A Comparison of Ethephon, DCIB, SADH, and DPA for Abscission of Fruits, Flowers, and Floral Buds in Determinate Tomatoes[1]

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Abstract. At the highest concentration, sodium 2,3-dichloroisobutyrate (DCIB), 2-(chloroethyl)phosphonic acid (ethephon) and N-dimethylaminosuccinamic acid (SADH) produced abscission (flowers + floral buds) of approximately 90, 66, and 32%, respectively. DPA, at the rates used, produced no abscission. Only DCIB at 6000 ppm caused significant fruit drop. Ethephon and SADH were more effective for the abscission of buds than flowers, the reverse was true for DCIB. At the highest concentration, ethephon and DCIB produced approximately 35% abscission within 2 days, whereas with SADH abscission did not begin until 8 days after application. The chemicals x cluster-age interaction was highly significant.

In experiments conducted earlier (8), the authors found that by manually deblossoming tomato plants at either the 4, 5, or 6 cluster stages, yield was significantly increased by virtue of larger fruit size. The problem with manual deblossoming is that on a commercial scale it is economically impractical. If however, a chemical could effectively substitute for the hand deflowering, the issue would be resolved. The use of an appropriate abscission agent is one method of achieving this end. Of the several chemicals known to cause flower abscission in tomatoes, 4 were selected; SADH (6, 7), ethephon (1, 2, 3), DCIB (4, 5), and DPA (1). This experiment was designed to compare the 4 chemicals with respect to abscission of fruits, flowers, and floral buds, effect of concn, rate of abscission, and effect of physiological age of cluster on abscission.

Materials and Methods

The experiment was conducted during the summers of 1968 and 1969 at the University of Manitoba, Winnipeg. However, because of extremely poor growing conditions, the results of 1968 have been waived even though they were generally in keeping with those of 1969.

Plants of the determinate tomato cv. Summit were established in the field, from transplants, at 91 x 91 cm spacing. The experiment was a completely randomized design with 5 single plant replications. Each chemical was used at 3 concn (ppm): ethephon (250, 500, 1000), DCIB (1500, 3000, 6000), SADH (2500, 4000, 6000), and DPA (400, 800, 1600). The control plants were sprayed with distilled water.

After the first 3 clusters had completely set fruit, all clusters on each plant were tagged. From each plant 12 clusters were selected so that 3 clusters fell into each of the following 4 physiological categories; 1) 100% fruits, 0% open flowers, 2) 50% fruits, 50% open flowers, 3) 0% fruits, 50% open flowers, and 4) 0% fruits, 0% open flowers. The 12 clusters were numbered and the necessary information recorded for each. The plants were sprayed immediately to drip off.

The number of non-abscised organs on each of the 12 clusters on each plant were recorded at 2 day intervals. If abscission had occurred, the number and nature of the abscised organs were also noted. At the same time, any necessary changes with respect to the non-abscised structures were made on the tag. Data were collected for a period of 16 days.

Results and Discussion

1. *Percent abscission.* Ethephon produced abscission (flowers + buds) of approx 66, 55, and 43% at 1000, 500, and 250 ppm, respectively (Table 1, Fig. 1). These values are reasonably close to the 71 and 63% abscission that Garrison and Taylor (2) obtained at 1000 and 500 ppm, respectively. While Collin (1) has reported abscission of tomato flowers and buds with concn of 100, 50, and 25 ppm, exact figures have not been stated. Similarly, Iwahori et al. (3) reported abscission of tomato flowers with concn as low as 10 ppm.

DCIB caused 90% abscission at the highest concn (6000 ppm) and 58% at the lowest (1500 ppm). Moore (4, 5) studied the induction of male sterility in field tomatoes with DCIB, but did not study its effect on abscission *per se*. He found that DCIB at 6000 ppm induced male sterility for 17 days, 12 days after treatment, while at 1500 ppm a high degree of sterility resulted for 13 days, 15 days after spraying. Since he did not record data on abscission of flowers and floral buds, it is possible that some abscission may have occurred at both the above mentioned concn prior to the onset of male sterility.

At 6000, 4000, and 2500 ppm SADH produced flower + bud abscissions of 33, 24, and 16%, respectively. These results conflict with those of Read and Fieldhouse (6) who reported almost complete abscission of flowers at concn of 3000-5000 ppm. However, whether they differentiated between the abscission of floral buds and open flowers is not indicated. In a subsequent paper (6), the authors found that at 5000 ppm SADH caused 100% bud abscission, whereas flower abscission was variable. However, the chemical used was succinic acid-2, 2-dimethyl hydrazide, a different analog of SADH than the one initially used.

