EFFECT OF BORON AND MOLYBDENUM FOLIAR SPRAYS ON GROWTH, YIELD AND FRUIT QUALITY OF "SUPERIOR" GRAPEVINE (*Vitis vinifera* L).

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ABSTRACT

This investigation was carried out during two successive seasons of 2007 and 2008 to study the effect of boron and molybdenum foliar sprays on growth, yield, berry quality and some chemical constituents of "Superior" grapevine cultivar. The vines were grown in loamy sand soil. The treatments were (control, B 100 ppm, B 200 ppm, Mo 50 ppm, Mo 100 ppm, B 100 ppm + Mo 50 ppm, B 100 ppm + Mo 100ppm, B 200 ppm + Mo 50 ppm and B 200 ppm + Mo 100 ppm. Generally, it was found that all treatments increased leaf area, shoot length, cane thickness, cluster weight(g), fresh and dry weight(g) of 100 berries compared with control. Yield per vine also increased by all treatments except Mo 50ppm. On the other hand, Mo treatments reduced total sugars (%) and TSS in berries. Acidity percentage in fruit juice decreased by foliar spray of boron and molybdenum. Total Carbohydrates, total chlorophyll, carotenoids, N, P, K, Fe, Zn and Mn in leaves increased by boron and molybdenum foliar spray.

Key Words: Grapevine (*Vitis vinifera* L), Boron, Molybdenum, growth, yield, chemical constituents.

INTRODUCTION

Grape (*Vitis vinifera,* L) is considered the most popular and favorite fruit crop in the world including Egypt, for being has an excellent flavors, nice test and high nutritional values. It can grow under different environmental conditions **(Abd El- Galil *et al.*, 2003).**

Boron is a vital element in the development and growth of new cells, in the fertilization of flowers, in the carbohydrate metabolism, and in the translocation of starch and sugars. It is indispensable in the nitrogen and phosphorus metabolism, in the synthesis of aminoacids and proteins. It has a role in the RNA and DNA synthesis, in the embrionary development, and in the hormonal regulation. Boron shows very low mobility within the plant (**Bergmann 1979, Keller 2005**).

Janaki, *et al.* (2004) emphasized that boron of foliar application significantly increased the N,P and K content in the petiole while the Ca content decreased with increase in boron spray due to negative interaction of Ca with B. As regards to micronutrients, Cu, Mn increased while Fe content decreased.

Pawel (2005) Black currant bushes were foliar or soil supplied with B (as boric acid). The results showed that vigor of black currant bushes, weight of 100 berries, soluble solids concentration and titratable acidity of fruit were unaffected by B fertilization. Foliar B sprays increased B concentrations in flowers and leaves, and also enhanced the fruit set and as well as cropping of black currants. Soil B application enhanced leaf B status but had no effect on flower B level and yield. These results indicate that foliar B sprays applied at or around the time of flowering should be recommended for black currant plantations to increase productivity of plants containing an insufficient flower B level.

Recent research indicated that molybdenum play an important role in: grapevine fruit set; seed formation; berry formation and development; and bunch yield **(Williams *et al.* 2004; 2007).**

Molybdenum is involved in nitrogen fixation and nitrate assimilation. Some investigators found that molybdenum deficiency leads to a decrease in the concentration of ascorbic acid in the plant **(Davidson, 1960).** There is some evidence that molybdenum is involved in the phosphorous metabolism of the plant, but the mechanism has not been explained. Molybdenum (Mo) is an essential micronutrient for normal growth, metabolism and reproduction of crop plants **(Gupta 1997).** It acts as a metallic cofactor in plant and animal enzymes. For example, Mo is involved in nitrate reductase for the conversion of nitrate taken up by the roots, into a form that the vine can use and in sulfite oxidase for sulphur-containing amino acid metabolism and other molybdoenzymes **(Yu *et al.* 2002).** Molybdenum (Mo), is a micronutrient involved in the conversion of nitrate nitrogen, taken up by the roots, into a form that the vine can use. It is also involved in enzymatic reactions essential for growth and reproduction in plants.

