

## COLOR ENHANCEMENT OF BELL PEPPER WITH ETHEPHON

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**Abstract.** Ethephon [2-chlorethyl phosphonic acid] was applied to 'Yolo Wonder L' bell pepper (*Capsicum annuum*) after 2 harvests for fresh market to hasten color development for processing. All fruits were harvested 2 weeks after ethephon application. Rates of .5, .75, 1.0, 1.25, and 1.50 lbs/acre ethephon increased the quantity of red fruit over the check by 50, 96, 139, 93, and 100%, respectively, during one season. Rates higher than 1.25 lb/acre caused defoliation of the bell pepper plants and resulted in an increase in sunburned fruit. Maximization of red color development occurred with the 1 lb/acre rate with 63, 34, and 3% of the fruits in the red, breaker, and green color categories, respectively, compared with the check with 23, 45, and 32%, respectively. During a second season, when peppers were sprayed with ethephon at a very advanced stage of maturity, color enhancement also occurred but the increase in cull fruit was more severe.

Bell pepper (*Capsicum annuum* L.), grown for the fresh market, are harvested in the mature green stage. The number of harvests in Florida generally vary from 2 to 6 depending on market demand. In many seasons, large quantities of fruit remain on plants at the end of this marketing period. In recent years, some pepper growers have marketed some of this remaining fruit in the red ripe stage for processing. Time required for complete red development is about 2 to 5 weeks after the mature green stage. Ethephon [(2-chloroethyl) phosphonic acid] has been shown to hasten ripening in pimiento pepper (1, 2, 3, 6, 7, 8, 9) and chili pepper (4, 5) when applied before first harvest. Effectiveness of ethephon has varied with cultivar (1), rate (1, 2, 3), number of applications (1), temp (2), and other environmental and physiological factors (3). Rates required to stimulate ripening have varied from 0.5 to 1.5 lb/acre. Higher rates have sometimes caused severe defoliation and result in fruit loss.

Studies reported here were conducted to determine the effectiveness of a single application of ethephon on hastening ripening of bell pepper after several mature-green harvests.

### Experimental Procedures

Experiments were conducted during the spring of 1976 and 1977 with 'Yolo Wonder L' bell pepper. Treatments were ethephon applied at the rates of 0, 0.5, 0.75, 1.00, 1.25, and 1.50 lb/acre and were arranged in a randomized block design with 4 replications. Fertilizer was applied broadcast at the rates of 140-75-125 lb/acre<sup>1</sup> N-P-K when the beds were formed. Peppers were transplanted through black polyethylene mulch in mid-March on double rows during 1976 and

on single rows per bed during 1977 with a spacing of 1 foot apart in the row. Plot sizes were 6 x 25 feet during the 1976 season and 4 x 50 feet during the 1977 season.

Mature green fruits were harvested two times in each season. Harvests were on June 3 and June 10 in 1976, and on June 9 and June 16, 1977. On June 22, 1976 and on June 28, 1977, all red and turning fruit (breakers) were removed from the plant. Ethephon (2 lb/gal formulation) was then applied to the pepper plants in a water spray at the rate of 43 gpa. The solution was applied in a two-foot band over the plants with a hand sprayer equipped with 8003 tee-jet nozzles operated at 30 psi. Two weeks after ethephon application, fruits were harvested and graded into full red, breaker, and green marketable fruit and cull fruit.

### Results and Discussion

*1976 season.* Plant growth and fruit production were excellent during the 1976 season and approximately 600 bu/acre of mature-green marketable fruit were harvested in the first 2 pickings. Application of ethephon significantly increased the number and weight of marketable fruit in the full red stage of maturity (Table 1). Yields of red fruit were increased from 1.90 to 4.55 tons/acre with an increase in the rate of ethephon applied from 0 to 1 lb/acre. With a further increase in the rate to 1.5 lb/acre, the yield of red fruit decreased slightly to 3.81 tons/acre. Production of fruit in both the breaker and green categories was reduced with an increase in the rate of ethephon and were minimized with an application of about 1 lb/acre ethephon. Marketable fruits in the red, breaker, and green categories were 23, 45, and 32% (152, 291, and 210 bu/acre), respectively, without ethephon and 41, 49, and 10% (364, 198, and 16 bu/acre) respectively, with an application of 1 lb/acre ethephon.

