reduced by all fungicides, but fungicidal efficacy was low except for prochloraz. In previous experiments, benomyl, imazalil, and fenapanil had no effect on the growth of *Rhizopus oryzae* on culture plates, and little effect on *Geotrichum candidum* (7). It is doubtful if the fungicides tested in the present study, other than prochloraz, exerted more than an indirect effect on soft-rot organisms. The incidence of soft rots was low where primary *Fusarium* infections were controlled, suggesting that the soft rots were secondary infections. Surface blemish was reduced by fenapanil, prochloraz, and imazalil; less than 100 mg/liter of these fungicides gave a disease score of 2.0.

The experimental technique used in this work has several novel properties. Each fungicide was tested over a 10^4-fold concentration range, and the resultant responses were described conveniently by quadratic equations. This treatment of the data is appropriate, since the scoring system used is an ordered classification (5). The technique enables fungicides to be tested on fruit, while requiring a minimal amount of experimental material, and with minimal recourse to artificial inoculation (inoculation was by surface contact, not deep wounding). The wide concentration range studied was deliberately chosen so that fungicides with high effective doses (ED_{50}) would not be arbitrarily discarded. We recognize that at dip concentrations of 10^3–10^4 mg/liter, surface residues of some fungicides may have reached saturation, and calculations of the dip concentration to give a particular disease score, such as those made for soft rots, may be artificial. Suffice it to say that the resultant estimates will have relative meaning—i.e., the estimated 6000 mg/liter of benomyl to give an apparent soft-rot score of 2 means that benomyl is not very effective.

Our results are provocative since they deprecate the role of soft-rot organisms in primary pathogenesis and imply that control of *Fusarium* rots will curtail soft rots. Further work is needed to clarify this point. Fenapanil, prochloraz, and imazalil had the most useful range of fungicidal activities in this work; and prochloraz was the most efficacious fungicide, in terms of disease control per unit concentration of active ingredient.

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Chlorflurenol Interrupts Ovule Development of Muskmelon

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Additional index words. *Cucumis melo,* methyl-2-chloro-9-hydroxy-fluorine, parthenocarpy

Abstract. **Application of 50 or 75 mg/liter chlorflurenol (methyl-2-chloro-9-hydroxy-fluorine) to muskmelon (*Cucumis melo* L.) 10 to 12 days prior to anthesis eliminated ovule development during later bud growth. The interruption of ovule development increased when chlorflurenol was applied 6–14 days prior to anthesis. Chlorflurenol did not interfere with pollination, pollen germination, or pollen tube growth.**

Chlorflurenol induces parthenocarpic fruit set on cucumbers and muskmelons (2, 3, 4, 5, 7, 8). Chlorflurenol can also improve fruit set of pollinated flowers and usually reduces the number of seeds per fruit (3, 4). This observation led Cantliffe to hypothesize that chlorflurenol interferes either with ovule or pollen tube development (3). This study was initiated to determine the validity of these hypotheses.

Chlorflurenol (Curbiset, EM Industries Inc.) at 50 mg/liter was sprayed to run-off onto 7 muskmelon lines (both cultivars and breeding lines) grown in the field. Pistillate flowers from treated and untreated plants were hand-pollinated 10 days after treatment and fixed in 8 ethanol : 1 formalin : 1 acetic acid (FAA) at intervals from 10 to 50 hr after pollination. Fixed flowers were rinsed, hand-sectioned, and hydrolyzed in 1 N NaOH at 60°C for 10 min and then rinsed and stained with 0.1% aniline blue in 0.1 N K_3PO_4. Pollen tubes were observed under ultraviolet light according to the methods of Martin (6). The quantity of pollen on each stigma, pollen germination, and ovule number per flower were rated on a scale of 0 (no pollen, germination or ovules) to 3 (sufficient pollination and germination or adequate ovule number). Extent of pollen tube growth was determined by visually assessing the location of the tube tip within the style or ovary. There were no statistically significant differences among the 7 muskmelon lines.

