Response of Cucumber to Soil and Foliar Application of Ethephon[1]

Daniel J. Cantliffe[2] and Sharad C. Phatak
Horticultural Experiment Station, Simcoe, Ontario

Abstract. **In field experiments with cucumber (*Cucumis sativus* L.) on both sandy and clay loam soils (2-chloroethyl)phosphonic acid (ethephon) at 125 or 250 ppm applied twice to the foliage was more effective in promoting pistillate flowers and yield on 'Wisconsin SMR 58', a monoecious cultivar, than granular ethephon applied at various rates as a sidedress at planting, placed directly on the seed at planting, or applied as a sidedress in the first true-leaf stage. Foliar sprays on 'Pioneer' were effective in reducing the number of staminate and increasing the number of pistillate flowers. However, ethephon applied by any method did not increase yields in 'Pioneer', a predominantly pistillate cultivar.**

The effects of foliar applications of ethephon on induction of pistillate flowering in cucumber have been well documented (5, 6, 7, 8, 9, 10, 11). The persistence of femaleness induced by ethephon under field conditions was dependent on many factors including concn of ethephon (9), uniformity of emergence, stage of growth, temperature, moisture, rainfall at the time of application, and cultivar (10). Hence, foliar sprays of ethephon may be limited in their ability to maintain femaleness. Cantliffe and Robinson (2) have proposed the use of granular ethephon applied to the soil to extend pistillate flower production. They found that soil applications of ethephon in the greenhouse were effective for several months. However, the rates used were so high as to not be economical. This investigation was made to determine effective rates and application techniques for soil applied ethephon to promote femaleness in cucumber and to compare these with foliar sprays under field conditions.

Seed of monoecious 'Wisconsin SMR 58' were planted in 15 cm plastic pots containing a 1 sand:1 soil:1 peat mix (pH 6.5) and placed in a greenhouse at 24°C (day) 20° (night), and 14 hr photoperiod. Granular ethephon (AmChem 68-229)[3] was banded at planting 5 cm below the seed at rates to give the equivalent of 0, 10, 25, 50, 100, 200 and 400 ppm ethephon per pot or sidedressed 5 cm to the side and 5 cm below the soil surface when the plants were in the first true-leaf stage at rates equivalent to 10, 50 and 100 ppm ethephon. Two sprays, 125 or 250 ppm ethephon (AmChem 68-240)[3] plus 0.1% polyoxyethylene sorbitan monolaurate (Tween 20), were applied to runoff at the 1 to 2-leaf stage and again in the 4 to 5-leaf stage to plants grown in untreated soil. All treatments were replicated 4 times in a completely randomized design.

In a field experiment, 'Wisconsin SMR 58' and the predominately pistillate 'Pioneer' were seeded on May 24, 1971, in Fox sandy loam and Lincoln clay loam soils in rows 1.5 m apart with plants in the row 10 cm apart to give a population of 98,840 plants/ha. Granular ethephon was sidedressed 5 cm to the side and 5 cm below the seed at planting at rates of 0, 3.4, 6.8, 13.6, and 20.5 g ethephon per m row or sidedressed at the first true leaf stage by applying the ethephon at rates of 6.8, 13.6,and 20.5 g per m row 5 cm to the side and 5 cm deep. Foliar sprays of ethephon were applied twice, in the first and third true-leaf stages, at rates of 125 and 250 ppm with 0.1% Tween 20 added as a wetting agent. Plots consisted of a row 7.6 m long and each treatment was replicated 4 times in a randomized complete block design.

All of the fruit from 6 m of row was harvested when 10% of the fruit reached 4.1 cm diam. It was then graded and valued according to fruit diam; No. 1 = < 1.9 cm ($253/metric ton), No. 2 = 1.9-2.5 cm ($171/ton), No. 3 = 2.5-3.2 cm ($149/ton), No. 4 = 3.2-3.8 cm ($83/ton), No. 5 = 3.8-4.1 cm ($55/ton), No. 6 = 4.1-5.1 cm ($28/ton), and oversize > 5.1 cm green and firm ($22/ton).