Table 1. Effect of ethephon rate on yield of red, breaker and green bell pepper, 1976.

Ethephon, lb/acre	Marketable yield			
	Red	Breaker	Green	Total
	no./plant			
0	.86	1.68	1.49	4.03
0.50	1.36	1.71	.48	3.55
0.75	1.74	1.24	.38	3.36
1.00	2.14	1.46	.16	3.76
1.25	1.79	1.51	.19	3.50
1.50	1.51	1.36	.34	3.21
F value*	L**Q**	NS	L**Q**	L**
	ton/acre			
0	1.90	3.64	2.62	8.15
0.50	2.85	3.46	.73	7.04
0.75	3.72	2.40	.52	6.65
1.00	4.55	2.48	.20	7.22
1.25	3.68	2.56	.19	6.43
1.50	3.81	2.35	.40	6.57
F value	L**Q*	L**	L**Q**	L**
	% of total marketable wt.			
0	23	45	32	
0.50	41	49	10	
0.75	56	36	8	
1.00	62	35	3	
1.25	57	40	3	
1.50	58	36	6	
F value				

\*Differences in rate were significant at the 5% (\*) or 1% (\*\*) levels and were linear (L) or quadratic (Q) or not significant (NS).

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<sup>1</sup>For metric conversions see Table near the front of this Volume. Ed.

The quantity of sunburned fruit was increased slightly with an increase in the rate of ethephon applied (Table 2). Approximately 7% of the fruit was sunburned with the 1 to 1.5 lb/acre ethephon rates as compared with 4% with the non-sprayed treatment. This increase in sunburned fruit was related to an increase in leaf senescence and plant defoliation, particularly above the 1.25 lb/acre ethephon rate. The quantity of cull fruit other than sunburned was not influenced by ethephon rate.

1977 season. The 1977 season was relatively drier and hotter than the 1976 season. At the time of ethephon application during the latter season, large quantities of breaker fruit were removed from the plant before ethephon was applied. The number and weight of marketable fruit in the red categories were not influenced by ethephon rate (Table 3). Total marketable fruit yields were low and quite variable and averaged 1 to 2 fruit per plant or about 1.6 to 3.1 tons/acre (130 to 250 bu/acre). On a percentage basis of total marketable fruit, ethephon application increased the quantity of fruit in the full ripe stage. Fruits in the red, breaker, and green categories were 78, 20, and 2% with 1 lb/acre compared with 38, 45, and 17%, respectively, for the check treatment. This increased red color development with ethephon application was also reflected in the linear reduction in weight of fruit in the breaker and green categories with an increase in the rate of application.

The number and weight of sunburned and other cull fruit were not influenced by ethephon rate (Table 4). Defoliation and sunburning of the fruit, however, were severe in all treatments. Approximately one-third of all fruit harvested were culls and were probably related to the advanced stage of maturity at the time of ethephon application. Based on a percentage of the marketable fruit number, application of ethephon did increase the percentage of sunburned fruit.

Table 2. Effect of ethephon rate on yield of cull pepper fruit, 1976.

Ethephon, lb/acre	Cull fruit		Total
	Sunburn	Others	
	no./plant		
0	.16	.35	.51
0.50	.19	.28	.46
0.75	.14	.59	.73
1.00	.36	.36	.73
1.25	.36	.37	.73
1.50	.44	.46	.90
F value	L*	NS	L*
	ton/acre		
0	.27	.46	.72
0.50	.31	.40	.71
0.75	.39	.82	1.21
1.00	.72	.51	1.22
1.25	.69	.50	1.19
1.50	.84	.61	1.44
F value	L*	NS	L*
	% of total marketable no.		
0	4	6	10
0.50	5	6	11
0.75	4	8	12
1.00	7	5	12
1.25	7	5	12
1.50	7	5	12
F value			

\*Differences in rate were significant at the 5% (\*) or 1% (\*\*) levels and were linear (L) or quadratic (Q) or not significant (NS).

Table 3. Effect of ethephon rate on yield of red, breaker, and green bell pepper, 1977.

