Screening Pepper Cultivars for Resistance to Flower Abscission: A Comparison of Techniques

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Abstract. In one greenhouse and two field experiments, eight or ten pepper (*Capsicum annuum* L.) cultivars were subjected to low-light stress by use of shade cloth (reducing light by 80%) or to foliar sprays of ethephon at 75 or 150 pi-liter-]. Both low-light stress and ethephon identified 'Ace', 'Canape', and 'Belrubi' as less susceptible to flower and flower bud abscission than other cultivars in the first field experiment. In the 2nd year, air mean maxima of 32C caused severe abscission in controls and shaded plants, and complete loss of flowers in those sprayed with ethephon. Abscission of disbudded pedicels was not related to abscission susceptibility of eight cultivars when subjected to shade. While ethephon spray can serve as a satisfactory abscission screening tool under unstressed growing conditions, low-light stress imposed by shading may be used under a wider range of conditions. Chemical name used: 2-chloroethyl phosphoric acid (ethephon).

Ethephon foliar spray at the preanthesis stage has been used to identify pepper cultivars with relatively low susceptibility to

stress-induced flower and flower bud abscission (Tripp and Wien, 1989). The screening technique is based on the finding that flower bud abscission is mediated by ethylene (Wien et al., 1989a). Given the variation in ethephon uptake and activity with changes in temperature (Kays and Beaudry, 1987), the reliability of the technique may vary with environmental conditions. Direct imposition of heat stress may prove complicated and expensive, involving construction of heated structures in the field (Nielson and Hall, 1985), or use of temperature-controlled greenhouses (Stoner and Otto, 1975). Recent

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Table 1. Effect of ethephon foliar spray or 1 week of 80% shade on abscission of flowers and flower buds on four flowering nodes of eight pepper cultivars (Expt. 1).

Cultivar	Abscission (%) ^a			
	Ethephon ($\mu\text{l}\cdot\text{liter}^{-1}$)			80% shading
	0	75	150	
Ace	4 a	38 a	58 a	39 a
Canape	20 ab	40 ab	63 ab	48 ab
Belrubi	33 b	47 ab	66 ab	49 ab
Lady Bell	15 ab	42 ab	74 ab	42 ab
Green Boy	28 b	67 ab	77 ab	67 abc
Big Bertha	26 ab	67 ab	75 ab	69 bc
E. Calwonder	32 b	70 b	86 b	81 c
Shamrock	29 b	70 b	88 b	87 c

^aEffects of treatments, cultivars, and their interaction significant at $P = 0.01$. Means within columns followed by different letters are significantly different at $P = 0.05$ as determined by HSD values of the arcsin-transformed percentage data.

Table 2. Effect of 10 days of 80% shade on abscission of flowers and flower buds from nodes 1 and 2 of 10 pepper cultivars (Expt. 2).

Cultivar	Abscission (%) ^a	
	Shade (%)	
	0	80
Ace	41 a	46 a
Lady Bell	79 b	70 ab
Wonder Bell	89 b	94 b
Bell Star	93 b	98 b
Bell Tower	97 b	96 b
Cadice	96 b	98 b
Bell Captain	98 b	98 b
Sweet Belle	98 b	98 b
Jupiter	99 b	99 b
Shamrock	100 b	98 b

^aEffect of shade not significant. Means within columns followed by different letters are significantly different at $P = 0.05$ as determined by HSD values of the arcsin-transformed percentage data.

research indicated that pepper cultivars susceptible to heat stress-induced abscission also showed increased abscission in heavy shade (Wien et al., 1989a). In other experiments, flower bud removal resulted in rapid abscission of all pedicels of stress-susceptible 'Shamrock', while some pedicels of resistant 'Ace' were retained. The present experiments were conducted to determine if shading or bud removal could serve as improved

screening techniques for bud and flower abscission susceptibility in peppers, as compared to the use of ethephon foliar sprays.

