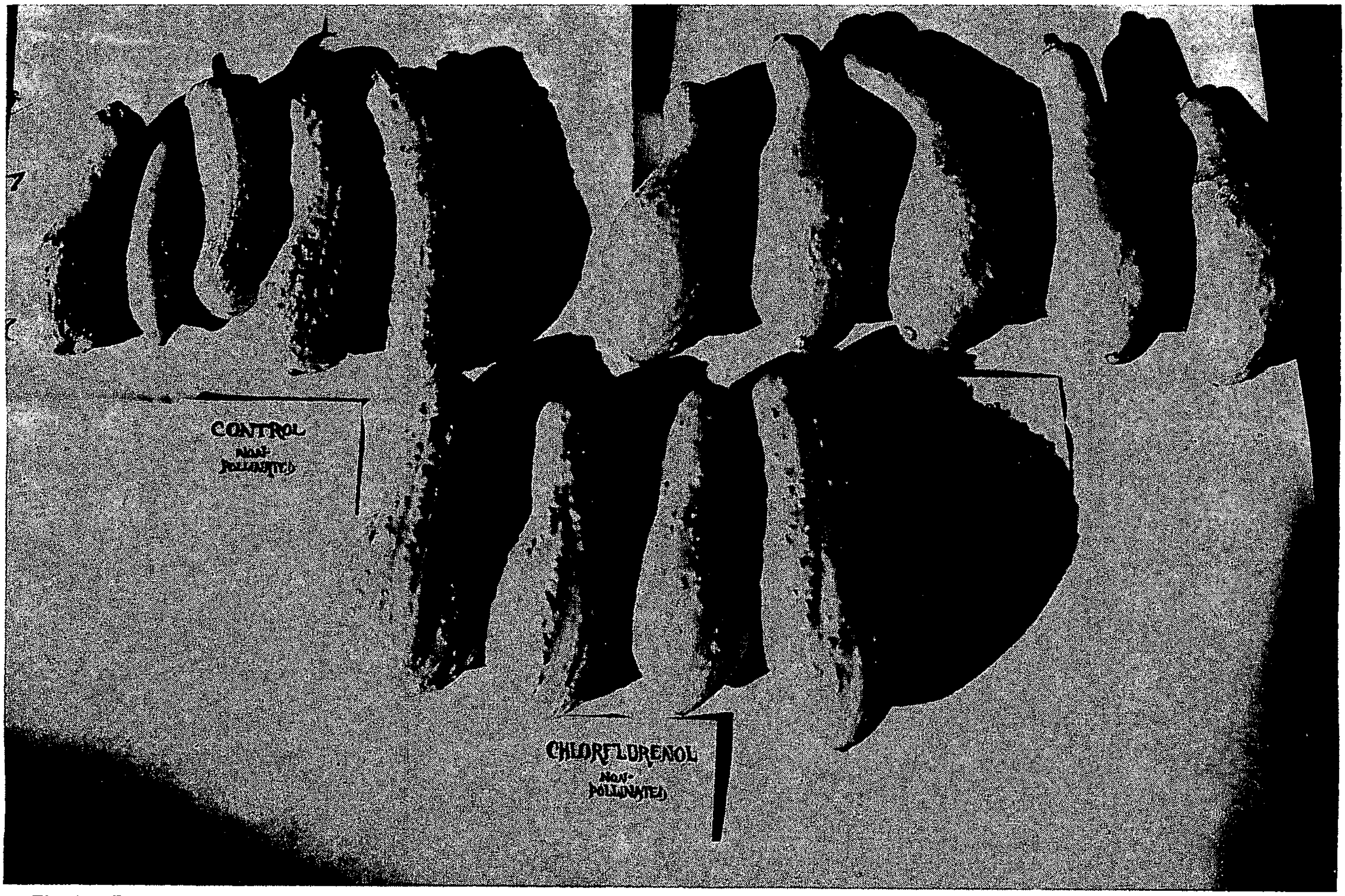

Fig. 2. Effect of chlorflurenol on shape of nonpollinated fruits. Upper left, the flowers were not pollinated; upper right, the flowers were pollinated; lower fruits, the flowers were not pollinated but the plants were treated with 50 ppm chlorflurenol.

Table 4. Main effects of chlorflurenol application on the weight per fruit of 'Seneca Prolific' and 'Dixie' squash grown in the field. Data for both cultivars was combined.

	Weight/fruit (lb.)			
Chlorflurenol concn (ppm)	First harvest	Early harvest (picks 1-3)	Late harvest (picks 4-7)	Mean
0	0.30ab[z]	0.25a	0.33d	0.30c
25	0.27a	0.25a	0.32cd	0.29bc
50	0.32ab	0.26a	0.26bc	0.26abc
100	0.34b	0.24a	0.23ab	0.24ab
200	0.31ab	0.24a	0.20a	0.22a

[z]Mean separation in columns by Duncan's multiple range test, 5% level.

increase in yield was related to an increase in fruit size for the early harvests, or an increase in the numbers of fruit produced per plant for the total yield. The addition of ethephon to the spray scheme had no additional benefit towards improving the effectiveness of chlorflurenol. There was a slight nonsignificant trend towards increased early yields. However, total yields were significantly reduced by 100 and 200 ppm concentrations of chlorflurenol. This was related to a decrease in individual fruit weights.

