EFFECTS OF (2-CHLOROETHYL) PHOSPHONIC ACID ON THINNING AND MATURATION OF BUNCH GRAPE

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CHAPTER I

INTRODUCTION

Many factors of grape growing enter into the production of quality fruit. Some of these are the more general factors, such as choice of variety, climate effect, and soil type along with the operations of cultivation, irrigation, and insect and disease control. Other factors are those that affect the vine and its fruit more directly, such as pruning the vine, thinning the crop, and the use of plant growth regulators. Although all of these factors are of importance, the use of plant growth regulators as a chemical thinning and abscission hormone is interesting.

Due to the cost and critical timing of hand thinning, much effort has been expended in attempts to develop means of thinning by the use of chemical sprays. At present, thinning is economically feasible only on table grape. A method of chemical thinning might make it possible to improve the quality of fruit for wine and raisin varieties. Thinning also may materially reduce diseases on the clusters.

Fruit growers also need chemical compounds that will initiate fruit abscission to facilitate harvesting. Several compounds which are effective in promoting abscission have recently been introduced. In cluster dipping experiments (44), morphactins have stimulated abscission of young fruits of certain varieties of Vitis vinifera. Ethephon (2-chloroethyl) phosphonic acid has been shown to enhance abscission in

fruits of apple, pear, and cherry (21).

Cooke and Randall reported ethephon an ethylene releasing compound (11). When applied as a foliar spray to Concord grape prior to harvest it promoted the abscission of berries within six days.

This study was designed to determine the effectiveness of ethephon at different concentrations on fruit thinning and maturation in bunch grape under Oklahoma condition.

Oklahoma selection 181 (Wine King x Keuka) was used in this study.

CHAPTER II

LITERATURE REVIEW

Effect of Ethephon on Vegetative Growth

Depending upon the crop, growth inhibition resulting from ethephon application may be important to induce or delay flowering or fruit maturing. Further, stopping terminal growth may stimulate lateral branching, thereby increasing sites for flower and fruit production.

Vegetative growth of fruit trees such as apple and pear has been suppressed with ethephon foliar sprays of 250 to 1,000 ppm (20, 19, 32, 47). On vigorous grape vines, reduced vegetative growth after mid-season foliar applications of 1000 ppm ethephon should reduce the labor required for pruning and stimulate more uniform cluster maturity as a result of better light penetration (45). Sprays of 125 to 1000 ppm ethephon applied to many cultivars of vegetables including sweet corn, beet, snapbean, eggplant, garden pea, pepper and tomato have inhibited terminal shoot growth (39).

Effect of Ethephon on Flowering

Flower induction is an essential part of production techniques of pineapples, particularly during the season of long photoperiod when the duration of vegetative growth is extended abnormally. Spraying pineapple plants with ethephon at rates of 1 to 4 lb./acre has generally induced 100% flower formation (11). The flowering response

is hastened with the higher rate of 4 lbs./acre. These plants matured 2 to 3 weeks earlier than did those treated at 1 lb./acre rate. Preliminary information indicates that foliar applications of 1000 ppm ethephon can promote earlier flowering of mango (17).

Fall and spring applications of 250 to 2,000 ppm of ethephon to apple and pear trees have in some cases suppressed vegetative growth and subsequently promoted flowering (18, 19, 32, 47).

Effect of Ethephon on Sex Expression and Seed Development

Breeding for seedlessness in grapes is difficult since seedless types cannot be used as female parents and the population of seedlessness is low in crosses with seeded types (44). Kender et al. reported that ethephon applied to grapevines as an aqueous spray of 100, 200, or 400 ppm induced hard seed formation in fruit or some seedless cultivars. Ethephon also promoted femaleness in the staminate flower of the SO_4 grape rootstock, resulting in producing berries with hard seeds in this normally fruitless cultivar (31).

Producing hybrid curcurbit seed is costly when staminate flowers are removed by hand from seed parents to prevent self-pollination. Ethephon sprays can be an important hybridizing tool for suppressing anther development in staminate flowers of cucurbit seed parents (35, 38, 41). Single or repeated foliar sprays of 125 to 250 ppm applied during the 1st to 5th true leaf stage can markedly increase earlier formation of pistillate flower types or perfect flower types while decreasing or eliminating staminate flower types from the first 15 nodes (13, 29, 30, 42, 43). The flowering pattern of monoecious cucumbers treated with ethephon resembles that of gynoecious cultivars.

Initially, ethephon-treated plants produce pistillate flowers primarily, then gradually revert to their original monoecious character after the 15th node. Ethephon applied to andromonoecious, monoecious and hermaphrodite muskmelon cultivars initiated a general flowering pattern characterized first by the production of pistillate flowers and later by increased frequency of hermaphrodite and staminate flowers (30, 42).

Effect of Ethephon on Abscission and Fruit Thinning

Many plant scientists have shown that ethylene will induce or accelerate abscission of leaves (16) and fruits (12). Regulating defoliation, flower abscission, immature fruit thinning and abscission of mature fruit provides important crop production control and could facilitate mechanical harvest.

Many cultivars of fruit trees frequently set more fruit than they can mature to commercial standards of size and quality. When this condition exists it is desirable to remove the surplus early in the growing season either by hand, mechanical, or chemical thinning of blossoms or immature fruit.

Spraying with 10 to 1000 ppm of ethephon in the pre-bloom and bloom stages shows promise for thinning flowers and fruit in some grape (Vitis vinifera) cultivars. A 1000 ppm treatment in the bloom stage may be useful for eliminating all fruit from young nursery stock and newly planted vineyards (45).

Apple fruit set has been significantly reduced following the application of 200 to 2000 ppm sprays of ethephon in the spring at the late dormant, pink bud, full-bloom and post-bloom stages of develop-

ment (18). Virtually all fruit was eliminated as a result of application of 2000 ppm with little or no leaf injury. Although effective thinning was obtained at some stages with rates as low as 200 ppm, fruit size often failed to increase significantly over unthinned controls. Spraying foliage with 250 to 1000 ppm ethephon in late fall, after harvest, reduced apple set the following spring (32).

Ethephon applied to citrus blossoms at a rate of 100 ppm caused tangerine fruits to be thinned without inducing leaf abscission (2).

Peach blossoms have been thinned by spraying with 250 to 500 ppm of ethephon at the 20 to 100% full-bloom stage. Fruit set was reduced without causing severe gumming or dwarfing subsequent vegetative growth (1, 5, 15, 23). Observations at harvest have generally shown that the size of fruit from trees adequately thinned with ethephon has been comparable to that of fruit from hand thinned controls. In some peach growing areas fruit set must be assessed before thinning to minimize the possibility of crop loss due to inadequate pollination or frost damage. Ethephon has most effectively thinned immature stone fruit when applied during cytokinesis, a short interval of about 4 days, when the fruit endosperm is changing from the free nuclear to the completely cellular stage (6). The optimum treatment concentration appears to be from 30 to 150 ppm (2, 4, 23, 37).

Most recently, horticulturist and agricultural engineers have been keenly interested in reducing the force required to separate fruit from its point of attachment to the plant (12). Ethephon appears to effect the abscission layer by weakening this point of attachment. This should increase machine harvest efficiency by reducing shaking force and time and consequently should reduce mechanical injury to both the

bark and root of tree crops. Although a number of machine and plant factors are involved in developing mechanical harvesting techniques, ethephon treatment should increase recoverable yields, decrease fruit bruising and lessen branch or spur breakage.

Sweet and sour cherry fruit removal force was reduced by the use of ethephon foliar sprays of 250 to 500 ppm applied 7 to 14 days before normal harvest maturity (3, 7, 21, 34, 46). Separation or loosening occurred at the fruit end of the stem rather than at the spur; consequently most of the cherries were removed without stems attached. The quality of ethephon harvested cherry fruit was generally better than that from controls. Applications of high concentration of ethephon (1000 to 4000 ppm) can be phytotoxic producing leaf abscission, terminal dieback, gummosis and enlarged lenticels.