In another field experiment, 'Wisconsin SMR 58' was seeded on June 27, 1972, in a Caledon sandy loam and Lincoln clay loam similar to the 1971 experiment. Ethephon at 0.3, 3.4 and 34.2 g per m row was applied on the seed at planting, sidedressed 5 cm to the side and 5 cm below the seed at planting or sidedressed 5 cm to the side and 5 cm below the seed level at the first true-leaf stage. Two sprays of 250 ppm ethephon were applied as in the 1971 experiment. The fruit was harvested when 10% of them reached 4.1 cm diam and graded the same as in 1971.

Results from the greenhouse experiment were similar to those reported by Cantliffe and Robinson (2), mainly that in pots soil applications of ethephon effectively induced femaleness in a monoecious line. Ethephon soil treatments of 25 ppm at planting or 10 ppm at the first true-leaf were as effective as foliar treatments in promoting pistillate flowers in 'Wisconsin SMR 58'.

In the 1971 field experiments, there were no differences between ethephon treatments due to soil type so the data were combined. Only foliar sprays of ethephon consistently increased yields ($/ha, tons/ha and fruit/plant) in 'Wisconsin SMR 58' (Table 1). Both spray concn were equally effective in yield promotion and induction of pistillate flowers. Sidedress treatments at planting of 3.4 and 6.8 g ethephon promoted yield but had little effect on femaleness in 'Wisconsin SMR 58'. Ethephon did not increase dollar and wt yields of 'Pioneer' but increased the no. of fruit per plant (Table 2).

What were the reasons for the differences between soil applied ethephon on induction of pistillate flowering in the greenhouse compared to the field? Ethephon releases ethylene (12) and the ethylene promotes pistillate flower development (1). The evolution of ethylene from ethephon commences within 4-5 hr (3, 4) of application and ceases within 2 days (12). Yet, Cantliffe and Robinson (2) reported pistillate flowering response in cucumbers grown in soil in which ethephon was incorporated 4 weeks prior to planting. They suggested that soil applied ethephon was absorbed by cucumber roots and translocated to apical plant parts. It is also possible that ethylene was given off from ethephon to the soil atmosphere and ultimately released at the soil surface. The field soil surface has a much larger diffusional area than a greenhouse pot and is subjected to greater air movement. Downward or lateral movement away from the application zone would also be greater in the field because of a larger volume of soil. Other environmental conditions affecting ethylene evolution and movement such as temp, moisture, leaching and air currents could not be closely regulated in the field. Also, microorganism activity in sterilized greenhouse soil was much different from that of unsterilized field soil. Thus, early attack by microorganisms on the soil ethephon may have occurred in the field.

Finally, and possibly most important, the roots were confined close to the ethephon source in the greenhouse pot, but not in the field. Therefore, in 1972 we applied granular ethephon directly on the seed at planting to insure direct plant contact

[1]Received for publication May 4, 1974.

[2]Present address: Vegetable Crops Department, McCarty Hall, University of Florida, Gainesville, FL.

[3]Ethephon formulations were provided by AmChem Products, Inc., Ambler, PA.

Table 1. Response of field grown 'Wisconsin SMR 58' cucumber to soil and foliar applications of ethephon, 1971.[z]

Application method	Ethephon concn g/m row or ppm	Yield $/ha	Yield Metric ton/ ha	Yield Fruit/ plant	No flowers to node 10 per plant Staminate	No flowers to node 10 per plant Pistillate
Control	0	761a[y]	6.1a	0.8a	17.8e	1.1a
Sidedress at planting	3.4	978b	7.0a	0.9a	15.2c	1.2a
	6.8	902b	5.8a	0.6a	16.7cde	1.4a
	13.6	680a	5.6a	0.9a	16.8cde	1.4a
	20.5	746a	5.8a	0.7a	17.3de	1.5a
Sidedress at first true-leaf	6.8	773ab	6.7a	0.6a	16.8de	0.9a
	13.6	783ab	6.5a	0.8a	17.1e	0.9a
	20.5	734a	6.1a	0.9a	16.5cd	1.6a
Foliar spray	125 ppm	1327c	12.0b	2.5bc	3.2a	8.0d
	250 ppm	1206c	15.0b	3.4d	4.5e	6.0c
Mean		889	8.2	1.2	14.2	2.4

[z]Data are summarized for both soil types as treatment differences between soil types were not significant.