The abscission produced by DPA at the highest concn (1600 ppm) was not significantly different from that of the control. This is interesting since Collin (1) reported abscission of flowers with this chemical at concn of 500-1000 ppm.

DCIB caused 10% abscission of fruits at 6000 ppm and 2% at 3000 ppm, none of the other treatments caused fruit drop (Table 1). The fruits that did abscise at these concn of DCIB were generally less than ½″ in diam. This could be of potential use in the control of fruit set and concn of fruit ripening by

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Table 1. The effect of ethephon, DCIB, SADH, and DPA on the abscission of fruits, flowers, and floral buds of the determinate tomato 'Summit', 1969.

Chemical and concn	(ppm)	Fruits Total no	Fruits no absc.	Fruits % absc.	Flowers Total no	Flowers no absc.	Flowers % absc.	Bud Total absc.	Bud no absc.	Bud % absc.
Control		93	1	1.1	70	8	11.4	108	1	0.9
Ethephon	1000	108	0	0	54	12	22.2	78	75	96.2
	500	95	0	0	57	14	24.6	99	71	71.7
	250	89	0	0	66	13	19.7	108	60	55.6
DCIB	6000	108	11	10.2	69	67	97.1	105	90	85.7
	3000	101	2	2.0	64	61	95.3	81	60	74.1
	1500	104	0	0	65	43	66.2	88	45	51.1
SADH	6000	108	0	0	78	16	20.5	119	49	41.2
	4000	93	0	0	47	7	14.9	120	33	27.5
	2500	84	0	0	54	8	14.8	108	18	16.7
DPA	1600	99	0	0	59	4	6.8	140	8	5.7
	800	76	0	0	38	2	5.3	103	4	3.9
	400	87	0	0	62	4	6.5	115	7	6.1

extending the time interval within which the chemical could be applied.

At the highest concn of DCIB (6000 ppm), ethephon (1000 ppm), SADH (6000 ppm), and DPA (1600 ppm), the percent abscission of flowers was about 97, 22, 21, and 7, respectively; at the lowest concn it was 66, 20, 14, and 7%. The abscission of flowers on the control plants was 11%.

The abscission of floral buds at the highest concn was 96, 86, 41, and 6% for ethephon, DCIB, SADH and DPA, respectively; at the lowest concn it was 56, 51, 17, and 6%. On the control plants there was 1% bud abscission.

2. *Rate of abscission.* Abscised floral buds were observed beneath the plants the day after spraying for all the ethephon treatments. Abscission was complete within 6 days at 1000 ppm, 10 days at 500 ppm, and 12 days at 250 ppm (Fig. 1). Such a rapid onset of abscission would seem to suggest a contact mechanism. Collin (1), however, has indicated that applications of ethephon to foliage alone is equally effective in causing