Similar promising results have been obtained from spraying 250 to 750 ppm ethephon to aid mechanical removal of apples (18, 22, 21) and 125 to 400 ppm on grape varieties 'Concord' and 'Thompson Seedless' (10, 28).

Foliar spray application of 500 ppm ethephon on pecan will hasten shuck dehiscence or opening (33) and 1000 ppm was the best treatment of loosening of shucks on the variety Stuart when applied September 30 in Oklahoma (26). In 1971, Hopfer and Hinrichs reported that concentration of 500 to 750 ppm ethephon were the most promising but some damage to foliage and the filling of the kernel occurred. Lower kernel percentage will result when the trees have set a heavy crop or when the application is too early. The nut shucks could be loosened 7 to 11 days earlier than the non-treated nuts (27).

Effect of Ethephon on Fruit Ripening

Reviews by Burg (8) and others (25, 40) have demonstrated the dramatic influence of ethylene on fruit ripening and maturity. Triggering or accelerating the ripening changes with ethephon either before or after harvest suggests the possibility of important agricultural uses such as increasing early harvest, programming harvest schedules, concentrating maturity to facilitate once-over mechanical harvest or to reduce the number of hand pickings required, and improving fruit color or market appearance.

In certain fruits such as fig (14) peach (9, 36) and grape (24) which typically have a double sigmoid growth pattern, applications of ethephon during late period II (the beginning of pit hardening) had triggered rapid fruit growth associated with period III (during final swell). Figs treated with a 250 to 500 ppm ethephon foliar spray a few days after all druplets within the fruit had turned red ripened 2 to 3 weeks earlier than untreated fruit and developed size and quality equal to those of later maturing controls. Concentrated as well as earlier maturity in this crop should permit the harvesting of a major portion of the crop in one operation. Similarly, 25 to 1000 ppm ethephon during later period II of peaches caused an increase in fruit diameter and carotenoid content at harvest (9, 36). Dipping clusters of Vitis vinifera grapes intact on vines in 400 and 1200 ppm ethephon hastened berry ripening when treatment was made during a short interval immediately before the start of period III. Treatment at other times delayed grape ripening (25).

CHAPTER III

MATERIALS AND METHODS

Twenty mature vines of bunch grape Oklahoma Selection 181 (Wine King x Keuka) growing at the Perkins Research Station at Oklahoma State University were used. The soil is a medium textured loam with a moderately permeable subsoil. It is a fairly good soil for grapes. Ten vines in row 133, and ten vines in row 138 were selected. The vines were pruned in February to four cane Kniffin system, each containing 10-18 buds.

Four vines were randomly selected for each of the applications which were made May 8 (one week before bloom), May 22 (one week after bloom), June 5 (two weeks after bloom), June 19 (four weeks after bloom) and July 29 (one week before ripening). Each cane on each vine receiving treatment was labelled giving the date, method and concentration of ethephon applied. The canes on the vines were identified by location as North Top, North Bottom, South Top, South Bottom (Figure 1).

The concentrations of ethephon used in this test were 0, 75, 125 and 200 ppm for chemical thinning and 0, 300, 400 and 500 for berry loosening. The ethephon was made available by the Amchem Company, Ambler, Pa., and identified by label as Amchem 68-240. The material was water soluble and contained 25% active ingredient. The solution of 75 ppm ethephon for 1,000 ml was obtained by using 0.3 ml ethephon

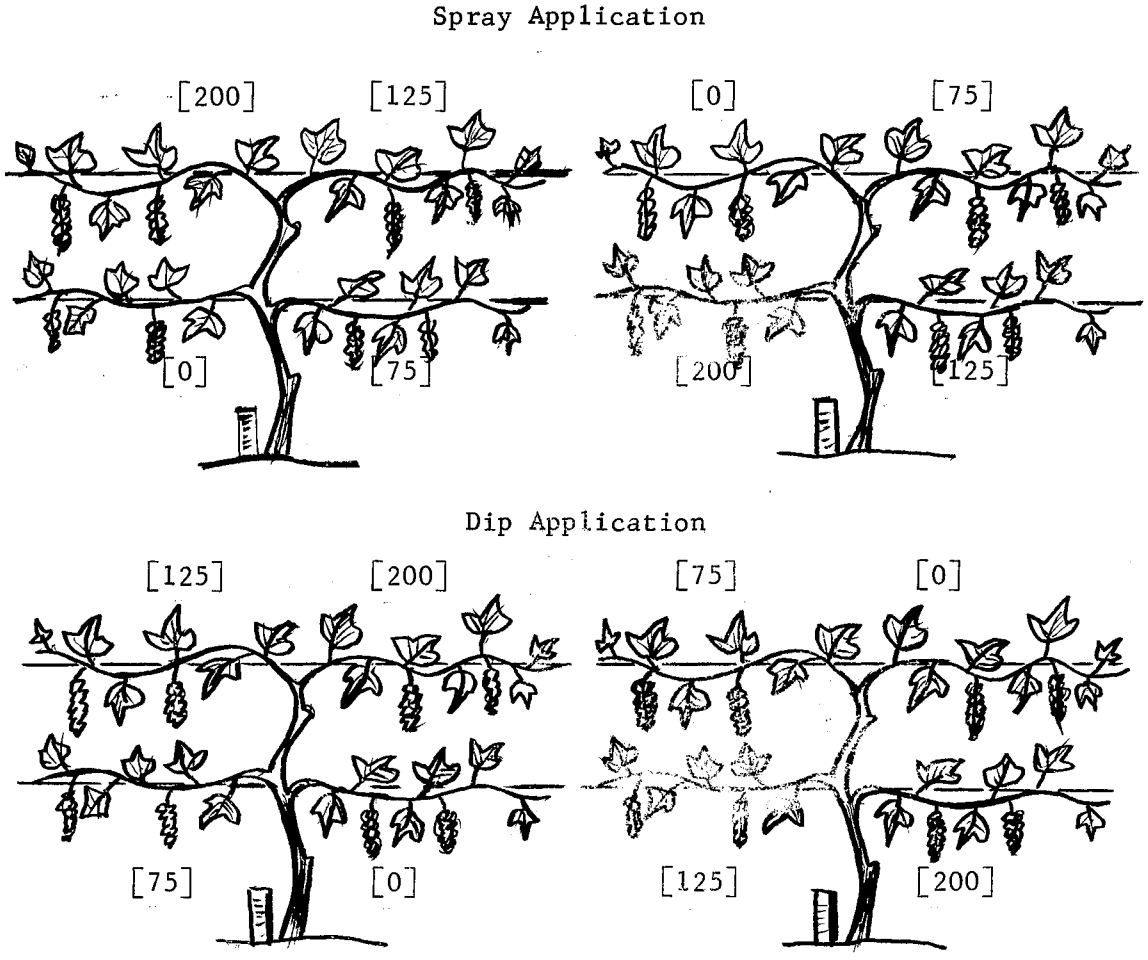


Figure 1. Diagram of the rotation and concentrations of ethephon spray and dip applications to grape plants.

+ 999.7 ml distilled water. While the solution of 125 and 200 ppm ethephon were made by using 0.5 and 0.8 ml ethephon added to the distilled water 999.5 and 999.2 ml respectively. Three drops of Tween-20 (Polyoxyethylene-20-sorbitan monolaurate) was added in each 1,000 ml to reduce surface tension to provide for more thorough contact of the solution upon treatment.

The concentrations applied on July 29 were 300, 400, and 500 ppm ethephon. The amount of ethephon required to prepare solution of 300, 400 and 500 ppm was 1.2, 1.6 and 2.0 ml respectively. Three drops of Tween-20 was also added per 1,000 ml of solution.