The use of low concentrations of chlorflurenol, 25 to 50 ppm, constitutes a useful tool to increase early yields of summer squash without adversely affecting total yields. Chlorflurenol consistently helped to maintain smaller fruit sizes, especially in later harvests. Most important, chlor-

Table 5. Main effects of ethephon and chlorflurenol on yields and fruit weight of 'Dixie' squash grown in the field.

	Yield (harvest 1+2)			Total yield		
Chemical concn (ppm)	Tons/acre	Fruit/plant	Weight/fruit (lb.)	Tons/acre	Fruit/plant	Weight/fruit (lb.)
Ethephon						
0	1.4	3.4	0.14	8.6	11.5	0.24
250	1.6	3.1	0.17	10.5	12.7	0.25
	*[z]	*	*	*	*	NS
Chlorflurenol						
0	1.3	3.0	0.14	10.5a[y]	12.4	0.26ab
25	1.4	3.0	0.17	11.0a	12.2	0.27a
50	1.4	3.1	0.15	9.5ab	12.4	0.24b
100	1.7	3.5	0.17	8.8b	12.0	0.24b
200	1.7	3.5	0.17	8.1b	11.6	0.23b
	NS	NS	NS		NS	

[z]Significantly different at the 5% level (*), or not significant (NS).
[y]Mean separation in columns by Duncan's multiple range test, 5% level, not significant (NS).

flurenol led to normal fruit shapes when pollination did not occur. The hybrid cultivars used in the present experiment appeared to have an adequate amount of female flowers without the use of ethephon, for maximum effectiveness of chlorflurenol.

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Proc. Fla. State Hort. Soc. 96:113-114. 1983.

LABELLING INSECTICIDES FOR USE IN FIELDS OF CHINESE CABBAGE AND ENDIVE[1]

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Additional index words. EPA, IR-4, methamidophos, mevinphos, residues.

Abstract. **Methamidophos (O,S-dimethyl phosphoramidothioate) (1.0 lb. a.i./acre) and mevinphos (2-carbomethoxy-1-methyl-vinyl dimethyl phosphate) (0.5 and 1.0 lb. a.i./acre) were evaluated for phytotoxicity and residue levels in Chinese cabbage** (Brassica campestris **L.) and endive** (Cichorium endivia **L.). Phytotoxicity was not observed on plants in any of the trials. Methamidophos concentrations in Chinese cabbage and endive harvested 28 days after last application were less than 0.02 ppm and 0.60 ppm, respectively. Mevinphos concentrations in Chinese cabbage or endive harvested 3 or 4 days after last application at high dosage rates were less than 2.65 ppm and 1.64 ppm, respectively. This data is being combined with information from other states and will be submitted to EPA for tolerances and subsequent labelling by way of the IR-4 program.**

Grown primarily on the mucklands of Zellwood and the Everglades, Chinese cabbage and endive occupy no more than 7,000 acres and are considered to be minor crops in Florida (1). Seeding of both crops begins in August and they are transplanted weekly so that fresh leafy vegetables may be harvested throughout the winter months until late May.

The long growing period provides conditions for a steady build up of insect pests including aphids, armyworms, foliar caterpillars, leaf hoppers and cutworms. With only a limited number of insecticides labelled for these uses, i.e., diazinon for endive and methomyl for Chinese cabbage, growers were left with inadequate means of insect control.

Several Florida growers and University scientists requested the USDA supported IR-4 program (2) for help in obtaining necessary labels. A number of insecticide use patterns were requested and the IR-4 program staff prioritized each submission.

The insecticides methamidophos (Monitor) and mevinphos (Phosdrin) were selected as IR-4 projects in 1983 since they had a proven record of insect control, had strong industry acceptance and EPA indicated that there were no data impediments. Field trials were established to test the growth effects and insecticide levels of these on Chinese cabbage and endive.

Materials and Methods

Three-wk old 'Jade Pagoda' Chinese cabbage and 'Green Curl White Rib' endive plants were transplanted into sandy loam soil (pH 5.1). The plants grew to maturity in 70 days where average daily temperatures varied between 72° and 46°F and there was a total rainfall of 9.22 inches.

Plants were set out 1 ft apart in rows 2 ft apart. Thirty two plots 6 ft by 30 ft were measured, and arranged into a randomized complete block design. Treatments consisted of nonsprayed controls, methamidophos (1.0 lb. a.i./acre) and mevinphos (0.5 and 1.0 lb. a.i./acre) applied at weekly intervals. Each treatment was replicated 4 times. Each insecticide was applied 4 times: methamidophos commencing February 18 and mevinphos starting March 18.

At a specific time the entire head of 4 plants were sampled from each plot and frozen immediately for subsequent pesticide residue analysis. Methamidophos treated plants were sampled 21 and 28 days after last application. Chinese cabbage treated with 0.5 and 1.0 lb. a.i./acre mevinphos were sampled 1 and 3 days respectively after last application. Endive treated with 0.5 and 1.0 lb. a.i./acre mevinphos were sampled 2 and 4 days, respectively after last application.

Samples treated with mevinphos were extracted with ethyl acetate and concentrated for analysis by gas chromatography using a modification of a procedure described by Shell Oil Co. (4).

Samples treated with methamidophos were extracted with acetone, partitioned with methylene chloride and

[1]Florida Agricultural Experiment Stations Journal Series No. 5114.