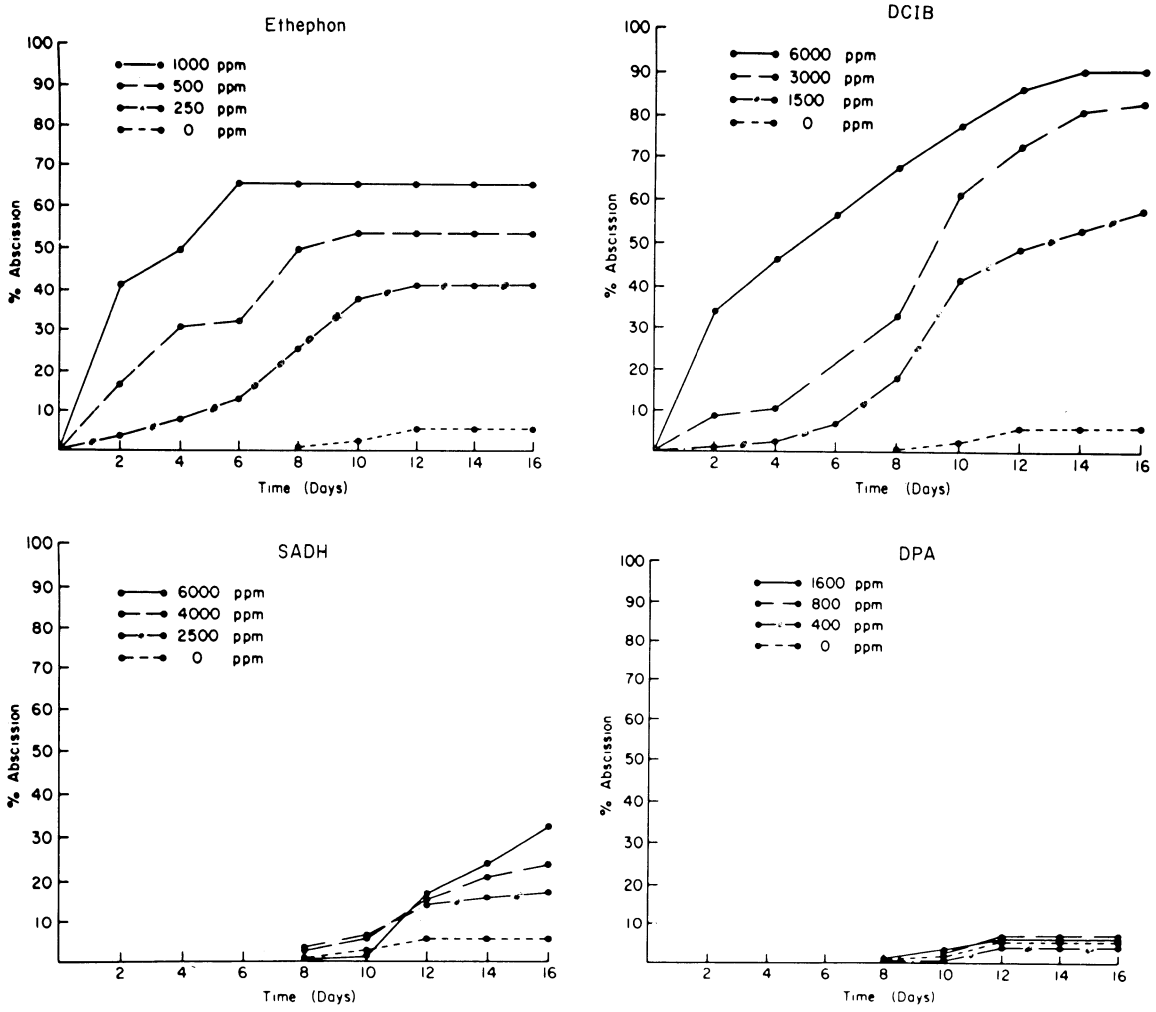

Fig. 1. The effect of ethephon, DCIB, SADH, and DPA on the rate of floral abscission (flowers + buds) in the determinate tomato 'Summit', 1969.

abscission. Since he did not study the rate of abscission, it is still possible that in overall plant applications a part of the abscission may be due to contact action.

As in the case of ethephon, abscission action started early and proceeded rapidly for DCIB at 6000 ppm, almost 35% of the abscission occurred within 2 days and reached a plateau in 14 days (Fig. 1). As mentioned earlier, the abscission action of DCIB at this concn is probably due to mechanisms other than male sterility. At the 2 lower concn, abscission was slower and continued throughout the duration of the experiment. It is possible that at these lower concn male sterility may have contributed substantially to abscission.

Abscission did not occur within the control or the SADH and DPA treatments until approx 8 days after spraying (Fig. 1). Subsequent abscission rates for DPA and the controls were similar. The SADH treatments differed in that none of them reached a plateau during the course of the experiment.

3. *Effect of physiological age of cluster on abscission.* The chemicals x cluster-age interaction was highly significant. With ethephon and DCIB, the abscission in all 4 stages was significantly different, the highest occurring in the youngest clusters and decreasing progressively with increasing cluster age (Table 2). A similar trend was noted with SADH, except that the 2 intermediate cluster-age classes did not differ significantly. For DPA, the abscission in the 3 younger cluster categories was similar, differing significantly from the all-fruit category within which no abscission occurred.

Table 2. The effect of physiological age of cluster on the chemical abscission of fruits, flowers, and buds in the determinate tomato 'Summit', 1969.

	Percentage abscission in cluster classes[z]			
Chemical	100% fruits, 0% flowers	50% fruits, 50% flowers	0% fruits, 50% flowers	0% fruits, 0% flowers
Ethephon	0.7[d]	16.9[c]	42.9[b]	82.1[a]
DCIB	1.9[d]	32.7[c]	47.4[b]	82.3[a]
SADH	0.9[c]	17.5[b]	15.4[b]	21.9[a]
DPA	0.0[b]	7.4[a]	7.9[a]	4.5[a]

[z]Means within rows followed by different letters are significant at the 5% level using Duncan's multiple range test. The arc-sin transformation was used prior to statistical analysis of data.

The experiment demonstrated that none of the abscission agents tested provided perfect control of fruit load. However, DCIB at 6000 ppm was approx 90% effective and would probably be the most successful treatment. Ethephon at 1000 ppm, caused up to 66% flowers + buds abscission, and is also worth recommendation. The fact that floral buds are more susceptible to ethephon than open flowers, which, in turn, are more affected by DCIB than buds, would suggest that the 2 chemicals used in combination may prove to be more efficacious than either alone. A factor that was not studied in this experiment was the duration of effect. Such information would be necessary to determine the required number of applications.

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