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THE EFFECT OF DIFFERENT WAYS AND DOSAGES OF BORON APPLICATION ON BLACK DIMRIT (*Vitis vinifera* L.) GRAPE'S YIELD AND QUALITY

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Abstract

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This study has been carried out to determine the effects of Boron on the yield and quality of Black Dimrit grape Hadim-Aladag (Konya) when NPK is applied and not applied as ground fertilizer. The experiment was carried out in $N_oP_oK_o$ not applied and NPK applied 150-50-50 g/vine stocks ($N_1P_1K_1$) by giving Boron as 11% Borax dosages; B_o 0 g, B_1 2,5 g, B_2 5 g, B_3 10 g Boron/vinestock. The Boron application: I. Boron application was on vinestock drop-lines by mixing it (20-30 cm deep) 15 days before blooming, II. Application started 15 days before blooming and repeated at 15 day intervals. One fourth of boron was applied by spraying on the leaves in four times.

Key words: Grape, Boron application, Soil analysis, V*itis vinifera* L., quality, grape

Introduction

The total area of vineyards in Turkey is 4.846.097 ha, grape production is 612.781 tons and the average grape yield for Cartesian is 745.50 kg. The vineyard are in Konya is 13.000 ha, grape yield is 63.266 tons, yield for cartesian is 478.90 kg. The vineyard area in Hadim is 7140 ha, grape yield is 37.498 tons, yield per Cartesian is 525.18 kg (Anonymous, 2007).

Turkey has the largest amount of boron reserves in the world with 66% (Demirtas, 2006).

Hadim-Aladag region is very convenient for vine cultivation both in terms of climate and soil characteristics. In spite these advantageous, the quality and yield is decreasing day by day. As a result of this, the number of farmers engaged with vine cultivation decreases and vineyard areas are getting smaller.

As vineyard is long lasting plant, it is rather difficult to determine the effects of fertilization, the amount and timing of nutrition on yield and quality. It is a must to take climate, soil and economic factors into consideration (Winkler et al., 1974). The improvement of vine cultivation is possible by using technical and cultural precautions like the use of improved seedling, irrigation, pest control etc. together with right and balanced fertilization (Brohi, 1984).

Just as the case with all other plants, besides other precautions, high grape yield is possible with

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the plants getting necessary nutritive elements at necessary levels when it needs it. Therefore, the soils lack of nutritive elements and the plants which cannot take nutritive elements at required levels should be provided with right and balanced fertilization. As a matter of fact, many researchers have determined zinc deficiency in both soil and plant samples in their vineyard nutrition conditions (Kovanci and Atalay, 1977; Danisman et al., 1983: Brohi and Aydeniz, 1987).

Moreover, Gezgin and Er (1996) studied the soil and leave samples from 13 vineyards in the region in Aladag to determine the nutrition conditions of them. They revealed that almost of the vineyards has insufficient zinc nutrition. The researchers also found out that although 15% of the vineyards have insufficient nitrogen, all have sufficient levels of P, K, Ca, Fe, Mn and Cu nutrition.

As a matter of fact many researchers revealed that Boron application to vineyards increased grape yield (Ahmedullah et al., 1987; Strakhov, 1988).

Boron is an essential element for the growth of optimum plant (Marschner, 1995). Excessive amounts of Boron -just as in the case of its deficiency- can have negative effects and stop the growth of plant (Marschner, 1986).

Boron has a more critical and important place in generative period compared to its place in vegetative period. The environments which are scarce of Boron lead to constraining of inter-cell sharing besides the growth and division of cells. Furthermore, there is a decrease in leaf surface and thus in parallel with this the photosynthesis ability decreases (Dell and Huang, 1997).

In plant nutrition, what makes Boron different form other elements is that plants need boron more than other micro elements (Marscher, 2002). The benefits of boron: It has crucial and apparent functions pertaining sugar carriage, cell wall synthesis, lignin amount, cell wall structure, carbohydrate metabolism, RNA metabolism, respiration, indole aesthetic acid (IAA) metabolism, phenol metabolism (Parr and Loughman 1983), the structural and functional characteristics of biological membrane (Lukaszewski and Blevins, 1996); Boron positively affects fruit growth (Faust, 1989).