The method of application was either by spraying or dipping. The spray application was made by means of small hand plastic sprayer and applied to the entire cane by directing the nozzle to all sides of cluster and foliage. The sprayer was rinsed with distilled water after each time the solution was changed. For the cluster-dipping application a 1,000 ml plastic beaker was used to immerse the entire cluster in the solution. When the cluster developed sufficient size which did not permit total immersion in the solution additional solution was poured over the exposed section of the cluster until all of the cluster became wet. The leaves were not dipped.

The first application was a prebloom treatment applied on May 8, 1971. The date of full bloom of Oklahoma Selection 181 was May 16.

Canes on two vines were treated by spray application and two vines were treated by cluster-dipping at concentration of 0, 75, 125, and 200 ppm of ethephon. Each vine received the four concentrations, one each on each of the four canes. After treatment, the information on date, method of application and concentration of ethephon used was placed

on each label and secured to the treated cane. This tag indicated the same information as on the stake at the base of the vine.

Each time during the treatment of canes on the top wire, the canes on the bottom wire were covered with newspaper to avoid possible spray drip on the canes of the lower wires.

Four other treatments were made. The post-bloom treatments were made May 22 at which time the clusters were at the capfall stage of development. The fruit-set treatments were made June 5 at which time the diameter of the individual berries was 5 to 6 mm. The post fruit-set treatments were made June 19 and the pre-harvest treatments were made July 29. All applications were made in the morning when the temperature was in the range of 68-72^{o}F.

Observations of treated materials were made throughout the season. No herbicide was applied around the treated plants. Weeds were controlled by hand hoeing and the soil was cultivated between the rows. When the fruit approached the stage of ripening soluble solids were determined at intervals until it increased to about 15% then the date of harvest was set three days later.

The fruits were harvested on August 2, 1971. Fruit samples were collected at harvest by choosing five representative clusters from each cane. Sample clusters of each treatment were placed in paper bags together with the treatment label. There were 64 samples when all the treated vines were harvested. During harvesting the bags with fruit were placed under the shade of the vine to avoid exposure to direct sunlight. All of the samples were then brought to the laboratory for analysis.

The weight of cluster was determined in grams. Each cluster was

weighed individually. The average weight of cluster was obtained from the weight of five clusters in each replication.

Number of berries retained on the clusters was obtained by counting the berries on five clusters and an average obtained from the five.

Ten berries per cluster from five clusters were measured for diameter in each replication. A total of 50 berries were measured per replication. The diameter of berries was determined in centimeter by using a Vernier caliper and was measured at the middle of the berry.

The 50 berries per replication were weighed and recorded in grams.

After weighing, the volume of the same 50 berries was determined. The total volume or mass was determined by placing the berries in a cylinder which contained a given amount of water. The increase of water volume in the cylinder by displacement was recorded as the volume of the 50 berries.

The average number of seeds per berry was determined by extracting the seed from 20 berries per replication.

Soluble solids were determined by means of a hand sugar refractometer with a sucrose scale. The berries were removed from five clusters in each replication. Ten berries were selected at random from the sample and soluble solids determinations were made from expressed juice of each individual berry. The average percent soluble solids of each treatment was obtained from ten readings per replication.

To determine the degree of loosening of berries the canes were shaken to collect the berries on a sheet. The jarring was accomplished by using the hand to strike the cane 50 uniform blows to each treated cane. The first shakings were made 5 days after application August 2. Additional shakings were made on August 4 and August 6.

CHAPTER IV

EXPERIMENTAL RESULTS

The investigations herein reported were conducted to determine the effect of ethephon (2-chloroethyl) phosphonic acid at various concentrations applied at five different periods of fruit development on berry thinning, berry diameter, cluster weight, berry weight, berry volume, soluble solids and degree of loosening of berries at harvest of bunch grape Oklahoma Selection 181.

The first application was made May 8, 1971. It was a pre-bloom treatment at which time flower clusters were tight and the caps remained on the flower. The spray and dip treatments were easily applied. The flower clusters were not injured by either method of application. Seven days after application, ethephon damage was not visible on either the clusters or foliage.

The second application made May 22 was principally a postbloom treatment since most of the flowers had passed the stage of full bloom. Some flowers were still in the cap stage of development. No injury was observed on the foliage in the spray application but there was heavy drop of the small berries in the spray and dip application on the treatment receiving 200 ppm ethephon. Quite a few berries dropped from the 125 ppm and a few from the 75 ppm treatment.

The fruit-set treatments were made June 5, when the berries were set, but small. Number of berries per cluster was determined three

days following treatment. It was found that the number of berries per cluster decreased with increase of concentration as compared to the zero level treatment.

The post-fruit-set treatment was made June 19. Since the berries were rather big the larger beaker was used in the dip treatment to avoid bruising the fruit. Visual observations were made in each treatment. There was no evidence of injury to the foliage of the vines.

The last application was made July 22 which was about one week before harvest and the ethephon concentrations of the solutions were increased to 300, 400, and 500 ppm ethephon. At the highest concentration there was no apparent damage to the leaves.

The Effect of Ethephon on Fruit Thinning of Grapes Applied at Four Different Stages of Fruit Development

There was no fruit thinning response from any of the pre-bloom treatments applied May 8. The number of berries retained on clusters were similar to the controls except one vine in a higher concentration of dip application had a lower count. This vine may have been of low vigor. The protection of the caps on the flower buds was probably the reason for ethephon not being effective.

With the post-bloom treatment applied on May 22, the number of berries per cluster decreased from the concentration of 75, 125, and 200 ppm ethephon as compared to the control. This thinning response occurred on both spray and dip applications. At 200 ppm spray application there was an average of 28.2 less berries per cluster than at 0 ppm. In the dip application there was an average of 29.2 less berries per cluster than at 0 ppm. (Table II). The concentration of 125

ppm ethephon did not thin as severely as did 200 ppm but it was considered the most desirable thinning. After thinning, 29.8 berries were retained per cluster. The clusters were not compact.

The fruit-set treatment was made on June 5. The thinning response from ethephon application was similar to those applied on May 22 but the degree of thinning was less. The number of berries per cluster decreased slightly from the 75, 125 and 200 ppm treatments when compared to the control. The number of berries retained per cluster was 59.3, 44.5, 44.6, 43.9 respectively to the concentration of the spray application, while the number of berries retained per cluster for the dip applications was 46.1, 42.1, 44.4, 38.7 respectively (Table I).

The post-fruit-set treatment of ethephon on June 19 did not influence the thinning of berries over the control. There was no difference between 0, 75, 125 and 200 ppm concentration of either spray or dip applications. This might be the result on the increase in maturity of the fruit. The abscission of the berries affected by ethephon up to 200 ppm was not sufficient to cause the berries to drop.

The Effect of Ethephon Treatment on the Diameter of Grape Berries at Four Stages of Fruit Development

The effect of ethephon treatment on berry diameter was determined by the average from 50 berries from each treated cane of the 0, 75, 125 and 200 ppm treatments and is given in Table II.

The average diameter of the berry increased the greatest as the treatment concentration increased for the postbloom and fruit-set applications. The prebloom and post-fruit-set applications was less effective.