The relationship between ovary development at the time of chlorflurenol treatment and the number of ovules present at anthesis was investigated with 'Saticoy' muskmelon plants grown in a greenhouse during the late fall. Plants were treated as above with 0, 50, or 75 mg/liter chlorflurenol. Ovary lengths of pistillate flowers were measured at the time of treatment or as soon as buds were detected. Flowers were collected and fixed at anthesis. Differences for date of anthesis, ovary length, and ovule rating between the 50 and 75 mg/liter treatments were not statistically significant. Consequently, data for these 2 treatments have been pooled for presentation.

Application of chlorflurenol did not reduce pollination or pollen germination (Table 1).

Table 1. Mean pollination and pollen germination ratings on stigmas from chlorflurenol-treated and untreated muskmelon plants.

Treatment	Pollination rating[z]	Pollen tube germination rating[z]
Control	2.9	2.9
Chlorflurenol[y]	2.8	2.7
Significance	NS	NS

[z]Rating scale where 0 = no pollen or germination and 3 = abundant pollination (stigmatic surfaces nearly covered with pollen) or pollen germination (pollen tubes appeared to occupy most of the available space within the style or ovary).
[y]50 and 75 mg/liter combined.
NSNonsignificant, 1% level.

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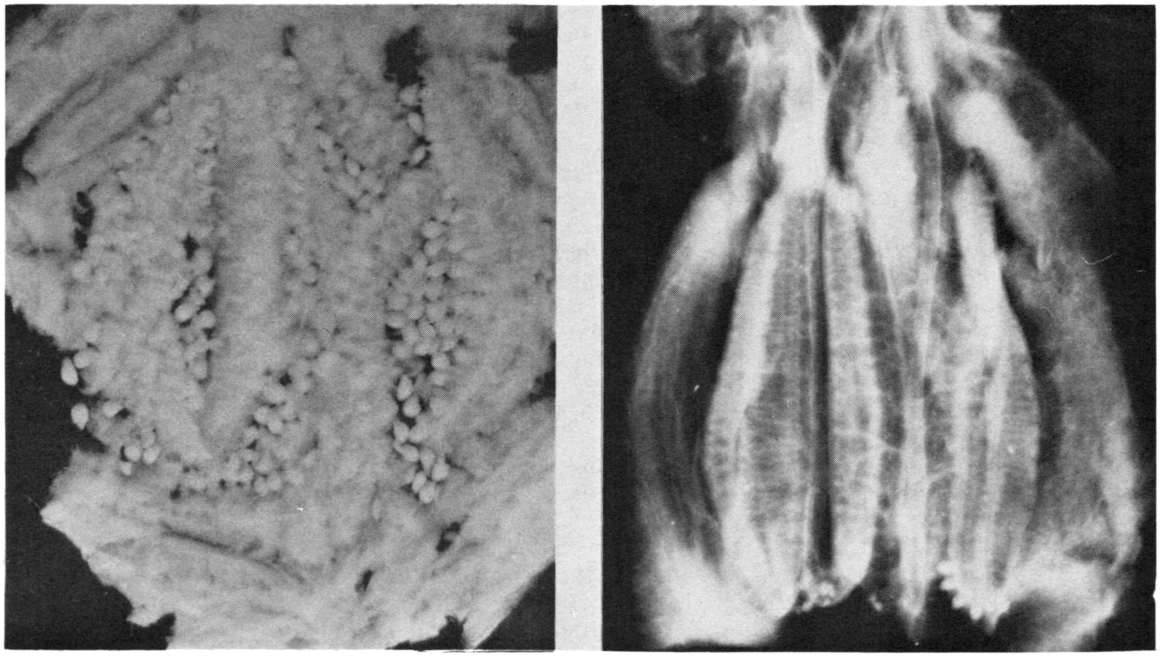

Fig. 1. Muskmelon ovary sections taken from control (left) and chlorflurenol-treated (right) plants showing lack of ovules. Only 36% of treated ovaries contained any ovules. The photo on the left was taken with reflected light only. The photo on the right was taken with transmitted light.

