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Effect of Growth Regulators on Branching, Flowering, and Fruit Development of Ornamental Pepper (*Capsicum annuum* L.)[1]

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Abstract. **Indoleacetic acid (IAA), benzyladenine (BA) and (2-chloroethyl)phosphonic acid (ethephon) were applied to pinched and non-pinched ornamental peppers (*Capsicum annuum* L. cv. Teno) before, after, or at the time of pinching. Ethephon increased the number of lateral branches, but reduced growth, delayed flowering, reduced the number of flowers per branch thus reducing fruit production. Ethephon applied at 300 ppm 2 weeks post-pinching substituted for hand pinching. BA and IAA had no desirable effect on ornamental characteristics of treated plants.**

Fruit number is important for the attractiveness of ornamental peppers. Since in this species the branches terminate in flowers and fruits, it is desirable to produce bushy plants with large numbers of branches and fruits. The present investigation was an attempt to study the effects of IAA, BA and ethephon, applied at different growth stages, on some vegetative and reproductive characters of ornamental peppers.

Materials and Methods

Seeds of 'Teno' ornamental pepper were sown in flats on Feb. 18, 1976 in the greenhouse in a medium consisting of equal parts of clay-loam soil, sand, and peat moss and the soil mixture steam-pasteurized at 120°C for 2 hr. Uniform seedlings were transplanted at 4 leaf stage into 16 cm pots. To facilitate drainage and high humidity, the pots were placed over a 5 cm thick layer of sand spread over a sheet of polyethylene.

During the course of the experiment average max day temp was 33.5° ± 3.6°C and the average min night temp was 14.7° ± 3.5°C. Average relative humidities in the greenhouse during the period of the experiment were 45% min and 71% max.

At weekly intervals throughout the experiment, liquid fertilizer which had 20N-15P-15K and quantities of microelements including 1% Fe as chelate, was applied with irrigation water at the rate of 2:1000 (by vol).

The experiment was conducted as a 3×4×3×2 factorial in a randomized ccmplete block design with 4 replications. The factors were controls; 3 growth regulators, each at 3 concn; 3 times of growth regulator application, and pinched vs. non-pinched plants. The growth regulator concn were: 50, 100 and 150 ppm for IAA; 400, 800 and 1200 ppm for BA; and 300, 600 and 900 ppm for ethephon. The application times were 2 weeks before pinching (May 5); at pinching (May 19) and 2 weeks after pinching (June 2, 1976). Each plant received only 1 application.

Plants were sprayed to the point of run-off by means of a small hand sprayer, and were harvested on August 9, 1976, when the following characters were measured: lateral branch no.; plant ht; plant diam (at ½ ht); flower, bud and leaf no.; average and total leaf areas; no. of ripe and unripe fruits; fruit length (on 4 randomly selected fruits per plant); node no.; leaf chlorophyll content, and plant fresh and dry wt.

To measure the average leaf area, 2 representative plants from each size (small, medium and large) were selected and their areas were measured by a planimeter (HAFF 315). The total plant leaf area was obtained by multiplying average leaf area by total leaf no.

The leaf chlorophyll content was measured on 5 randomly selected leaves, according to Arnon (1). To obtain dry wt, different plant parts were dried at 85-90°C for 48 hr.

Results

Lateral branch development. Ethephon significantly increased lateral branching over controls (Fig. 1) but there were

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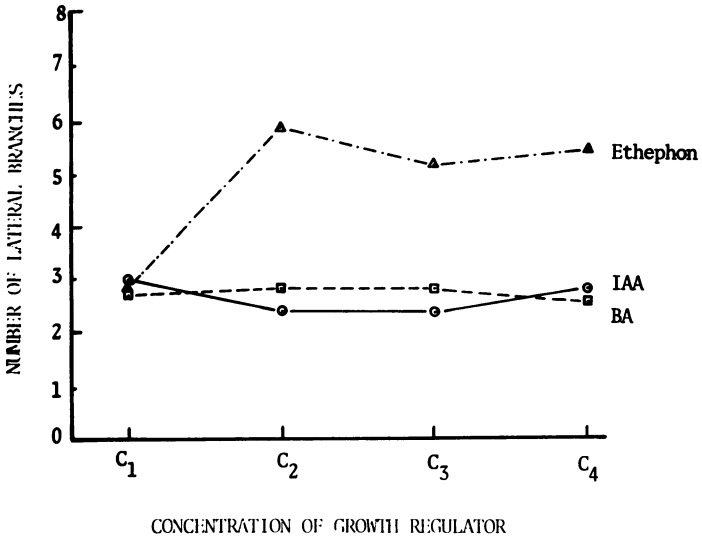

Fig. 1. Effect of ethephon, BA and IAA on lateral branch development of ornamental peppers. (C_1 to C_3 represent 300, 600, 900 ppm ethephon, 400, 800 1200 ppm BA and 50, 100, 150 ppm IAA respectively.