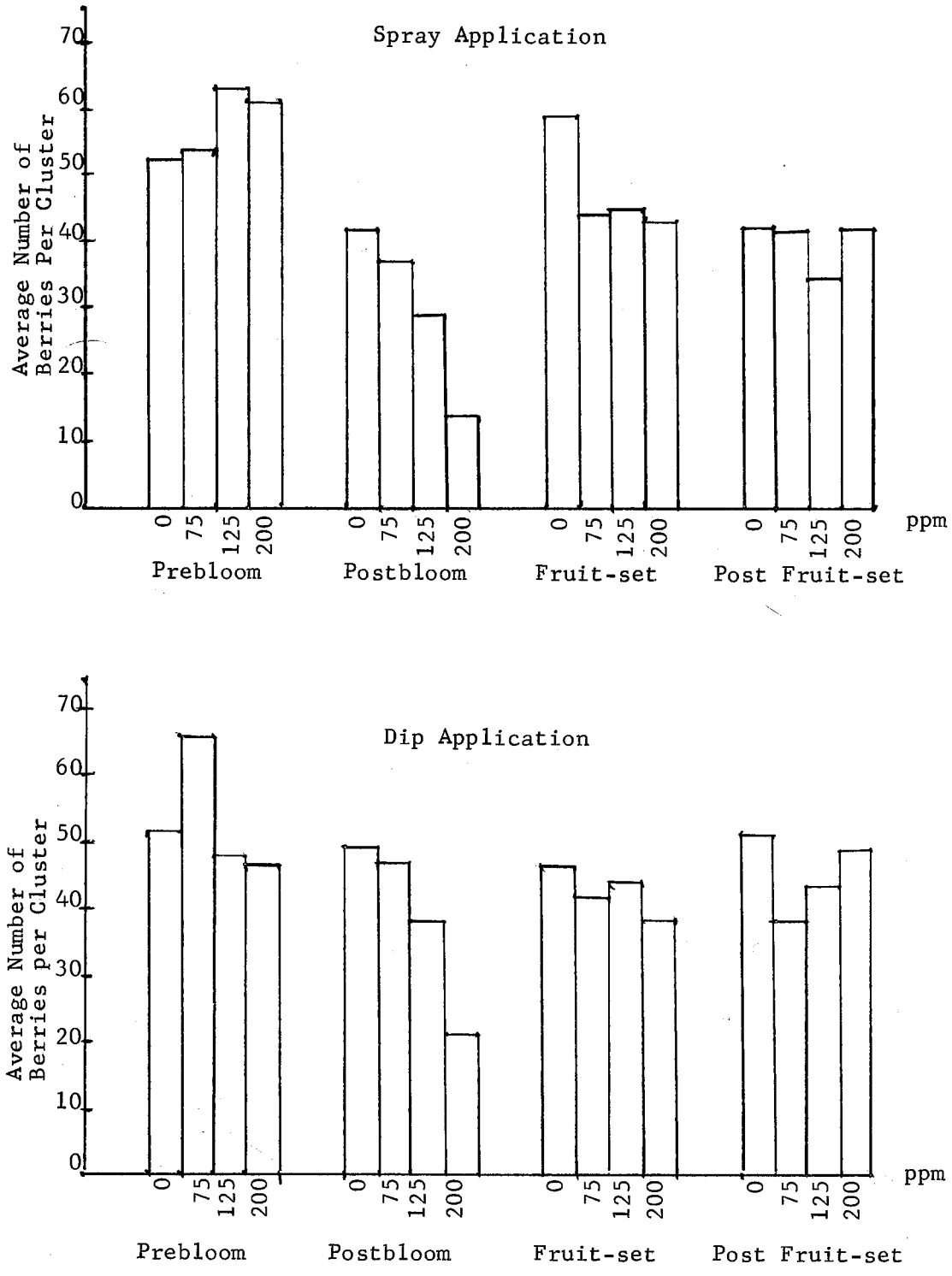


Figure 2. Number of berries per cluster in bunch grape Oklahoma Selection 181 treated with ethephon at four development stages.

TABLE I

EFFECT OF ETHEPHON APPLIED AT FOUR CONCENTRATIONS AND AT FOUR STAGES OF FRUIT DEVELOPMENT ON NUMBER OF BERRIES RETAINED ON CLUSTERS OF BUNCH GRAPE OKLAHOMA SELECTION 181

ppm of Ethephon	Average number of berries retained per cluster					
	Spray Application			Dip Application		
	Vine 1	Vine 2	Average	Vine 3	Vine 4	Average
			Applied May 8			
0	54.0	50.0	52.0	57.4	44.8	51.1
75	49.6	58.0	53.8	64.6	66.8	65.7
125	68.0	59.4	63.7	58.4	37.0	47.7
200	63.0	59.2	61.1	55.8	36.6	46.2
			Applied May 22			
0	41.4	43.0	42.2	47.0	52.6	49.8
75	36.4	35.8	36.1	40.4	55.2	47.8
125	31.4	28.2	29.8	39.0	37.0	38.0
200	7.6	20.4	14.0	30.6	10.6	20.6
			Applied June 5			
0	66.2	52.4	59.3	46.0	46.2	46.1
75	44.2	44.8	44.5	38.6	45.6	42.1
125	39.0	50.2	44.6	39.6	49.2	44.4
200	51.6	36.2	43.9	35.0	42.4	38.7
			Applied June 19			
0	42.0	43.4	42.7	57.6	45.4	51.5
75	38.0	46.2	42.1	39.4	36.2	37.8
125	20.8	48.6	34.7	39.8	49.6	44.7
200	38.2	46.6	42.4	50.4	48.0	49.2

TABLE II

EFFECT OF ETHEPHON APPLIED AT FOUR CONCENTRATIONS AND AT FOUR STAGES OF FRUIT DEVELOPMENT ON AVERAGE BERRY DIAMETER OF BUNCH GRAPE OKLAHOMA SELECTION 181

ppm of Ethephon	The average diameter of berry in centimeter*					
	Spray Application			Dip Application		
	Vine 1	Vine 2	Average	Vine 3	Vine 4	Average
			Applied May 8			
0	1.69	1.70	1.695	1.66	1.77	1.715
75	1.70	1.73	1.715	1.75	1.83	1.790
125	1.72	1.71	1.715	1.73	1.71	1.720
200	1.71	1.71	1.710	1.74	1.60	1.670
			Applied May 22			
0	1.64	1.70	1.670	1.66	1.69	1.675
75	1.82	1.78	1.800	1.75	1.73	1.740
125	1.83	1.80	1.815	1.75	1.82	1.790
200	1.84	1.84	1.840	1.78	1.84	1.810
			Applied June 5			
0	1.70	1.67	1.685	1.64	1.63	1.635
75	1.70	1.72	1.710	1.64	1.65	1.645
125	1.70	1.73	1.715	1.65	1.66	1.655
200	1.71	1.73	1.720	1.66	1.66	1.660
			Applied June 19			
0	1.63	1.62	1.625	1.65	1.67	1.660
75	1.63	1.62	1.625	1.68	1.73	1.705
125	1.71	1.68	1.695	1.65	1.74	1.695
200	1.70	1.68	1.690	1.66	1.72	1.690

*Average of 50 berries

Best results were obtained from treatments made May 22. The average diameter of the berries from the spray application of 0, 75, 125 and 200 ppm ethephon treatments applied May 22 was 1.670, 1.800, 1.815, and 1.840 mm while those from the dip application was 1.675, 1.740, 1.790 and 1.810 mm respectively.

Berries with the largest average diameter were from both dip and spray treatments applied May 22. Berry diameter from the spray treatment was 1.84 cm. While those from the dip treatment was 1.81 cm.

The greatest response to increased berry diameter by ethephon treatments was from those applied May 22. Possibly the berries at postbloom stage were too sensitive to the effect of chemical treatment.

The diameter of the berries from the treatment applied on June 5 was increased some but not as great as those treated May 22. The diameter of the berries from spray application of 0, 75, 125 and 200 ppm was 1.685, 1.710, 1.715 and 1.720 cm. While from the dip application was 1.635, 1.645, 1.655 and 1.660 cm. respectively.

The Effect of Ethephon on Weight of Cluster and of Berries Applied at Four Stages of Fruit Development

The average cluster weight was decreased less from the treatments of 75, 125, and 200 ppm than the control, in the application made May 22. (Table III). Treatments made May 8, June 5, and June 19 did not have an effect on average cluster weight.

The weight of 50 berries increased from treatments of 75, 125 and 200 ppm over the control for application made May 22, June 5 and June 19. Treatments applied May 8 had no effect.

