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Effect of Phosphonic Acid (2-Chloroethyl) on Physical and Chemical Characteristics of Trakya Ilkeren and Red Globe Table Grapes (*Vitis vinifera* L.)

HARUN ÇOBAN
Alasehir Vocational Training College, Celal Bayar University
45600 Alasehir, Manisa, Turkey
E-mail: harun.coban@bayar.edu.tr

In this study, the effect of phosphonic acid (2-chloroethyl) on the physical and chemical characteristics of Red globe and Trakya ilkeren table grapes were determined. The experiment was completely randomized block desing with 10 treatment combinations replicated in three blocks. Ethephon (active ingredient of Ethrel®, containing 480 mg L^{-1} ethephon) of four dosages and a control (0 control, 150, 300, 450, 600 mg L^{-1}) were applied at a spray volume of 1000 (L ha^{-1}) to bunches using a backpack pressure sprayer with hand to ensure thorough wetting and applications times (T_1-T_4). The application times (T) may be described as follows :T_1-beginning of berry colour; T_2-20 to 25 % berry colour; T_3-40 to 50 % berry colour and T_4-80 to 90 % berry colour. It was found that various ethephon application times and dosages generally had statistically no significant effects on physical characteristics (berry weight, berry length, berry width) and sugar fractions (fructose, β-glucose, α-glucose, sorbitol, galactose) in all grape varieties. However, chemical characteristics were observed a decrease titratable acidity and an increase total soluble solids and the amount of color pigments (total anthocyanins). As results of the study, general recommendations are made of 300 (mg L^{-1}) ethephon for Red globe and Trakya ilkeren table grapes, both applied at 20 to 25 % berry colour (T_2).

Key Words: Ethephon, Grapevine, Table grapes, Dosage, Timing.

INTRODUCTION

Turkey has different ecological and a wide range of species and cultivar richness in grape varieties adapted to these regions. Grape growing (with 535,000 ha growing area, 3,650,000 ton production) is of great significance in Turkey's horticulture[1]. Although vineyards are spread throughout the country, the leading regions are Aegean, Central Anatolia and Mediterranean, accounting for over 80 % of total production[2].

Phosphonic acid (2-chloroethyl) was developed and named ethephon in year 1946. In plants this compound releases ethylene, a natural plant growth regulator (PGR), which is responsible for the physiological action of the product[3]. It has found many applications on various crops in the agricultural field, including promoting flowering, inhibiting vegetative growth, as a thinning agent, inducing disease and freezing resistance, improving latex production and improving ripening and maturity; inducting better fruit colour[4]. Ethephon has been used since the year 1970 to improve colour and hasten maturity of grapes[5-13], in other fruits[4].

In this study, the effect of phosphonic acid (2-chloroethyl) on the physical and chemical characteristics of Red globe and Trakya ilkeren table grapes were determined.

EXPERIMENTAL

This experiment was carried out in 2005-2006 at the grapevines of Trakya ilkeren and Red globe (*Vitis vinifera* L.) in Alasehir location, Manisa, in the Gediz Valley. The climate of the region is semi arid with hot dry summers and cold wet winters. Average yearly temperature is 21 ºC and total amount of annual rainfall is about 569 mm[14]. Trakya ilkeren (Alphonse Lavallée × Perlette) and Red globe were grafted on *Vitis berlandieri* × *Vitis riparia* 5 BB in 1998. The planting distances were 3.0 m between the rows and 2.0 m on the rows and trained onto a T-trellis system. A drip irrigation system was used and the soil structure of these vineyards are homogenously and the loamy alluvial soil and the routine cultural processings such as soil management, fertilizers. Physical and chemical parameters of the soil sampled from the experimental vineyard are shown in Table-1.

In all varieties, crop load was regulated to 4 four bunches per square metre canopy.

Ethephon (active ingredient of Ethrel®, containing 480 mg L^{-1} ethephon) dosages of 150, 300, 450 and 600 (mg L^{-1}) were applied at a spray volume of 1000 (L ha^{-1}) to bunches using a backpack pressure sprayer with hand to ensure thorough wetting. The experiment was completely randomized block desing with 10 treatment combinations replicated in three blocks. The treatment desing was a 5 × 4 factorial with the following factors; four ethephon dosages and a control (0 control, 150, 300, 450, 600 mg L^{-1}) and applications times (T_1-T_4). The application times (T) may be described as follows :T_1-beginning of berry colour; T_2-20 to 25 % berry colour; T_3-40 to 50 % berry colour and T_4-80 to 90 % berry colour.

At harvest, berry weight (g), berry length (mm) were determined in fresh fruit samples randomly taken from each vine[15,16]. Total soluble solids (%) were obtained with a hand-held refractometer (Atago, Japon). Titratable acidity (%) was assessed with 0.1 NaOH (to a pH of 7.0).