Ethephon, lb/acre	Marketable yield			Total
	Red	Breaker	Green	
	no./plant			
0	.70	.90	.37	1.97
0.50	.78	.50	.13	1.42
0.75	.59	.33	.11	1.03
1.00	.91	.32	.05	1.11
1.25	.63	.40	.08	1.10
1.50	.59	.40	.06	1.05
F value	NS	NS	L**Q*	L*
	ton/acre			
0	1.20	1.40	.53	3.13
0.50	1.42	1.04	.09	2.55
0.75	1.11	.55	.10	1.77
1.00	1.77	.45	.03	2.26
1.25	1.06	.54	.05	1.66
1.50	1.04	.51	.03	1.58
F value	NS	L*	L**Q*	L*
	% of total marketable wt.			
0	38	45	17	
0.50	56	40	4	
0.75	63	31	6	
1.00	78	20	2	
1.25	64	33	3	
1.50	66	32	2	

\*Differences in rate were significant at the 5% (\*) or 1% (\*\*) levels and were linear (L) or quadratic (Q) or not significant (NS).

### Conclusions

In this study, application of ethephon at 1 lb/acre maximized red ripe fruit production. This rate was higher than that reported by Osteri *et al.* (6). Lower and higher rates were also effective in this study, but defoliation becomes a severe problem with the higher rates (1).

Table 4. Effect of ethephon rate on yield of cull pepper fruit, 1977.

Ethephon, lb/acre	Cull fruit		Total
	Sunburn	Others	
	no./plant		
0	.56	.14	.70
0.50	.45	.07	.52
0.75	.27	.09	.36
1.00	.53	.05	.58
1.25	.48	.18	.66
1.50	.36	.07	.43
F value	NS	NS	NS
	no. x 1000/acre		
0	8.23	1.94	10.17
0.50	6.42	.97	7.39
0.75	3.88	1.21	5.09
1.00	7.75	.61	8.36
1.25	7.02	2.55	9.57
1.50	5.21	.97	6.18
F value	NS	NS	NS
	% of marketable no.		
0	29	7	36
0.50	32	5	36
0.75	26	8	34
1.00	49	4	52
1.25	44	16	60
1.50	35	7	42

\*Differences in rate were significant at the 5% (\*) or 1% (\*\*) levels and were linear (L) or quadratic (Q) or not significant (NS).

During the 1977 season, 38% of the marketable fruit developed full red color without treatment as compared with only 23% during the 1976 season. With the advanced maturity and low fruit yields as during the 1977 season, ethephon application provided a small increase in red fruit yield. In contrast, in the 1976 season, application of 1 lb/acre of ethephon provided a 140% increase in ripe fruit.

#### Literature Cited

1. Cantliffe, D. J. and P. Goodwin. 1975. Red color enhancement of pepper fruits by multiple applications of ethephon. *J. Amer. Soc. Hort. Sci.* 100:157-161.
2. Knavel, D. E. and T. R. Kemp. 1973. Ethephon and CPTA on color development in bell pepper fruits. *HortScience* 8(5):403-404.
3. Lockwood, D. and H. M. Vines. 1972. Red color enhancement of pimiento peppers with (2-chloroethyl) phosphonic acid. *J. Amer. Soc. Hort. Sci.* 97(2):192-197.
4. Love, J. E., J. F. Fontenot, and J. W. White. 1971. Ripening hot peppers with Ethrel. *Louisiana Agric.* 14(4):14-15.
5. Nakayama, R. M. and F. B. Matta. 1973. Extractable red color of chili peppers (*Capsicum frutescens*) as influenced by fruit maturity and alar, gibberellic acid and ethephon treatments. *HortScience* 8(3):252. (Abstract).
6. Osterli, P. P., R. M. Rice, and K. W. Dunster. 1975. Effect of ethephon on bell pepper fruit ripening. *Calif. Agric.* 29(7):3.
7. Sims, W. L., H. B. Collins, and B. L. Gledhill. 1970. Ethrel effects of fruit ripening of peppers. *Calif. Agric.* 24(2):4-5.
8. ———, D. Ririe, R. A. Brendler, M. J. Snyder, D. N. Wright, V. H. Schweers, and P. P. Osterli. 1974. Factors affecting ethephon as an aid in fruit ripening of peppers. *Calif. Agric.* 28(6):3-4.
9. Worku, Z. and R. C. Harner. 1971. Effect of (2-chloroethyl)-phosphonic acid (ethephon) on color of pepper (*Capsicum annuum* L.). *HortScience* 6(3):279. Abstract.