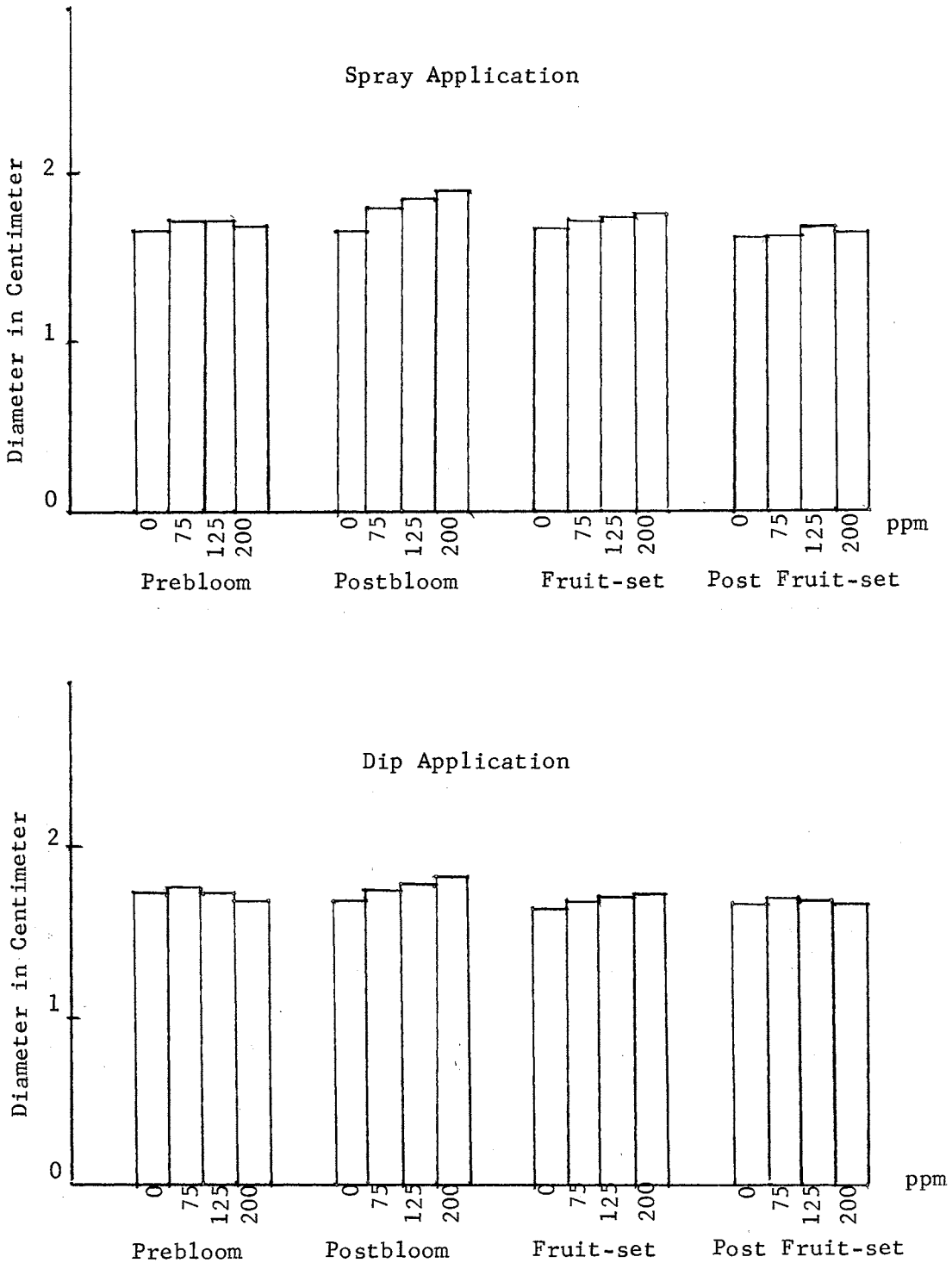


Figure 3. Average berry diameter of bunch grape Oklahoma Selection 181 treated with ethephon at four development stages.

TABLE III

EFFECT OF ETHEPHON APPLIED AT FOUR CONCENTRATIONS AND AT FOUR STAGES OF FRUIT DEVELOPMENT ON THE WEIGHT PER CLUSTER OF BUNCH GRAPE OKLAHOMA SELECTION 181

ppm of Ethephon	Average weight per cluster in grams					
	Spray Application			Dip Application		
	Vine 1	Vine 2	Average	Vine 3	Vine 4	Average
			Applied May 8			
0	153.3	153.1	153.2	146.7	192.5	169.9
75	139.3	189.8	164.6	187.0	233.0	210.0
125	205.6	184.8	195.2	170.0	90.2	128.2
200	184.3	179.0	181.7	154.9	85.1	120.0
			Applied May 22			
0	116.4	139.5	128.0	138.9	164.4	151.7
75	123.8	134.5	129.2	139.5	176.4	157.9
125	110.7	103.5	107.1	134.1	114.6	124.4
200	27.3	75.0	51.2	98.3	46.0	72.2
			Applied June 5			
0	200.8	158.3	179.6	134.2	138.7	136.4
75	133.9	139.8	136.9	126.8	145.9	137.8
125	120.9	158.8	139.8	130.1	158.3	144.2
200	161.9	121.8	141.9	121.7	139.8	130.8
			Applied June 19			
0	119.4	108.5	99.7	161.1	137.0	149.1
75	106.7	128.2	117.5	118.1	121.9	120.0
125	67.4	136.9	102.2	108.2	164.3	136.3
200	110.3	125.5	117.9	160.4	126.8	161.6

The weight of 50 berries from the 200 ppm treatments applied May 22 was the greatest. The weight of 50 berries from the treatment of 0, 75, 125 and 200 ppm was 156.95, 173.10, 195.60 and 217.3 grams respectively for spray applications and 154.25, 169.85, 177.15 and 179.75 grams respectively from dip application (Table IV, Figure 4).

The weight of 50 berries coincides with the diameter of the berries. As the diameter of the berries increased the weight of berries increased. These were directly related to increased concentrations of treatments.

The Effect of Ethephon on Volume of 50 Berries of Grape Applied at Four Different Stages of Fruit Development

The volume of 50 berries was increased from the treatments of 75, 125, and 200 ppm over the control in 3 applications but in the prebloom application made May 8 the volume of 50 berries was similar to the control (Table V, Figure 5). The greatest volume was obtained from 200 ppm applied May 22.

The result on volume of 50 berries was the same as the results obtained on diameter, and the weight of 50 berries in every treatment.

Treatments applied May 8 did not influence the volume of 50 berries.

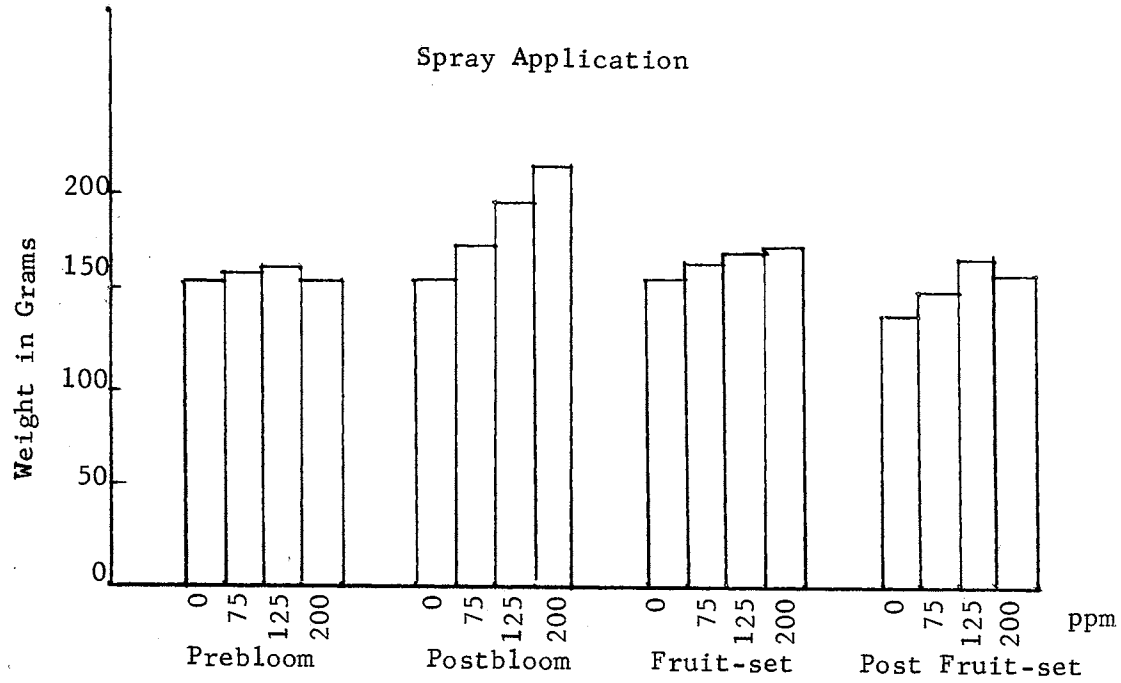
Percent Soluble Solids Response of Ethephon Treatments Applied at Four Different Stages of Fruit Development

