Control of Sex Expression in Summer Squash (*Cucurbita pepo* L.)

Cheng Yongan, Zhang Bingkui, Zhang Enhui, Zhao Zunlian

Northwest Sci-Tech University of Agriculture and Forestry, Yangling Shaanxi, P.R.China, 712100

Abstract. The sex expression of pumpkin [*Cucurbita pepo* L.] was found to be controlled by foliar sprays with ethephon, GA and $AgNO_3$. Ethephon (2-chloroethyl phosphoric acid) at a concentration of 50 mg/l cause increase of femaleness and inhibition of male flower, while gibberellin at a concentration of 1000 mg/l and $AgNO_3$ at a 200/300 mg/l caused increase of maleness and inhibition of female flowers. The foliar spray stage was at the cotyledon-stage. Different varieties responded similarly in sex expression with ethephon, gibberellin and $AgNO_3$. Ethephon at a concentration of 100 mg/L caused plant injury or death. Gibberellin at a concentration of 1000 mg/l caused excessive growth.

Introduction. The sex expression of summer squash is determined by genetics as well as environment (e.g. photoperiod, temperature etc.). Because of low temperatures and short photoperiods in early spring, the summer squash cultivated in spring usually have more female flowers and fewer male flowers. This affects the regular pollination and fruit setting. In autumn, because of high temperatures and long photoperiods, summer squash usually exhibit more male flowers and fewer female flowers. This will cause decreases of its fruit yield. Many kinds of plant-growth regulator have been used in production of *Cucurbita* crops (Halevy 1963, Galun et al 1965, Iwahor et al 1970). Usually, the utilization of ethephon, GA_3, $AgNO_3$ are very common (Robinson et al 1960, Splittstoesser 1970, George 1971)[1]. Employment of any one of chemicals, or manipulating temperature and/or illumination will cause a change of sex expression in summer squash. However, manipulating temperature and/or illumination is more difficult than applying chemicals. The aim of this research is to determine the effect of certain chemicals on the sex expression of summer squash.

Materials and Methods. The cultivars employed in this experiment were "9805"and "021m". Chemically, pure ethephon, GA_3 and $AgNO_3$ were used for chemical treatments.

Concentrations of GA_3 were 50,100,1000 mg/l, concentrations of $AgNO_3$ was 2000,300 mg/l respectively. Experiments were carried out in a greenhouse at the Vegetable and Flower Institute. Solutions were applied by hand using a small sprayer. The plants employed for this test were sprayed at the cotyledon stage and 4-leaf stage. In each stage, plants were sprayed 3 times with a time interval of 3 days. The control was a distilled water spray. Ten normal plants were selected for each treatment. The treatments were arranged randomly with 3 repetitions. Between-row and between-plant is 70 cm and 50 cm respectively. The cultivating practice is same as that used for commercial production. After plant size reached 20 nodes or more, the number of female and male flowers was counted. The data in all tables is the average of all plants treated, and these data were subjected to variance analysis.

Results and Analysis. *Effect of ethephon on sex expression of C. pepo*. Table 1 shows that the effect of 50mg/L ethephon on sex expression is significant. In comparison with the control, the number of female flower was increased by 69%. The treatment with 100mg/l affects the normal growth and development of the plants. The plants were small, weak and had too many branches; some plants died. These results indicated that the effect of treatment with 100mg/l is not significant on sex expression in *C. pepo,* and is is similar to that of previous reports [1].

Table 1. The effect of ethephon on sex expression of pumpkin [*Cucurbita pepo* L.]

Treatment	Node position of the first female flower	Significant level		Average No. of female flower/plant	Significant level		Average No. of male flower/plant	Significant level	
		5%	1%		5%	1%		5%	1%
CK	7.7	ab	AB	7.1	B	A	12.7	a	A
Ethephon (50mg/L)	5.5	b	B	12.1	A	A	3.7	c	C
Ethephon (100mg/L)	8.3	a	A	6.2	B	A	6.0	b	B

Table 2. The effect of GA_3 and $AgNO_3$ on sex expression of *Cucurbita pepo L.*

Treatment	Node position of the first female flower	Significant level		Average No. of female flower/plant	Significant level	
		5%	1%		5%	1%
GA_3 (100 mg/L)	1.0	a	A	18.7	a	A
$AgNO_3$ (300 mg/L)	1.0	a	A	17.4	a	AB
$AgNO_3$ (200 mg/L)	1.0	a	A	17.3	a	AB
GA_3 (100 mg/L)	1.0	a	A	15.4	b	BC
GA_3 (50 mg/L)	1.0	a	A	15.3	b	BC
CK	1.3	b	b	12.7	c	C

Table 3. The effect of different treating stage on male expression of[*Cucurbita pepo* L.]

Treating stage	The first node position of male flower			Average No. of male flower		
	CK	G 50	Ag 200	CK	G 50	Ag 200
Cotyledon stage	1.3	1.0a	1.0a	12.7	15.3a	17.3a
4-Leaf stage	1.3	1.2a	1.2a	12.7	13.7b	15.1b

Effect GA_3 and $AgNO_3$ on sex expression in C. pepo. Table 2 shows that the effect of GA_3 and $AgNO_3$ on male flower inducement is significant at the 0.01 level. The node position of the first male flower was decreased and the number of male flowers was increased. Different concentrations of GA_3 had different effects on male flower inducement. The number of male flowers with 100 mg/l GA_3 was 18.7, and the number of male flowers with 50 mg/; GA $_3$ was 15.3 or 15.4. The effect of 100 mg/l and 200 mg.l on male flower inducement was similar.

Effect of treatment stage with GA_3 and AgNO on sex expression in C. pepo. By treating with 50mg/l GA_3 and 200 mg/l $AgNO_3$, node position on the first male flower was similar in two treatment stages, but the number of male flowers was different. The number of male flowers treated in cotyledon stage was more than that treated in 4-leaf stage (Table 3). According to previous research[3,4] about floral differentiation in cucumber, at 5 or 6-leaf stage the sex expression of floral bud under 10th node cannot be changed through the chemical regulator. Chemical regulator may change only sex expression of floral buds up to the 10^{th} node. This experiment indicatd that the effect of treating in 4-leaf stage could be seen after the 20^{th} node. This showed that *C. pepo*. was similar to cucumber in floral differentiation. This research also showed that different treatment stages did not affect the node position of the first male flower.

Conclusion and discussion. Previous research results [1,2,3,4,9] showed that the ethephon is effective in controlling expression of female flowers. GA_3 and $AgNO_3$ are effective in controlling expression of male flowers. This test indicated that the ethephon, GA_3 and $AgNO_3$ also have similar effect on the sex expression of *C. pepo*.L. With respect to chemical treatment, starting from the cotyledon stage and spraying twice is recommended. The 50mg/l ethephon treatment was the best concentration in this test.

The GA_3 and $AgNO_3$ have similar effects on sex expression, but their effect on field production is somewhat different. Li Shuxuan [4] believed that, in the range from 50-2000mg/l, the effect of GA_3 was in direct proportion with concentration.
This study found that 1000mg/l GA_3 affected the normal growth and development of *C. pepo* L. The plants that were treated with 200/300 mg/l $AgNO_3$ grew normally. These results agree with previous research [2,3] which reported that the treatment effect of $AgNO_3$ was better than that of GA_3. Therefore, $AgNO_3$ should be selected to use first for male flower inducement.

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