[y]Mean separation within each column by Duncan's multiple range test, 5% level.

Table 2. Response of field grown 'Pioneer' cucumber to soil and foliar applications of ethephon, 1971.[z]

Application method	Ethephon concn g/m row or ppm	Yield $/ha	Yield Metric ton/ ha	Yield Fruit/ plant	No. flowers to node 10 per plant Staminate	No. flowers to node 10 per plant Pistillate
Control	0	1584cd[y]	13.7a	2.2a	4.0cd	9.1ab
Sidedress at planting	3.4	1510bc	13.9a	2.6b	4.6d	8.5a
	6.8	1559bcd	12.8a	2.8de	2.8bc	9.4b
	13.6	1559bcd	13.7a	2.4a	4.5b	9.2b
	20.5	1389a	11.7a	2.7cd	2.3b	9.2b
Sidedress at first true-leaf	6.8	1443ab	12.6a	2.3a	2.0ab	9.0ab
	13.6	1557c	13.9a	2.5bc	4.4d	9.1b
	20.5	1581cd	13.9a	2.5bc	1.0ab	11.0d
Foliar spray	125 ppm	1569cd	15.0a	2.9ef	1.3ab	10.4cd
	250 ppm	1609cd	14.6a	3.2f	0.6ab	10.6cd
Mean		1536	13.6	2.6	2.8	9.6

[z]Data are summarized for both soil types as treatment differences between types were not significant.

[y]Mean separation within each column by Duncan's multiple range test, 5% level.

Table 3. Response of field grown 'Wisconsin SMR 58' cucumber to soil and foliar applications of ethephon, 1972.[z]

Application method	Ethephon concn g/m row or ppm	Yield $/ha	Yield Metric ton/ ha	Yield Fruit/ plant	No. flowers to node 10 per plant Staminate	No. flowers to node 10 per plant Pistillate
Control	0	734dc[y]	10.1cd	0.4a	12.7c	1.8a
On Seed at planting	0.3	447b	6.5b	1.3b	10.2bc	2.9abc
	3.4	141a	1.8a	1.9c	6.1ab	2.7ab
	34.2	72a	0.9a	1.1b	8.5bc	3.8bc
Sidedress at planting	0.3	546bc	6.7b	0.4a	12.8c	0.9a
	3.4	662cd	9.2c	0.5a	11.9b	1.3ab
	34.2	694dc	9.0c	0.3a	10.5b	2.8ab
Sidedress at first true-leaf	0.3	692dc	9.9c	0.2a	12.5b	1.1a
	3.4	724dc	9.6c	0.4a	12.7c	1.3ab
	34.2	810c	11.4d	0.2a	10.4b	5.8c
Foliar spray	250 ppm	1028e	13.5c	2.4d	1.2a	11.7d
Mean		595	8.1	0.8	10.0	3.3

[z]Data are summarized for both soil types as treatment differences between soil types were not significant.

[y]Mean separation within each column by Duncan's multiple range test, 5% level.

with the chemical. Again in 1972, there were no differences between treatments due to soil type. Placement of ethephon with the seed promoted female flowering and the no. of fruit produced per plant in 'Wisconsin SMR 58' (Table 3). However, yields, as dollars per ha and tons per ha, were greatly reduced. This was attributable to a reduction in plant stand: 39% at 0.3 g ethephon, 91% at 3.4 g ethephon, and 94% at 34.2 g ethephon. Germination was not inhibited, but growth was retarded long enough for insect and disease attack which resulted in plant loss. The highest ethephon sidedress rates (34.2 g/m row) applied at planting or in the first true-leaf stage also promoted pistillate flowering. However, none of these treatments led to a yield increase. A foliar spray of ethephon did not completely prevent staminate flowers from forming, especially at the higher nodes, but it was the most effective method of application to induce pistillate flowers.

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