TABLE-1
CHEMICAL AND PHYSICAL PROPERTIES OF THE EXPERIMENT SOILS
(0-30 cm, 30-60 cm AT THE SOIL DEPTH)

Depth (cm)	pH	Salt (μS cm^{-1})	$CaCO_3$ (%)	Organic matter (%)	Texture	Total N (%)
0-30	7.75	314	< 0.03	1.08	Sandy-loamy	0.07
30-60	7.92	350	< 0.03	0.83	Sandy-loamy	0.08

	Available (mg kg^{-1})								
Depth (cm)	P	K	Ca	Mg	Na	Fe	Zn	Mn	Cu
0-30	5.7	380	3440	409	50	2.80	4.31	3.50	1.98
30-60	3.9	300	3440	382	70	2.67	2.87	3.01	1.76

To determine the amount of colour pigments, 100 g of whole berries were covered with 0.1 % HCl in methyl alcohol. The mixture was then cooled and filtered and absorbance of the liquid was read at 520 nm (total anthocyanins) using a spectrophotometer[4,5,17] (Hitachi U 2000 UV Model 121-002).

After the fruit samples were lyophilized, sugar fractions were also determined using the gas chromatography methods[17]. Genstat package program was used for the evaluation of the results obtained[18].

RESULTS AND DISCUSSION

Statistical analysis of the obtained data were done and effects of phosphonic acid (2-chloroethyl) of the physical characteristics (berry weight, berry length and berry width) and the chemical characteristics (total soluble solids, titratable acidity, the amount of colour pigments (total anthocyanins) and sugar fractions) of Red globe and Trakya ilkeren table grapes were investigated.

Effect of ethephon dosages on physical and chemical characteristics: As shown in Table-2, ethephon dosages did not significantly affect on physical characteristics such as berry weight, berry length and berry width, but all dosages both Red globe and Trakya ilkeren relatively increased than control.

Total soluble solids (TSS) were affected from different ethephon dosages which are statistically significant and as a result of analysis of variance three different groups were determined (Table-2).

In Red globe, highest amount of TSS was found at 300 (mg L^{-1}) and at 450 (mg L^{-1}) dosage [17.46 % (a group); 17.02 % (ab group)] followed by at 150 mg L^{-1} dosage [16.55 % (b group)]. Similar results were found in the Trakya ilkeren grape variety. However, between from different ethephon dosages and titratable acidity no determined any relation, but all dosages both Red globe and Trakya ilkeren relatively decreased than control (Table-2). This was also confirmed by previous researchers[3-5,7-12].

TABLE-2
EFFECT OF DIFFERENT ETHEPHON DOSAGES ON THE PHYSICAL AND CHEMICAL CHARACTERISTICS OF RED GLOBE AND TRAKYA ILKEREN

Ethephon (mg L^{-1})	Berry weight (g)	Berry length (mm)	Berry width (mm)	Total soluble solids (%)	Titratable acidity (%)	Colour (520 nm)
			Red globe			
Control	11.66	23.10	22.16	16.60 b	4.59	0.40 b
150	11.74	23.17	22.14	16.55 b	4.57	0.48 b
300	12.02	23.58	22.26	17.46 a	4.56	0.62 a
450	11.73	23.12	22.12	17.02 ab	4.57	0.60 a
600	11.52	23.48	22.20	17.00 ab	4.57	0.59 a
LSD*	NS	NS	NS	0.44	NS	0.11
			Trakya ilkeren			
Control	5.01	15.34	12.13	16.46 b	3.98	0.53 b
150	5.14	15.47	12.16	16.58 b	4.09	0.56 b
300	5.22	15.48	12.17	16.74 a	4.03	0.72 a
450	5.13	15.32	12.18	16.65 ab	4.06	0.69 a
600	5.22	15.38	12.17	16.63 ab	4.07	0.67 a
LSD*	NS**	NS	NS	0.32	NS	0.14

*Value width the same letters do not differ significantly from each other at the 5 % significance level ($p < 0.05$); ** NS = Non-significant.

Effect of application timing of ethephon on physical and chemical characteristics: The results are given in Table-3. Application timing of ethephon dosages did not significantly affect on physical characteristics such as berry weight, berry length and berry width.

Total soluble solids (TSS) affected from different application timing of ethephon statistically significant and three different groups were determined. For both Red globe and Trakya ilkeren, the highest amount of total soluble solids were found from 20 to 25 % berry colour (T_2) [(17.24 and 16.76 % (a group)] followed by 40 to 50 % berry colour (T_3) [17.02 % (a group) and 16.64 % (ab group)] as well as from 80 to 90 % berry colour (T_4) [(16.88 and 16.52 % (ab group)] application timing of ethephon dosage.

Lowest value of total soluble solids were determined at the beginning of berry colour (T_1) [(16.65 and 16.42 % (b group)] (Table-3). However, titratable acidity affected from different application timing of Ethephon statistically no significant, but all different application timing of Ethephon both Red globe and Trakya ilkeren relatively decreased than control. This was also confirmed by previous researchers[3,9,12].