The percent soluble solids response of ethephon treatment was decreased from the treatments of the 75, 125 and 200 ppm under the control in all applications. The soluble solids ranged from 14.4 to 19.0%.

TABLE IV

EFFECT OF ETHEPHON APPLIED AT FOUR CONCENTRATIONS AND AT FOUR STAGES OF FRUIT DEVELOPMENT ON THE WEIGHT OF 50 BERRIES OF BUNCH GRAPE OKLAHOMA SELECTION 181

ppm of Ethephon	The weight of 50 berries in grams					
	Spray Application			Dip Application		
	Vine 1	Vine 2	Average	Vine 3	Vine 4	Average
			Applied May 8			
0	150.7	155.7	153.20	149.0	175.6	162.30
75	151.5	167.2	159.35	170.3	188.2	179.25
125	162.5	157.8	160.15	126.5	148.8	155.64
200	155.2	162.3	158.75	165.3	128.2	146.75
			Applied May 22			
0	148.9	165.0	156.95	150.3	158.2	154.25
75	166.8	179.4	173.10	169.7	170.0	169.85
125	190.7	200.5	195.60	171.5	182.8	177.15
200	193.3	241.3	217.30	174.6	184.7	179.75
			Applied June 5			
0	163.9	153.4	158.65	145.1	146.2	145.65
75	160.5	163.5	162.00	146.8	161.7	154.25
125	164.7	169.7	167.20	149.7	169.2	159.45
200	166.4	170.0	168.20	154.5	171.2	162.85
			Applied June 19			
0	143.2	135.3	139.25	151.2	154.6	152.90
75	146.9	146.0	146.45	159.0	174.6	166.80
125	169.5	155.8	162.65	153.5	176.0	164.75
200	154.6	161.5	158.05	155.7	170.2	162.95



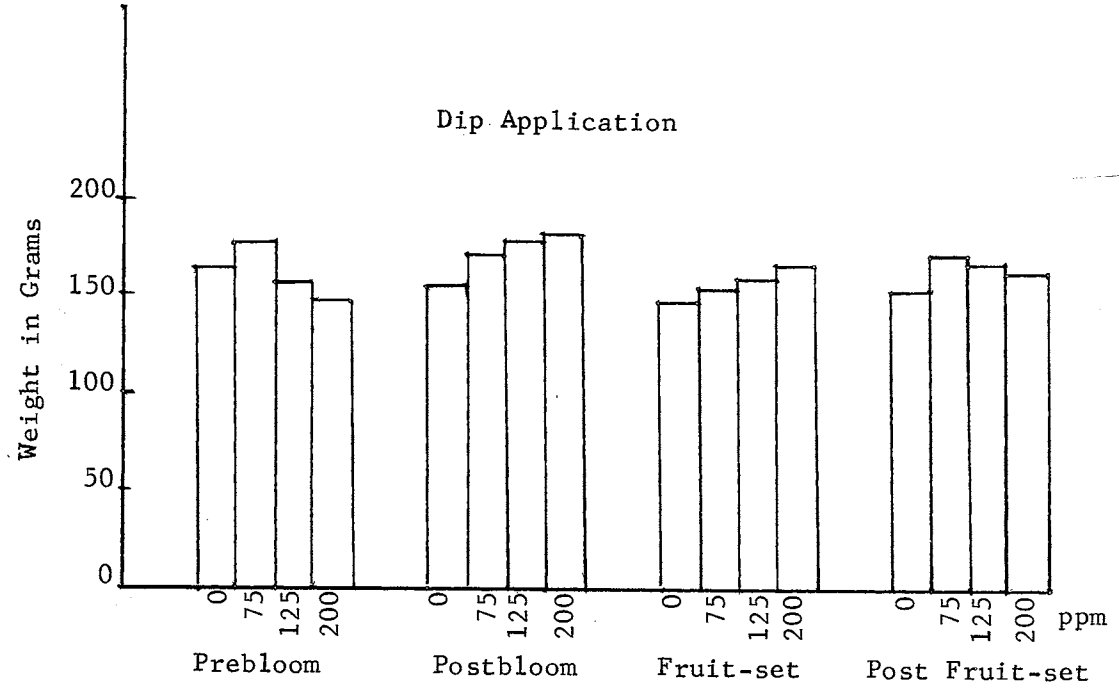


Figure 4. Weight of 50 berries in bunch grape Oklahoma Selection 181 treated with ethephon at four development stages.

TABLE V

EFFECT OF ETHEPHON APPLIED AT FOUR CONCENTRATIONS AND AT FOUR STAGES OF FRUIT DEVELOPMENT ON THE VOLUME OF 50 BERRIES OF BUNCH GRAPE OKLAHOMA SELECTION 181

ppm of Ethephon	The volume of 50 berries in milliliters					
	Spray Application			Dip Application		
	Vine 1	Vine 2	Average	Vine 3	Vine 4	Average
			Applied May 8			
0	138	150	144.0	140	165	152.5
75	144	158	151.0	161	177	169.0
125	152	151	151.5	152	138	145.0
			Applied May 22			
0	138	154	146.0	140	148	145.0
75	173	166	169.5	163	159	165.25
125	178	185	181.5	165	173	175.25
200	180	189	184.5	167	175	177.75
			Applied June 5			
0	154	145	149.5	137	139	138.0
75	152	154	153.0	138	153	145.5
125	156	162	159.0	152	158	155.0
200	157	166	161.5	155	160	157.5
			Applied June 19			
0	133	128	130.5	146	147	146.5
75	140	141	140.5	156	165	160.5
125	160	148	154.0	147	167	157.0
200	146	152	149.0	149	161	155.0