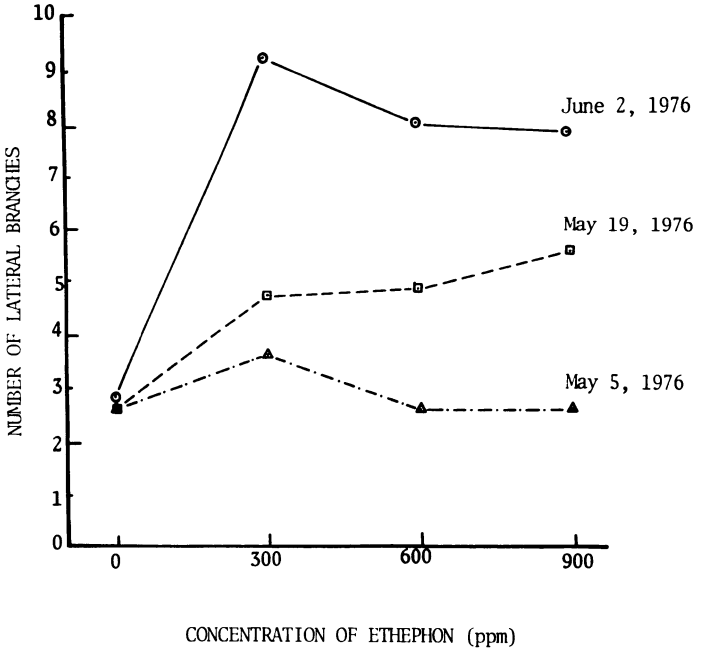

Fig. 2. Effect of ethephon applications, at different times, on no. of lateral branches of ornamental peppers.

no differences due to concn. The later the time of application the more the branching. Interactions of time of ethephon application with concn and pinching were significant. Application of 300 ppm ethephon at 2 weeks after pinching was more effective in increasing lateral branches than other application times (Fig. 2). We conclude that ethephon application could substitute for hand pinching.

BA and IAA did not affect the no. of lateral branches (Fig. 1). Regardless of growth regulator application, pinched plants had more lateral branches than non-pinched plants as expected.

Fruiting. Ethephon significantly reduced fruit no. (Table 1) and delayed fruit maturity (color development) resulting in fewer red fruits at harvest. IAA had no significant effect on fruit production and ripening and BA delayed ripening without affecting fruit production. Regardless of growth regulator type and concn, pinching delayed flowering and fruit ripening.

Ethephon reduced both fruit fresh and dry wt (Table 2). The third application time had greatest effect in reducing fruit dry wt as compared to the first or second times. Ethephon produced shorter fruits (Table 2).

Plant size. Generally, ethephon reduced plant size over the controls. The 300 ppm concn had the greatest effect in reducing plant ht and the 900 ppm the greatest effect in reducing plant diam (Table 2). Late application time had the maximal effect in decreasing plant diam and plant ht.

Ethephon concn significantly increased no. of nodes, the max effect being produced by 900 ppm (Table 2). Fresh and dry wt of shoots were significantly reduced with 300 ppm concn had the least effect (data not shown). The extent of ethephon action in reducing shoot dry wt increased with application time.

Leaf areas. Ethephon reduced leaf size. The highest concn produced the smallest total leaf area compared to the control. Application before pinching was the most effective time for reducing leaves.

Pinched plants treated with all 3 growth regulators had generally smaller leaf areas than non-pinched plants.

Leaf number. Pinching significantly increased leaf no. per plant. The interaction of time of ethephon application and pinching was also significant.

Chlorophyll content. Ethephon increased chlorophyll concn as compared with BA and IAA (Table 3). The later the time of ethephon application the more chlorophyll.

Root fresh and dry weights. Generally ethephon reduced root growth (2.6 g fresh wt) over control (3.9 g fresh wt). Root dry wt showed a similar pattern.

