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.

Literature Cited

1. Beyer, E.M. Jr. and B. Quebedeaux. 1974. Parthenocarpy in cucumber: mechanism of action of auxin transport inhibitors. J. Amer. Soc. Hort. Sci. 99:385–390.
2. Cantliffe, D.J. 1974. Alteration of growth and flowering habit in cucumber by chlorflurenol. Can. J. Plant Sci. 54:771–776.
3. Cantliffe, D.J. 1974. Promotion of fruit set and reduction of seed number in pollinated fruit of cucumber by chlorflurenol. HortScience 9:577–578.
4. Cantliffe, D.J. 1977. The induction of fruit set in cucumbers by chlorflurenol with or without pollination. HortScience 12:58.
5. Elassar, G., J. Rudich, and N. Kedar. 1974. Parthenocarpic fruit development in muskmelon induced by growth regulators. HortScience 9:579–580.
6. Martin, F.W. 1959. Staining and observing pollen tubes in the style by means of fluorescence stain. Stain Technol. 34:125–128.
7. Robinson, R.W., D.J. Cantliffe, and S. Shannon. 1971. Morphactin-induced parthenocarpy in the cucumber. Science 171:1251–1252.
8. Shannon, S. and R.W. Robinson. 1976. The use of chlorflurenol in production of pickling cucumbers. HortScience 11:476–478.
9. Watkins, J.T. and D.J. Cantliffe. 1980. Regulation of fruit set in *Cucumis sativus* by auxin and an auxin transport inhibitor. J. Amer. Soc. Hort. Sci. 105:603–607.

HortScience 18(3):347–349. 1983.

Silver Nitrate Induction of Staminate Flowering in Hermaphroditic Pickling Cucumbers

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Additional index words. *Cucumis sativus*, hybrid seed production, gynoecious, monoecious

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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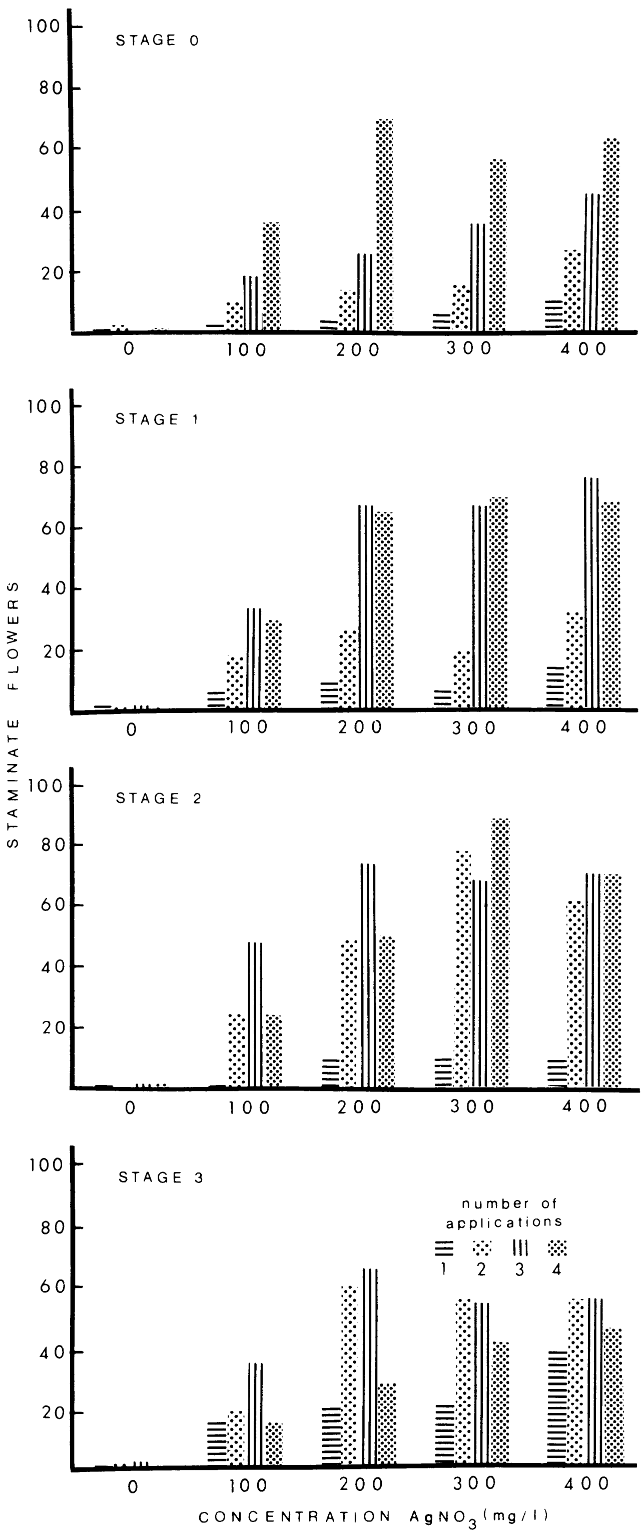

Fig. 1. Mean duration of staminate flowering period (averaged over genotype) resulting from $AgNO_3$ applications on hermaphroditic cucumber lines MSU 7152H and MSU 669H. SE of treatment means = ±2.19.