Lack of Boron is the most serious illnesses in vine cultivation. Fruit growth gets weaker and the yield decreases by 80% compared to the plants nourished with boron. This is a result of the need for high amount of boron for pollen tube growth and vividness (Mengel and Kirkby, 2001).

Depending on the main material in soils and the distribution and fissions levels of this main material, total boron amount generally ranges between 20 ppm and 200 ppm. Sandy soil have lower amount of boron content compared to clayey soils. It is generally accepted that less than 5% of total boron is beneficial for plant (Sezen, 1998).

In Middle Anatolia favorable boron concentration range between 0.01 and 63.9 (average being 2.48 mg/kg), which is a very large range. There is a positive correlation between boron concentration and the limestone, clay, organic substance contents, and sodium, potassium, magnesium concentrations (Gezgin et al., 2001).

The most important soil characteristics which affect the intake of boron by plants are the pH of the soil. Because of increase in the pH of soil and excessive level of calcification, boron intake decreases (Bartleta and Picarelli, 1973; Bennett and Mathias, 1973). In high pH calcareous soils, the application of boron as borax on the leaves is very common (Mengel and Kirkby, 2001).

The fact that approximately 85% of the soils in our country have high pH levels, 56.4 % have excessive amount of limestone, 61.9 % have heavy textured clay and 94% lack sufficient amount of organic substance-although toxicity and sufficient limits ranges across the plants- increased the importance of boron application -which is very limitedly used- in agricultural production as yield increaser. Vineyard is one of the plants which suffer from boron deficiency. In plants whose yield decreases significantly in case of boron deficiency dehydrated borax ($Na_2BO_{10}O_{16}$ 10 H_2O) and sodium borates ($Na_2BO_{10}O_{16}$. 10 H_2O) are given as fertilizers. Besides, water-soluble sodium pentaborate or sodium exta-borate is used by spraying on products (Demirtas, 2006).

The suitability of boron is affected by soil and climate factors. The main factors that affect boron suitability are: pH, slat content, organic substance, limestone, texture and changeable cations (Keren and Bingham, 1985; Sakal and Singh, 1995; Rahmatullah et al., 1999).

In black currant grape type which grows on heavy texture soil, the borax application in blooming period increased fruit growth and as a result the yield of the black currant grape-which used to be low because of boron deficiency- increased (Wojcik, 2005).

Significant levels of yield and quality increase in chickpea by Bayrak et al. (2005); in bean by Gulumser et al. (2005); in carrot by Demiray and Esiz Dereboylu (2005) were determined.

Material and Method

The place area is between Taurus Mountains to the south of Middle Anatolia at an altitude of 700m. The Goksu runs through the valley. The experiment vineyard was planted in Black Dimrit grape vineyard in Gaziler village of Aladag area of Hadim, a town in Konya province. The physical and chemical characteristics of the soil in trial vineyard are given in Table 1.

Table 1
Some properties of experimental soil at different depths

Soil properties	Soil depth, cm		Methods
Mechanical analysis	0-30	30-60	
Sand, %	51.4	54.7	Tuzuner, 1990
Silt, %	27.9	25.2	Tuzuner, 1990
Clay, %	20.7	20.1	Tuzuner, 1990
pH,1:2 W/v	7.87	7.65	Bayrakli, 1987
$CaCO_3$,%	12.4	4.5	Saglam,1978
Organic matter, %	1.43	2.47	Bayrakli, 1987
NH_4OAC extrac. (me/100 g)			
Ca+Mg	13.98	11.32	Saglam,1978
K	0.99	1.25	Saglam,1978
Na	0.14	0.19	Saglam,1978
Efficient P ppm	8.72	20.12	Olsen, 1954
DTPA extrac. (ppm)			
Fe	4.03	1.84	Lindsay and Norwell, 1978
Mn	11.27	10.63	Lindsay and Norwell, 1978
Zn	1.09	1.33	Lindsay and Norwell, 1978
Cu	1.54	1.32	Lindsay and Norwell, 1978
B	0.1	0.1	Bayrakli, 1987

In here , warm was about 30.5^{0}C from the langer – years, in July. But it could be -13.6^{0}C in January. The average warm was 9.2^{0}C and the humidity was 59.7 % and rain quantity was 615 mm in a year. Soil textures were sandy silt, soil was slightly alkaline, poor in terms of organic material.