Table 1. Effect of growth regulators concn on total and red fruits of ornamental pepper.

	Ethephon		BA		IAA	
concn	Total no. of fruits	No. of red fruits	Total no. of fruits	No. of red fruits	Total no. of fruits	No. of red fruits
Control	11.7a[z]	3.9a	10.9a	5.2a	10.0a	4.0a
C_1[y]	9.8b	1.8b	9.2a	4.2ab	9.7a	3.1a
C_2	7.0c	1.1b	10.0a	2.9b	9.7a	3.2a
C_3	7.4c	1.1b	8.8a	3.5b	9.1a	2.8a

[z]Means separation in columns by Duncan's multiple range test, 5% level.
[y]C_1 to C_3 represent 300, 600, 900 ppm ethephon, 400, 800, 1200 ppm BA and 50, 100, 150 ppm IAA, respectively.

Table 2. Response of different characters of ornamental pepper plants to applications of ethephon.

Ethephon (ppm)	Fruit fresh wt (g)	Fruit dry wt (g)	Plant ht (cm)	Plant diam (cm)	Fruit length (cm)	No. of nodes
Control	15.4a	2.8a	42.6a[z]	75.6a	2.9a	34.8b
300	10.8b	2.0b	37.8b	69.9b	2.7b	43.6ab
600	8.1b	1.4c	35.5b	66.7b	2.7b	45.3a
900	8.0b	1.4c	35.0b	67.9b	2.7b	47.4a

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

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Table 3. Changes in chlorophyll content of pepper plants due to application of growth regulators.

Concn	Chlorophyll content (mg/dm^2)		
	Ethephon	BA	IAA
Control	4.9b[z]	4.5ab	4.6ab
C_1[y]	5.8a	5.0ab	5.0a
C_2	5.2ab	5.2a	4.7ab
C_3	5.1b	4.4b	4.2b
Mean	5.3	4.8	4.6

[z]Means in each column, followed by the same letter, are not statistically different at 5% level of probability (Duncan's new multiple range test).
[y]C_1 to C_3 represent 300, 600, 900 ppm ethephon, 400, 800, 1200 ppm BA and 50, 100, 150 ppm IAA, respectively.

Discussion

Stimulation of lateral branch growth in this experiment by ethephon is in accordance with results previously reported for 'Delaware Bell' peppers (6), and for such ornamentals as azaleas and chrysanthemums (9), poinsettias (5), roses (10), and geraniums (3). The inhibition of apical dominance by ethephon is attributed to the injury produced in the terminal bud resulting in interruption of its activity (6). The greater effect of ethephon when applied 2 weeks after pinching as compared to other application times may be explained on the basis of inhibitory action of ethylene on the apical meristem. When ethephon was applied in the presence of the apical meristem (before or at pinching), the ethephon effect was considerably diluted. This explanation is strengthened by the observation that regardless of growth regulator application, pinched plants behaved in a manner similar to those treated 2 weeks post-pinching with ethephon. The concn of 600 and 900 ppm of ethephon resulted in morphologically fewer desirable plants while 300 ppm application had no adverse effects producing the most desirable results. Ethephon could substitute for hand pinching and the use of a combination of ethephon application and hand pinching may result in production of more compact plants. Further experiments are needed to investigate the concn between 0 and 300 ppm to possibly find a more suitable concn for promotion of branching without delaying flower and fruit production.

In vegetable peppers (6), chrysanthemums (9), and geraniums (3) ethephon delayed flowering. Similar results were obtained for ornamental peppers in this investigation. This may be explained on the basis of bud breaking action of ethephon which resulted in prolonged vegetative state of treated plants. Ethephon, not only delayed flower production, but also produced fewer flowers per plant. This was due to the fact that not all branches terminated in flowers, and the no. of flowers per flowering branch was reduced.

Benzyladenine is used for induction of branching in such ornamental plants as roses (4, 7), poinsettias (2, 5), and geraniums (3). However, in this experiment treated plants failed to show any useful response to added BA. BA delayed flowering and fruit color development as those reported for geraniums. The inability of BA in induction of lateral branch development may be due to a need for higher concn for inducing shoot growth in peppers than in other species (8). In poinsettias (2, 5) leaf chlorosis develops after application of 1000 ppm BA but in this study application of 1200 ppm of BA caused no injury to ornamental peppers.

Application of IAA, in most cases, had no positive effect on ornamental quality of pepper plants in contrast to results obtained for geranium (3).

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