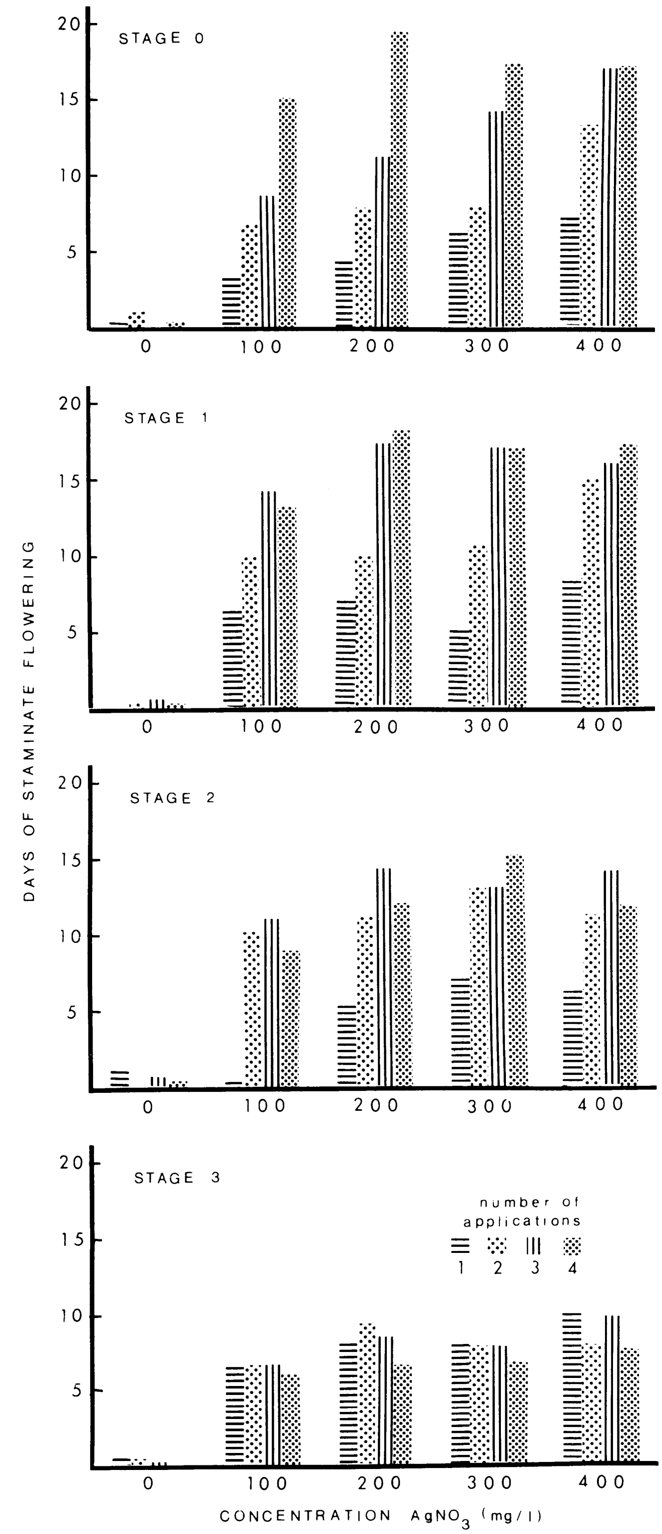

Fig. 2. Mean of staminate flowers per plant (averaged over genotype) resulting from $AgNO_3$ application on hermaphroditic cucumber lines MSU 7152H and MSU 669H. SE of treatment means = ±6.75.

Table 2. Total number of staminate flowers on the main stem and laterals and perfect flowers on the main stem (averaged over stage and application number) resulting from $AgNO_3$ application in hermaphroditic cucumber lines.

$AgNO_3$ concn (mg/liter)	Total staminate flowers (main stem and laterals) + perfect flowers (laterals)[z]	
	MSU 7152H	MSU 669H
0	53.2	58.4
100	58.2	66.0
200	58.3	81.6
300	65.8	72.6
400	59.4	78.2

[z]Scheffe's MSD within columns is 7.1 (5% level).

increasing the concentration or making more than 1 or 2 applications.

Maximum benefit from conversion is achieved by inducing as many staminate flowers as possible during the critical period of fruit set. The number of staminate flowers produced on the main stem and laterals was influenced by the interaction between stage, concentration, and application number. Treatments initiated at stages 1 and 2 produced the greatest numbers, up to 89, in stage 2 (Fig. 2). Two applications of 300–400 mg/liter $AgNO_3$ induced the maximum number of staminate flowers for stage 2 plants. More applications were required when treatments were begun at earlier stages (e.g., 3 applications for stage 1 and 4 applications for stage 0).