Two vine stocks are placed in one parcel in the trial vineyard which was established according to factorial trial design with 3 repetitions in random blocks. Boron was applied to the soil at once with nitrogen and urea in parcels where the vine stocks were not applied with $N_0P_0K_0$ and where vine stocks were applied with 150-50-50 g/vine stock (($N_1P_1K_1$), Phosphor, Triple-superphosphate, and Potassium were applied to soil with Boron as Potassium sulfide fertilizer in order (N, P_2O_5, and K_2O, respectively).

Boron was applied to vine stocks as 11% Borax in the following dosages, B_0 0 g, B_1 2.5 g, B_2 5 g, B_3 10 g Boron/vine stock. Boron was applied in 2 different ways, to the soil and to the leaves. In the I. Application, all of the Boron was applied to the drop-lines of vine stocks 15 days before blooming by mixing it with NPK (20-30 cm deep), and the II. Application started 15 days before blooming and continued for 4 sessions at 15 day intervals- in each session ¼ of boron being sprayed to the leaves.

In the harvest, fresh grape yield was calculated according to Celik (1991) as soluble dry substance (%), and standardized acidity (g/100 cc).

Results and Discussions

Grapevines treated and non-treated with NPK were applied with boron in different ways and an increasing levels in Hadim - Aladag region. Mean values and results of LSD tests belong to the effect of boron on yield of wet grape and its quality are presented in Table 2.

The Grapevine Yield, kg/grapevine

Statistically significant difference was not found between $N_0P_0K_0$- $N_1P_1K_1$ treatments and wet grape yield.

This might be due to the medium level of organic matter content and high levels of available phosphorous and potassium of test soils.

The yield increased at the range of 13.50 % - 70.45 % with the increase of boron level as compared to the control. The highest yield (11.74 kg /grapevine) was obtained with 40 g boron treatment. However, there was no statistically significant difference ($p<0.05$) between 40 g boron (B_3) and 20 g boron (B_2) treatment.

As compared to the NPK treatment, the effect of boron treatment on yield didn't change significantly. The highest grape yield (13.23 kg/grapevine) was obtained by applying 20 g of boron to grapevine in $N_0P_0K_0$ application and 40 g of boron in $N_1P_1K_1$. This situation showed the increase of NPK treatment to the leaves increase the boron need as stated by Loneragan and Webb (1993).

Grape yield increased with increasing of boron level applied to the leaves in both $N_0P_0K_0$ and $N_1P_1K_1$ treatments. Similarly, many researchers found significant increase in grape yield with boron application (Ahmedullah et al., 1987; El- Shamy and Haggah, 1987; Strakhov, 1988; Ravi-Kumar et al., 1988).

Boron applied to the leaves has enhanced the yield more than one applied to the soil (6.44 and 12.05 kg/grapevine respectively). According to the LSD test, the difference between the boron application to the leaf and soil is considerably at important level from the point view of the wet grape yield ($p<0.0.5$).

The pH of Grape Juice

The pH of grape juice has been determined as 3.80 and 3.69 in $N_0P_0K_0$ and $N_1P_1K_1$ treatments, respectively. According to LSD test the difference between average values has been considered to be important ($p<0.05$). Besides, the pH of grape juice obtained in the treatments of boron applied on the leaves was lower than the one obtained in the treatments of boron applied to the soil. Furthermore, while the boron applied on the leaf was increasing, the pH of grape juice decreased as compared to the control. Statistically important positive correlations were determined between pH of grape juice and NPK application and boron doses ($r=0.551^{**}$ and $r= -0.370^{**}$, $p<0.01$), respectively.