The 1987 screening (Expt. 1) in the field compared the ethephon foliar spray technique of Tripp and Wien (1989) to heavy shade to identify stress-resistant cultivars (Wien et al., 1989a). On 28 May, eight pepper cultivars were sown in seedboxes containing a peat-vermiculite soilless mix. Seedlings were transplanted to 5×5 -cm cell size styrofoam trays 2 weeks later, and transplanted to the field on 1 July. Plants were spaced 46 cm apart in staggered double rows 60 cm apart, mulched with black polyethylene 122 cm wide, and spaced 152 cm apart on center. The soil was an Eel silt loam (fine-loamy, mixed, nonacid, mesic Aquic Udifluent). Subplots consisted of 12 plants arranged in a randomized complete-block design with a split-plot treatment arrangement. Main plots consisted of stress treatments; cultivars were subplots. There were four replications.

Ethephon foliar sprays of 0, 75, or 150 $\mu\text{l}\cdot\text{liter}^{-1}$ applied 17 and 24 days after transplanting (DAT) were compared to a 1-week 80% shade treatment, begun 20 DAT. Polypropylene shade fabric 183 cm wide was draped over steel hoops, with edges and ends buried in the soil, forming a tunnel 45×90 cm (height/width). One week after the end of the shading treatment, eight plants per subplot were harvested and examined for bud abscission at the lowest four branching levels (Tripp and Wien, 1989).

A second field screening experiment (Expt. 2) with identical statistical design was conducted in 1988, comparing the relative stress resistance of 10 bell pepper cultivars using ethephon sprays or 80% shade. Experimental procedures were similar to Expt. 1, except that ethephon sprays were applied 11, 17, and 23 DAT. Shade treatment was imposed for 10 days, starting 11 DAT. Abscission notes on the lowest three branching levels were taken in a destructive harvest 30 DAT.

A pedicel abscission experiment was conducted in a greenhouse in early Summer 1987 to determine if cultivar differences in low light-induced abscission were correlated to the abscission rate of disbudded pedicels. The greenhouse was at 27/21C day/night cycle.

Four weeks after seeds were sown in styrofoam transplant trays, seedlings were transplanted into peat-vermiculite soilless mix in 40 polyethylene pots. To achieve simultaneous flowering, seeds of the late-flowering 'Shamrock', 'Big Bertha', and 'Early Calwonder' were sown 1 week ahead of the other five cultivars. The same eight cultivars compared in Expt. 1 were each subjected to one of the following treatments, beginning when buds at branching level 5 were 5 to 8 mm in diameter (63 and 56 DAT for late and early cultivars, respectively): 1) Control, not treated; 2) removal of five buds (5 to 8 mm diameter) per plant, leaving a 1-cm pedicel stub; or 3) shading the plants for 7 days with a canopy of polypropylene shade fabric (80% shade). In treatments 1 and 3, observations were made daily, beginning at bud removal on five tagged buds of 5- to 8-mm diameter, found at branching levels 5 or 6. One week after the end of the shade treatment, abscission was determined at these nodes and at three nodes above the tagged node. There were seven pots per cultivar per treatment, arranged in a completely random design on the greenhouse bench before and after shade treatment. In all experiments, statistical analysis was performed on the arcsin-transformed percentage abscission data (Tripp and Wien, 1989).

The results of Expt. 1 confirmed the findings of Tripp and Wien (1989) that ethephon foliar spray can identify pepper cultivars that are least susceptible to stress with regard to flower bud abscission (Table 1). As in the earlier work, 'Ace' and 'Canape' showed less abscission than 'Shamrock' and 'Big Bertha'. The same range of susceptibilities occurred in the present experiment when plants were subjected to 7 days of 80% shade. Abscission in the unshaded control plants was moderate, and not well-correlated with abscission under low-light stress or ethephon spray.