For both Red globe and Trakya ilkeren, different ethephon dosages and application timing of ethephon did not significantly affected sugar fractions

TABLE-3
EFFECT OF APPLICATION TIMING OF ETHEPHON DOSAGES ON PHYSICAL AND CHEMICAL CHARACTERISTICS OF RED GLOBE AND TRAKYA ILKEREN

Application times**	Berry weight (g)	Berry length (mm)	Berry width (mm)	Total soluble solids (%)	Titratable acidity (%)	Colour (520 nm)
Red globe						
T_1	11.66	23.10	22.16	16.65 b	4.59	0.40 b
T_2	11.74	23.17	22.14	17.24 a	4.59	0.61 a
T_3	11.75	23.48	22.26	17.02 a	4.56	0.55 a
T_4	11.73	23.12	22.12	16.88 ab	4.53	0.52 a
LSD*	NS	NS	NS	0.44	NS	0.11
Trakya ilkeren						
T_1	5.01	15.34	12.13	16.42 b	3.98	0.55 b
T_2	5.14	15.47	12.16	16.76 a	4.09	0.71 a
T_3	5.22	15.48	12.17	16.64 ab	4.06	0.62 ab
T_4	5.13	15.32	12.18	16.52 ab	4.03	0.63 ab
LSD*	NS***	NS	NS	0.32	NS	0.14

*Values width the same letters do not differ significantly from each other at the 5 % significance level ($p < 0.05$); **T_1-beginning of berry colour; T_2-20 to 25 % berry colour; T_3-40 to 50 % berry colour; T_4-80 to 90 % berry coour; ***NS = Non-significant.

such as fructose, β-glucose, α-glucose, sorbitol and galactose. However in all dosages, increased substantially the amount of fructose and β-glucose than control (Table-4). In addition, in all application times of ethephon, increased only the amount of fructose in all grape varieties (Table-5).

In conclusion, it was found that various ethephon application times and dosages generally had statistically no significant effects on physical characteristics (berry weight, berry length, berry width) and sugar fractions (fructose, β-glucose, α-glucose, sorbitol, galactose) in all grape varieties. However, the main changes were observed a decrease titratable acidity and an increase total soluble solids and the amount of colour pigments (total anthocyanins). These results are in accord with findings of various researchers[4-12].

As results of the study, general recommendations are made of 300 mg L^{-1} ethephon for Red globe and Trakya ilkeren table grapes, both applied at 20 to 25 % berry colour (T_2). These recommendations apply to vines of normal vigour that are subject to normal crop-load, climate and unique genetic vines with well-balanced growth. Therefore adjustments in dosage and timing may be necessary.

TABLE-4
EFFECT OF DIFFERENT ETHEPHON DOSAGES ON SUGAR FRACTIONS OF FRESH FRUIT

Ethephon (mg L^{-1})	Fructose (%)	β-Glucose (%)	α-Glucose (%)	Sorbitol (%)	Galactose (%)
			Red globe		
Control	37.34	20.05	11.12	2.43	0.68
150	37.34	20.36	11.45	2.32	0.73
300	37.75	20.43	11.32	2.39	0.68
450	37.78	20.45	11.53	2.54	0.57
600	37.78	20.45	11.53	2.54	0.57
LSD*	NS	NS	NS	NS	NS
			Trakya ilkeren		
Control	32.14	19.55	10.73	2.53	0.59
150	32.22	19.76	10.73	2.46	0.63
300	32.32	19.73	10.74	2.39	0.68
450	32.36	19.85	10.62	2.54	0.57
600	32.39	19.85	10.62	2.54	0.57
LSD*	NS	NS	NS	NS	NS

*NS = Non-significant

TABLE-5
EFFECT OF APPLICATION TIMING OF ETHEPHON DOSAGES ON SUGAR FRACTIONS OF FRESH FRUIT

Application times**	Fructose (%)	β-Glucose (%)	α-Glucose (%)	Sorbitol (%)	Galactose (%)
			Red globe		
T_1	37.43	20.15	11.22	2.13	0.55
T_2	37.41	20.26	11.25	2.12	0.53
T_3	37.55	20.13	11.31	2.18	0.58
T_4	37.68	20.25	11.23	2.14	0.54
LSD*	NS	NS	NS	NS	NS
			Trakya ilkeren		
T_1	32.22	19.68	10.38	2.50	0.61
T_2	32.24	19.66	10.33	2.46	0.65
T_3	32.32	19.73	10.40	2.36	0.68
T_4	32.35	19.75	10.42	2.50	0.57
LSD*	NS	NS	NS	NS	NS

*NS = Non-significant; **T_1-beginning of berry colour; T_2-20 to 25 % berry colour; T_3-40 to 50 % berry colour; T_4-80 to 90 % berry coour.

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