Water Soluble Dry Matter, %

There was statistically significant difference in average values of water soluble dry matter of grape juice at $N_0P_0K_0$ and $N_1P_1K_1$ treatments. With

Table 2

The effect of NPK and boron on the quality and yield of Black Dimrit grape type

	Grapevine yield, kg/grapevine					pH 1/2:5			Water soluble dry mat., %			Titratable acidity, g/100cc		
Doses	Application	$N_oP_oK_o$	$N_1P_1K_1$	Average	% Incre.	$N_oP_oK_o$	$N_1P_1K_1$	Average	$N_oP_oK_o$	$N_1P_1K_1$	Average	$N_oP_oK_o$	$N_1P_1K_1$	Average
B_o	U1	5.60	3.97	4.79		3.86	3.62	3.74	19.3	18.07	18.69	3.31	4.02	3.67
	U2	8.23	10.43	9.33		3.85	3.82	3.84	17.47	18.37	17.92	2.87	3.66	3.27
	Average	6.91c	7.2d	7.06c		3.86	3.72	3.79a	18.38	18.22	18.3a	3.09	3.84	3.47ab
B_1	U1	5.47	4.60	5.04	5.20	3.80	3.81	3.81	18.63	18.23	18.43	3.46	3.11	3.29
	U2	9.30	13.43	11.37	21.80	3.78	3.63	3.71	18.57	16.97	17.77	3.37	3.59	3.48
	Average	7.38c	9.01c	8.2c	13.50	3.79	3.72	3.76b	18.6	17.6	18.1b	3.41	3.35	3.38c
B_2	U1	7.00	7.33	7.17	49.70	3.82	3.66	3.74	19.6	16.07	17.84	4.12	3.99	4.06
	U2	9.47	16.17	12.82	37.40	3.76	3.68	3.72	17.8	17.63	17.47	3.26	3.96	3.61
	Average	8.23b	11.7b	9.99b	43.50	3.79	3.67	3.73c	18.7	16.6	17.65c	3.69	3.97	3.83a
B_3	U1	8.70	8.87	8.79	83.50	3.85	3.66	3.76	17.7	17.97	17.84	3.59	3.4	3.5
	U2	11.77	17.60	14.69	57.40	3.74	3.68	3.71	19.83	16.9	18.37	3.84	3.74	3.79
	Average	10.23a	13.23a	11.74a	70.45	3.79	3.67	3.73c	18.76	17.43	18.1b	3.71	3.57	3.64b
Average NPK		8.18	10.28			3.80	3.69	3.75	18.61	17.46	18.03	3.47	3.68	3.58
Average 1		6.69b	6.19d	6.44c	46.13	3.83	3.68	3.76a	18.8	17.58	18.2a	3.62	3.63	3.63a
Average 2		9.69a	14.4a	12.05a	38.86	3.78	3.7	3.74b	18.41	17.34	17.88a	3.33	3.73	3.53b

U1: One applied soil U2: One applied leaves

*The avarage of 3 replicates

** Values for a particular column followed by the same letter are not significantly different ($p<0.01$)

an increase of boron quantity regular increase or decrease was not found in water soluble dry matter of grape juice. The highest water soluble dry matter was obtained with 20 g boron application to the grapevine. Furthermore, according to the LSD test, although there was a statistically important difference between B2 and other boron doses which causes the highest water soluble dry matter, the other differences between boron doses were not at significant levels. Besides, the application of boron to the soil has supplied more water soluble dry matter (%) than the one on the leaf (18.20 % and 17.88%, respectively). According to the LSD test, the difference between both averages of the ratio of water soluble dry matter (%) has been considered to be statistically important ($p<0.05$).

The Titrable Acidity of Grape Juice, g/100cc

The average acidity level of grape juice was higher in $N_0P_0K_0$ treatments than in $N_1P_1K_1$ treatments (3.47 g/100cc and 3.68 g/100cc, respectively) and these average values were statistically important ($p<0.05$). The highest acidity was obtained in the application of 20 g/grapevine (B2) as compared to the one obtained in the control application (Bo). However, significant difference was not determined between 20 g boron application (B2) and control (Bo). The boron applied to the soil has caused more acidity than the one on the leaf (3.63g/100cc and 3.53g/100cc, respectively). According to the LSD test, the difference between both average acidity levels was found to be statistically important ($p<0.05$). Important negative correlations were found among NPK application, pH specialty and the acidity level of grape juice ($r= -0.358^{**}$ and $r= -0.594^{**}$ $p<0.01$).

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