In Expt. 2, there was virtually complete flower and flower bud abscission in eight of the 10 cultivars, even in unshaded controls (Table 2). The period of treatment coincided with record high temperatures in the field, with mean maxima averaging 32C for the first week of shading; 4C higher than the equivalent period in Expt. 1. Minima were 16 and 15C in Expts. 1 and 2, respectively. Only 'Ace' showed significantly less abscission than the others under these conditions, with 'Lady Bell' giving an intermediate response. The shade treatment did not further accentuate abscission of these cultivars. All cultivars showed complete flower and flower bud abscission with both ethephon spray treatments. The release of ethylene from ethephon and ethephon uptake by plant tissue are enhanced by high temperature (Kays and Beaudry, 1987). When combined with the direct stress effect of the temperature, which presumably also caused ethylene production by the plant (Wien et al., 1989a), the total ethylene generated apparently was sufficient to cause complete abscission in even resistant 'Ace'. Tripp and Wien (1989) found in some ethephon foliar spray experiments

Table 3. Abscission of flowers and flower buds from eight bell pepper cultivars as a result of shade treatment, compared to pedicel stub abscission after bud removal.

Cultivar	Abscission (%) ^a			
	Control ^b	Pedicel ^c stub	80% shade	
			Tagged nodes	Nodes ^d above
Ace	6 $\pm$ 10	66 $\pm$ 28	48 $\pm$ 32	28 $\pm$ 16
Canape	0	97 $\pm$ 8	28 $\pm$ 23	26 $\pm$ 13
Belrubi	0	100	37 $\pm$ 14	12 $\pm$ 12
Lady Bell	3 $\pm$ 8	88 $\pm$ 16	83 $\pm$ 24	52 $\pm$ 14
Green Boy	0	88 $\pm$ 16	88 $\pm$ 11	68 $\pm$ 18
Big Bertha	0	100	86 $\pm$ 19	60 $\pm$ 23
E. Calwonder	6 $\pm$ 10	83 $\pm$ 29	94 $\pm$ 10	59 $\pm$ 15
Shamrock	6 $\pm$ 10	100	66 $\pm$ 38	59 $\pm$ 26

^aMean $\pm$ standard error. Abscission data taken 1 week after end of a 1-week 80% shade treatment.

^br (tagged nodes vs. pedicel stub abscission) = -0.09 ns.

^cAbscission of buds from three higher nodes on the same branch as the tagged node.

that 200 to 300 µl ethephon/liter brought about total flower and flower bud loss in all pepper cultivars tested. Phytotoxic effects of ethephon on other crops have been associated with use of normally optimal concentrations under high temperature conditions (Flore and Bukovac, 1982).

In the pedicel abscission experiment, pedicel stub abscission was not well-correlated with abscission rate under low light (Table 3). Although 'Ace' showed less pedicel abscission than 'Shamrock', the stress abscission-resistant cultivars Canape and Belrubi had high rates of pedicel abscission. Retention of the pedicel stub after bud removal probably means that the pedicel is producing sufficient auxin to prevent formation of an abscission layer (Wien et al., 1989a). Abscission resistance of intact flowers and flower buds under stress appears not to be related to pedicel auxin content of nonstressed plants.

As in previous experiments, low-light stress produced less abscission in 'Ace', 'Canape', and 'Belrubi' than in the other five cultivars (compare Tables 3 and 1). 'Ace' and 'Canape' also were least susceptible to heat stress-induced abscission (Wien et al., 1989b). Low light conditions are more readily imposed under field conditions than high temperature. With shade-fabric row covers or larger enclosures, light levels can be uniformly reduced over large areas without substantial changes in air temperatures (Wien et al., 1989a). High temperature screening in temperate climates requires good temperature control in greenhouses (Stoner and Otto, 1975), or field tunnels with artificial heat, imposed during the night (Nielson and Hall, 1985). During the day, such tunnels require ventilation or removal to prevent excessive heat. The ethephon foliar spray technique (Tripp and Wien, 1989) worked well under conditions of good growth in Expt. 1, but resulted in excess abscission under the higher temperatures of Expt. 2. The technique is thus only useful when climatic conditions during the immediate pre-bloom period can be predicted to be optimal for pepper growth and fruit set.

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