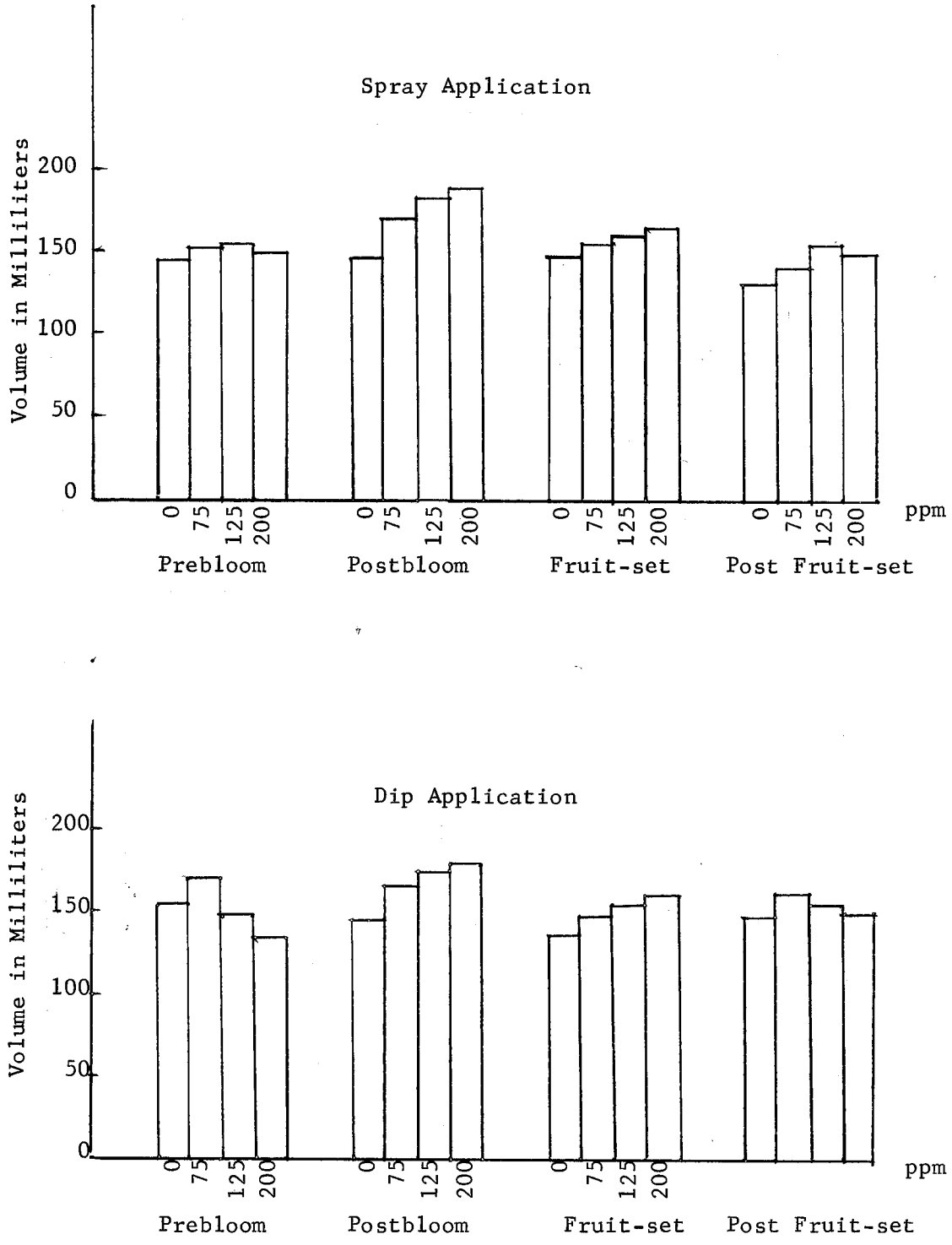


Figure 5. The volume of 50 berries for bunch grape Oklahoma selection 181 treated with ethephon at four development stages.

The difference in percent soluble solids between control and the 200 ppm was 1.30, 1.05, 1.50 and 1.55% from treatments applied May 8, May 22, June 5 and June 19 respectively (Table VI, Figure 6). The application of ethephon resulted in a lower soluble solids content. The lowest percent was obtained from the highest concentration.

The Effect of Ethephon Treatments on the Average Number of Seeds Per Berry

Treatments with ethephon did not alter the average number of seeds per berry. A range of 4 to 5 seeds per berry was present in all treatments (Table VIII).

The Effect of Ethephon Treatment on Berry Loosening

The effect of ethephon on the loosening of grape berries was determined by shaking the treated canes five days after application. The shaking was made at three different times (August 2, 4, and 6). The berries that dropped were caught on film plastic and after harvest those left on the canes were counted then the total number of berries on each cane was determined.

The percent of berries that dropped with increasing ethephon treatments increased. The treatments and percent berries dropped were: 0, 300, 400 and 500 ppm 31.63, 46.50, 50.13, 76.79% respectively on the spray application (Table VIII). With the dip applications the percent of berries that dropped increased with increased ethephon treatments of 0, 300, 400 and 500 ppm. The percent was 32.76, 49.36, 66.60 and 88.10% respectively. The percent of berries that dropped in the dip applications was greater than from the spray application in

TABLE VI

EFFECT OF ETHEPHON APPLIED AT FOUR CONCENTRATIONS AND AT FOUR STAGES OF FRUIT DEVELOPMENT ON THE PERCENT SOLUBLE SOLIDS OF BUNCH GRAPE OKLAHOMA SELECTION 181

ppm of Ethephon	Percent Soluble Solids*					
	Spray Application			Dip Application		
	Vine 1	Vine 2	Average	Vine 3	Vine 4	Average
			Applied May 8			
0	19.0	17.9	18.45	17.8	16.5	17.15
75	18.1	17.0	17.55	16.3	16.3	16.30
125	16.4	17.3	16.85	16.1	13.7	14.90
200	16.6	17.7	17.15	14.7	14.8	14.75
			Applied May 22			
0	18.6	17.8	18.20	16.5	17.5	17.00
75	17.1	17.6	17.35	16.0	17.2	16.60
125	17.1	17.7	17.40	15.8	17.3	16.55
200	16.9	17.4	17.15	14.8	17.3	16.05
			Applied June 5			
0	17.1	16.3	16.70	18.3	17.4	17.85
75	15.4	15.4	15.40	16.9	16.6	16.75
125	15.5	15.2	15.35	16.2	16.5	16.35
200	15.4	15.0	15.20	14.1	16.1	15.10
			Applied June 19			
0	16.8	15.9	16.35	14.8	15.5	15.15
75	15.9	15.8	15.85	14.8	14.9	14.85
125	15.3	14.4	14.85	14.8	14.7	14.75
200	15.4	14.2	14.80	14.7	14.4	14.55

*Average of 10 readings per replication at harvest August 2, 1971.