Pollen tube growth in treated and untreated ovaries was sufficient to allow fertilization within 48 hr (Table 2). Chlorflurenol reduced the ovule number; mean ovule rating was 0.7 for chlorflurenol as compared to 3.0 for control, significantly different at the 1% level. Only 36% of the ovaries from treated plants (Fig. 1) contained a few ovules. The minor reduction of pollen tube growth (Table 2) may have resulted from a physical change in the ovary caused by the lack of ovules rather than from a direct effect of the chlorflurenol treatment.

When plants were grown and treated in the greenhouse, the greatest significant reduction of ovule number occurred in buds which opened 12 days after treatment (Table 3). Fertile ovaries from treated and untreated plants had similar growth rates and lengths at anthesis (Table 4). However, among treated plants, ovaries without ovules were shorter at anthesis and grew more slowly than fertile ovaries (Table 4).

The ability of chlorflurenol to induce parthenocarpic fruit development, to improve fruit set of pollinated flowers, to reduce the number of seeds per fruit arising from pollinated flowers, and to reduce fruit growth rate has been documented by others (2, 3, 4, 5, 7, 8). The latter 2 phenomena may be related to interrupted ovule development because the extent of ovule development would influence seed number and the rate of ovary growth. According to Elassar et al. (5) application of chlorflurenol prior to anthesis is essential for parthenocarpic development of muskmelon fruit. According to Cantliffe (2) and Shannon and Robinson (8), application prior to anthesis of cucumber buds is just as or possibly more effective for inducing fruit development than application after anthesis. Consequently, the induction of parthenocarpic fruit development and the interruption of ovule development by chlorflurenol coincide at least in some instances. Both Beyer and Quebedeaux (1) and Watkins and Cantliffe (9) presented data which demonstrate that chlorflurenol interfered with polar auxin transport from cucumber ovaries. They consequently hypothesized that the ovary was the target of chlorflurenol action and that an elevation of auxin in ovaries causes parthenocarpic development. Our data demonstrate that the muskmelon ovule may be a target for the consequences of chlorflurenol application and that the response of this organ to chlorflurenol application varies during bud development. The 2 responses to chlorflu-

Table 2. Extent of pollen tube growth in styles and ovaries of flowers collected 10 to 50 hr after pollination for chlorflurenol-treated and untreated muskmelon plants.

Time after pollination (hr)	Control		Chlorflurenol-treated	
	No. of flowers	Extent of tube growth	No. of flowers	Extent of tube growth
10	17	Upper-ovary	18	Upper-ovary
22	15	Mid-ovary	12	Upper to mid-ovary
34	8	Mid-to lower-ovary	6	Mid-ovary
46	3	Mid-to lower ovary	5	Mid-ovary
50	0		4	Lower-ovary

Table 3. Number and percentage of sterile ovaries arising from buds treated with chlorflurenol 2 to 14 days before anthesis.

Days from chlorflurenol application to anthesis	No. of ovaries	Ovaries without ovules	
		(No.)	(%)
2	4	0	0
3	8	0	0
4	2	0	0
5	4	0	0
6	4	1	25
7	6	0	0
8	3	1	33
9	4	1	25
10	3	0	0
11	11	3	27
12	18	9	50**
13	12	1	8
14	3	2	67

**Significantly different from 0 by χ^2, 1% level.

Table 4. Mean length of ovaries at anthesis and ovarian growth rates on untreated and chlorflurenol-treated muskmelon plants.

Treatment	Ovary length at anthesis (mm)	Ovary growth rate (mm/day)
Control	13.7 a[z]	1.25 a
Fertile ovaries grown on treated plants	15.2 a	1.68 a
Sterile ovaries grown on treated plants	10.8 b	0.98 b

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

renol—the induction of parthenocarpic fruit set and the interruption of ovule development—coincide to an extent. However, it remains to be determined whether interrupted ovule development is a primary or secondary event occurring during the induction of parthenocarpy or a completely independent event.