Other researchers have used the number of staminate nodes as an indication of the effectiveness of treatments on sex expression (1, 2, 5, 6, 9, 10). We examined the percentage of staminate nodes to take into account the difference in the number of nodes caused by the determinate and indeterminate growth habits of the 2 lines used in this study. The conclusions were similar to those for duration of staminate flowering.

An unanticipated observation was that $AgNO_3$-treated plants produced more flowers than control plants (Table 2). It appears that $AgNO_3$ stimulates supernumerary bud development. A similar effect has been noted by researchers working with gibberellic acid (1, 4).

The maximum number of staminate flowers resulted when treatments were initiated at stages 1 and 2. Since the maximum period of early conversion occurred for treatments initiated at stages 0 and 1, stage 1 was determined to be the optimum stage at which to begin $AgNO_3$ treatment. Conversion to staminate flowering for G x H hybrid seed production was optimized by 3 to 4 applications of 200 to 400 mg/liter $AgNO_3$ initiated at stage 1. We suggest that seedsmen use these guidelines to experiment with the use of $AgNO_3$ to improve seed yields in stock seed programs and in hybrid production schemes using hermaphroditic cucumbers.

Literature Cited

1. Atsmon, D. and C. Tabbak. 1979. Comparative effects of gibberellin, silver nitrate, and aminoethoxyvinyl glycine on sexual tendency and ethylene evolution in the cucumber plant (*Cucumis sativus* L.). Plant & Cell Physiol. 20:1547–1555.
2. den Nijs, A.P.M. and D.L. Visser. 1980. Induction of male flowering in gynoecious cucumbers (*Cucumis sativus* L) by silver ions. Euphytica 29:273–280.
3. El-Shawaf, I.I.S. and L.R. Baker. 1981. Performance of hermaphroditic pollen parents in crosses with gynoecious lines for parthenocarpic yield in gynoecious pickling cucumber for once-over mechanical harvest. J. Amer. Soc. Hort. Sci. 106:356–359.
4. Fuchs, E., D. Atsmon, and A.H. Halevy. 1977. Adventitious staminate flower formation in gibberellin treated gynoecious cucumber plants. Plant & Cell Physiol. 18:1193–1201.
5. Kalloo, R.K.J. and S. Franken. 1978. Chemical induction of staminate flowers in four determinate gynoecious lines of pickling cucumber. Gartenbauwissenschaft 43:280–282.
6. Owens, K.W., G.E. Tolla, and C.E. Peterson. 1980. Induction of staminate flowers on gynoecious cucumber by aminoethoxyvinylglygine. HortScience 15:256–257.
7. Pike, L.M. 1974. 'TAMU Triple Cross' pickling cucumber. HortScience 9:83.
8. Pike, L.M. and W.K. Mulkey. 1971. Use of hermaphrodite cucumber lines in development of gynoecious hybrids. HortScience 6:339–340.
9. Pike, L.M. and C.E. Peterson. 1969. Gibberellin A_4/A_7 for induction of staminate flowers on the gynoecious cucumber (*Cucumis sativus* L.). Euphytica 18:106–109.
10. Tolla, G.E. and C.E. Peterson. 1979. Comparison of gibberellin A_4/A_7 and silver nitrate for induction of staminate flowers in a gynoecious cucumber line. HortScience 14:542–544.

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Parthenocarpy in Gynoecious Cucumber as Affected by Chlorflurenol, Genetical Parthenocarpy, and Night Temperatures

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Additional index words. auxin transport inhibitor, fruit growth, cucumber, vegetable breeding, pickling

Abstract. **Methyl-2-chloro-9-hydroxyfluorene-(9)-carboxylate (chlorflurenol) effectively promoted parthenocarpic fruit development in gynoecious pickling cucumbers, *Cucumis sativus* L. Treatment with chlorflurenol increased yields of fruits under both greenhouse and open-field conditions. Yields were dependent on the degree of genetic parthenocarpy for each cultivar. Parthenocarpic yields following chlorflurenol treatment were higher with night temperatures of 16° and 21°C than with 27°.**

Once-over mechanical harvest of pickling cucumbers in Michigan produces a marketable yield of one to 2 fruits per plant with 115,000 plants/ha (11). The yield limitation in seeded cucumber is probably due to a phenomenon known as crown-fruit dominance (9) or "first-fruit" inhibition (17). First-fruit inhibition is an inhibitory effect on subsequent flowering, fruiting, and vegetative growth that is imposed by the first-fruit set on the vine. Therefore, in a once-over destructive harvest, only the one or 2 dominant fruits are removed and any further yield is precluded. Growers harvest mechanically when the majority of the fruit reach a size of 3.8 to 5.1 cm diameter to maximize economic returns (11). The large-sized fruits provide a large part of the value per hectare because of their weight, but price per unit weight is relatively less than for smaller fruits. Obviously, economic returns would be increased substantially if large numbers of small premium fruit could be harvested while

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