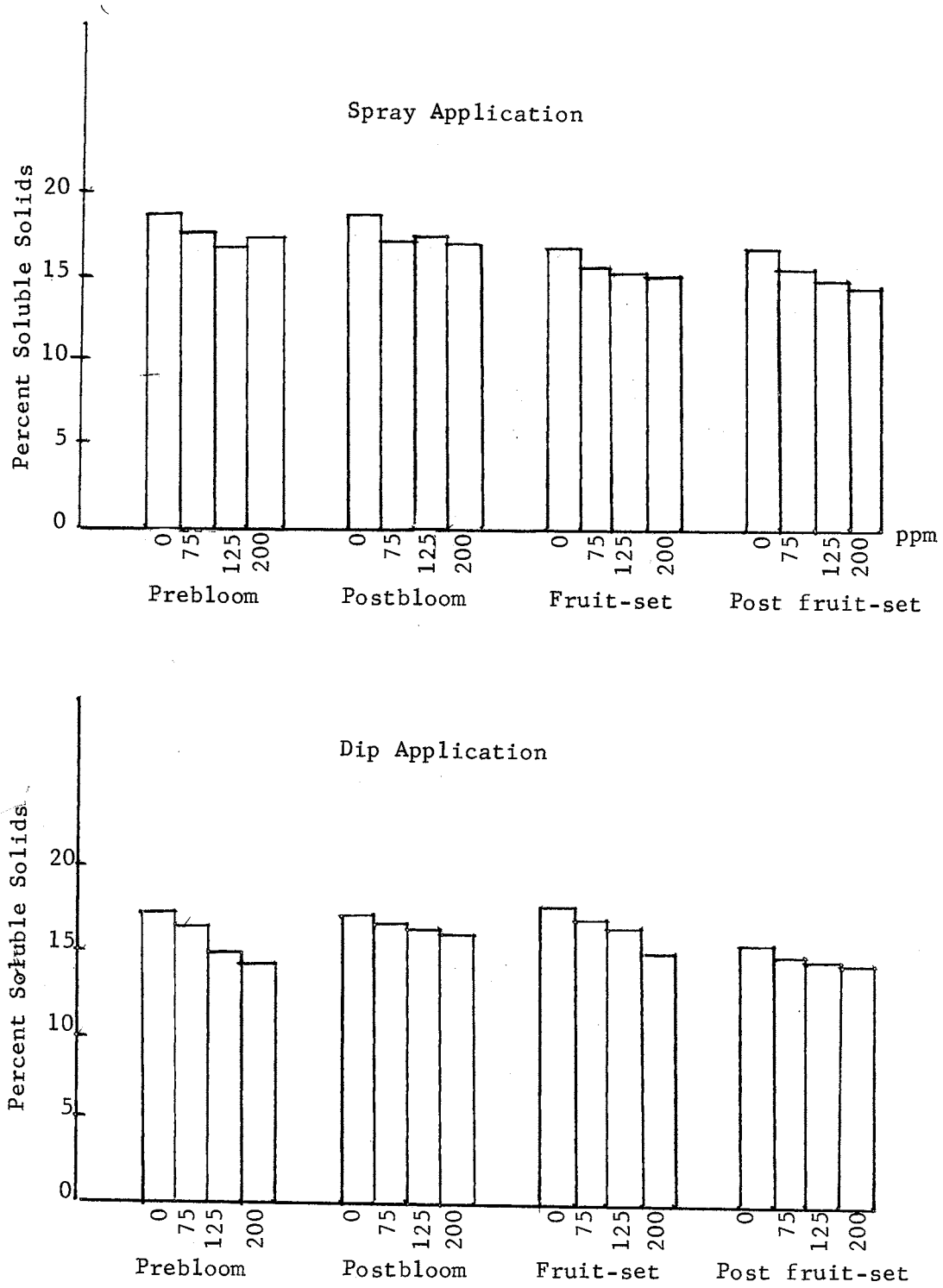


Figure 6. Percent soluble solids in bunch grape Oklahoma Selection 181 treated with ethephon at four development stages.

TABLE VII

EFFECT OF ETHEPHON APPLIED AT FOUR CONCENTRATIONS AND AT FOUR STAGES OF FRUIT DEVELOPMENT ON THE NUMBER OF SEEDS PER BERRY OF BUNCH GRAPE OKLAHOMA SELECTION 181

ppm of Ethephon	Number of seeds per berry*					
	Spray Application			Dip Application		
	Vine 1	Vine 2	Average	Vine 3	Vine 4	Average
			Applied May 8			
0	4.3	4.2	4.25	4.1	4.3	4.20
75	4.2	4.7	4.45	4.9	4.2	4.55
125	4.2	4.3	4.25	4.6	4.1	4.35
200	4.1	4.2	4.15	4.2	4.2	4.20
			Applied May 22			
0	4.0	4.5	4.25	3.9	4.0	3.95
75	4.6	4.4	4.50	4.8	4.8	4.80
125	4.7	4.6	4.65	4.5	4.7	4.60
200	4.4	4.5	4.45	4.7	4.5	4.60
			Applied June 15			
0	4.3	4.1	4.20	4.1	4.0	4.05
75	4.3	4.5	4.40	4.2	4.3	4.25
125	4.2	4.3	4.25	4.4	4.0	4.20
200	4.6	4.6	4.60	4.6	4.5	4.55
			Applied June 19			
0	4.1	4.6	4.35	4.5	4.1	4.30
75	4.4	4.6	4.50	4.5	4.7	4.60
125	4.0	4.8	4.40	4.6	4.1	4.35
200	4.2	4.6	4.40	4.5	4.3	4.40

*Average of 20 berries

TABLE VIII

EFFECT OF ETHEPHON APPLIED AT FOUR CONCENTRATIONS AT ONE WEEK BEFORE HARVEST ON BERRY LOOSENING OF BUNCH GRAPE OKLAHOMA SELECTION 181

ppm of Ethephon	Percent berries dropped by shaking					
	Spray Application			Dip Application		
	Vine 1	Vine 2	Average	Vine 3	Vine 4	Average
0	20.34	42.91	31.63	24.01	41.50	32.76
300	47.26	45.74	46.50	33.88	64.84	49.36
400	50.14	50.12	50.13	59.19	74.01	66.60
500	86.73	60.85	76.79	92.53	83.67	88.10

the 500 ppm treatment by 11.31% and 55.34% greater than the control. This showed that loosening the berries increased with an increase in concentration of ethephon and the dip application were more effective than the spray application.

CHAPTER V

DISCUSSION AND CONCLUSION

Ethephon an abscission-promoting substance was most effective in thinning grape berries when applied during the postbloom stage. Treatments applied later usually did not cause fruit abscission. The result can be explained by the fact that abscission in Vitis vinifera grapes can and does normally occur during the early growth stage, immediate following pollination, whereas relatively little abscission occurs at later and more mature stages of development of the berry (45).

The effect of ethephon on fruit thinning is shown in Figure 2. The average number of berries per cluster decreased as a result of ethephon applications from postbloom through fruit-set stages. The amount of fruit thinning was determined from the amount of fruit retained and was found to be related to the concentration of ethephon. Heavy thinning was found on vines treated with 200 ppm of ethephon applied May 22 which was considered over thinned. Optimum fruit thinning occurred on plants treated with 125 ppm ethephon applied at postbloom stage.

The diameter of berries was increased as the number of berries per cluster decreased. The largest size was obtained from vines treated with 200 ppm of ethephon applied May 22.

The weight of the berry was closely associated with the volume of berries. As the weight increased the volume increased and the

increase was in order from 0, 75, 125 and 200 ppm ethephon applied during postbloom, fruit-set and post-fruit-set stages.

The weight of the berry could be increased in thinning the number of berries per cluster but the total weight of the cluster was less than the control. The remaining berries did not increase sufficiently in size to offset the number of berries that had abscissed.

The soluble solids of grape berries decreased as a result of treatments of 75, 125 and 200 ppm when compared to the untreated controls. This agrees with work done in California (45).

Ethephon causes the berries to loosen and as such could become an aid to harvesting the crop. The percent of berry loosening increased as the concentration of ethephon increased. The 500 ppm ethephon treatment caused the berries to drop 76.79% of the berries from the spray treatments and 88.10% from the dip treatments. The concentration of 500 ppm of ethephon gave good results but was not adequate to cause 100% drop of fruit.

In order to obtain 100% drop it appears that further study of higher concentrations should be made ranging from 600-1200 ppm. Ethephon is more active in high temperature. The next objective would be to determine the concentration that causes 100% fruit drop and yet not defoliate the plant when machine harvesting is employed.

CHAPTER VI

SUMMARY

The effects of ethephon treatment on bunch grape at the concentrations of 0, 75, 125 and 200 ppm were applied at four periods and one at 0, 300, 400 and 500 ppm during the 1971 growing season were studied. Bunch grape Oklahoma Selection 181 growing at the Perkins Research Station near Perkins, Oklahoma, was used.

The objectives of this study were to determine (1) the effect of ethephon on berry thinning, (2) the effect of ethephon on berry diameter, (3) the effect of ethephon on berry weight, (4) the effect of ethephon on berry volume, (5) the effect of ethephon on soluble solids of berries, and (6) the effect of ethephon on berry loosening.

Results of this study indicate:

(1) the greatest amount of fruit thinning was obtained from the 125 ppm ethephon treatments applied May 22.

(2) the diameter of berry increased as the concentration of ethephon treatment was increased.

(3) the weight and volume of berries were precisely increased as the amount of berry thinning increased.

(4) soluble solids content of the berries was lower with ethephon treatments.

(5) the number of seeds per berry was not affected by ethephon treatments.

(6) the ethephon treatments of 500 ppm applied one week before harvest caused 88% of berries to drop when the vine was shaken.

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