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Silver Nitrate Induction of Staminate Flowering in Hermaphroditic Pickling Cucumbers

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Abstract. **Optimum conversion to staminate flowering in hermaphroditic lines of pickling cucumber (*Cucumis sativus* L.) was obtained with 3 to 4 applications of 200–400 mg/liter of silver nitrate ($AgNO_3$) at 4-day intervals, with initial treatment at the first true leaf stage.**

Single-cross hybrids involving gynoecious (G) x hermaphrodite (H) parents have been developed to maximize pistillate expression in hybrids used for pickling cucumber production (8). Alternatively, an acceptable level of female expression occurs in 3-way crosses utilizing (G x H) F_1 seed parents and monoecious (M) pollen parents (7). Both hybrid schemes fall short of their potential seed yield in the G x H cross as well as in H stock seed increases. Although the exact basis for the decreased seed yields has not been determined, we speculate that the restricted hypantheum of the hermaphroditic flower inhibits bee visitation or pollen transfer. If we were able to convert the H line to staminate flowering, G x H seed production would be improved. This would allow direct use of the superior female expression of the G by H cross for pickling cucumber production.

$AgNO_3$ has been successfully used on G lines to induce staminate flowering for stock seed increase (2, 5, 10). The timing and degree of conversion needed for G x H seed production is, however, quite different from that required for G stock seed increase. It is desirable for G x H seed production to induce the greatest possible number of staminate flowers during the period of most concentrated fruit set, which occurs during the first 3 weeks of flowering (J.H.L. Vos, personal communication).

Our objective in this study was to evaluate conversion in the hermaphrodite and to examine interactions among treatment factors. A randomized incomplete block experiment was conducted in the greenhouse during Spring 1980. The experiment utilized the determinate H line MSU 7152H and an indeterminate H line MSU 669H (3). Temperatures were maintained at 25° ± 2°C (day), and 15° ± 2° (night).

$AgNO_3$ at 0, 100, 200, 300, or 400 mg/liter was applied as a foliar spray to the entire plant until run-off. One, 2, and 3 applications were made, beginning at the following plant developmental stages: stage 0, in which the cotyledons were fully expanded, and stages 1, 2, 3, and 4 in which the first through 4th true leaves, respectively, had attained a 4-cm diameter. Subsequent applications were made when each succeeding leaf had attained a 4-cm size, about every 4 days. The plastochron was chosen as the interval between applications since it is directly related to plant development and can be extrapolated to field growing conditions.

The date of anthesis, nodal position, and sex type were determined for each flower on the main stem and each staminate flower on all laterals during the first 3 weeks of flowering. Toxicity was inconsequential at any stage or concentration in our experiment. Serious toxicity on G lines had been noted by other researchers when applications were made before stages 3 or 4 (2, 10).

It is desirable to induce staminate flowers at the onset of flowering to avoid poorly pollinated and incompletely fertilized fruit, which inhibit later fruit set. The length of the lag period, or days between onset of flowering and start of the staminate flowering phase, proved to be dependent on stage, genotype, and their interaction. Treatments initiated at stages 0 and 1 produced staminate flowers from the onset of flowering or, at the latest, by day 2 (Table 1). The lag varied up to 11 days when treatments were initiated at later stages.

Duration of the staminate flowering phase was found to be dependent on the interaction between stage, $AgNO_3$ concentration, and application number. Conversion lasted up to 18 or 19 days when treatments were initiated at stages 0 and 1 (Fig. 1). As the concentration was increased, fewer applications were needed to achieve the maximum period of conversion for these stages. When treatments were initiated later, there was little benefit within the 3-week conversion period from

Table 1. Days of flowering before the onset of staminate flowers induced by $AgNO_3$ (averaged over application number and concentration) in hermaphroditic cucumber lines.

Stage	Days of flowering before onset of staminate flowers[z]	
	MSU 669H	MSU 7152H
0	0.1	0.0
1	0.7	1.2
2	6.9	4.5
3	11.6	9.8

[z]Scheffe's MSD (1% level) is 1.4 within columns and 1.0 between columns.

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