Williams *et al.* (2004) on Merlot vines has shown that the application of Mo can increase yield as a result of increased bunch weight. An increase in functional seeds and percentage of coloured berries was seen as a result of Mo application before flowering in two foliar applications. **Longbottom *et al.* (2005)** also reported an increase in crop yield as a result of Mo application to Mo deficient Merlot vines, through increased fruit set. Mo was applied at two rates as sodium molybdate at 0.101 g/vine and 0.202 g/vine at two application timings, 10cm shoot length and one week later. The high rate did not improve the response of Mo application

Gridley (2003), Williams *et al.* (2003; 2004) and **Longbottom *et al.* (2004)** have reported yield increases in response to foliar Mo sprays applied before flowering to Merlot vines on own roots.

MATERIALS AND METHODS

This study was carried out during the two successive seasons of 2007 and 2008 on grapevine cv, namely "Superior" grown at the Experimental farm of Faculty of Agric. Fayoum at Demo, Fayoum, Egypt to study the effect of boron and molybdenum application on grapevines. The vines were 10 years old when experiment was started and grown in loamy sand soil and irrigated with Nile water under drip irrigation system. The vines were spaced 3×3 m. and vines were can training system with four wire trills in the telephone supporting system and pruned by leaving about 72 buds (6 fruiting canes involved 12 buds/cane). Vines were selected in January, 2007 uniform as possible for the following spraying treatments:

1- Control (spraying with tap water)
2 Spraying with B 100 ppm
3- Spraying with B 200 ppm
4 Spraying with Mo 50 ppm
5- Spraying with Mo 100 ppm
6- Spraying with B 100 ppm + Mo 50 ppm
7- Spraying with B 100 ppm + Mo 100 ppm
8- Spraying with B 200 ppm + Mo 50 ppm
9- Spraying with B 200 ppm + Mo 100ppm.

Boric acid and molybdic acid as sources of boron and molybdenum that used in this concern.

All treatments were sprayed three times, the first was achieved when the new shoots attained 10 cm. long, the second was at full bloom stage, and then third was 15 days after full bloom with a volume 5 L/vine for each one. Triton B as a wetting agent at 0.1% was added to the spraying solution. All the agricultural and horticultural practices were carried out as usual. In all experiments, Phosphorous as calcium super phosphate (15.5% P_2O_5) at the rate of 200 kg/feddan was added in the second week of February. Nitrogen as ammonium nitrate (33 % N) at the rate of 150 kg /feddan was added in two equal doses. The first dose at the second week of February and the second dose before top flowering (at the first week of April). Potassium sulphate (48% K_2O) at the rate of 100 kg/fed. was given in two equal doses in alternative with nitrogen fertilizer. The first dose was added in (March) and the second one was given after 30 days from the first.

The following parameters were determined to evaluate the effect of different spray treatments on growth, yield, fruit quality and chemical constituents of "Superior" cv. grapevine.

The experiment was designed in Randomized Complete Block Design with 9 treatments. Each treatment was replicated 3 times on 3 vines per replicate.

Vegetative growth parameters.

1. Shoot length (cm): was estimated by measuring 10 canes non fruitful per vine at the second week of November in each season.
2. Cane thickness (cm): was estimated at cane banging by measuring 10 canes per vine at the second of week November in each season
3. Leaf area (cm^2): samples of twenty leaves per vine were picked from those opposite to the first cluster on each shoot at the second week of July to determine leaf area. Leaf area was estimated using digital Planimeter (Planix 7).

Leaf Chemical composition.

Representative leaf samples consisting 25 mature leaves were taken at the fourth week of July to determine: total carbohydrates (%) in dry weight colorimetrically by using phenol-sulphuric acid reagent according to the method described by **Herbert *et al.* (1971)**. Total chlorophyll (mg/g^{-1}) and carotenoids (mg/g^{-1}) were extracted by 80% acetone according to **Arnon (1949).**

Leaf mineral contents.

Leaf samples consisted of 25 mature leaves were collected at the second week of October from current season's growth from each vine. Leaves were prepared and dried in an electric oven at 70 C^o, ground and stored in air-tight pages until analysis. Nitrogen was determined using orange G day colorimetric method according to **Hafez** and **Mikelsen, (1981).** Phosphorus was determined calorimetrically using the method described by **Jakson *et al.* (1973).** Potassium was determined by Flame photometer apparatus according to **Page *et al.* (1982).** Fe, Zinc and manganese determined by using Atomic absorption.

Fruit quality.

At the second week of June, when harvesting took place. Ten clusters from each vine were taken at random to determine the average weight of cluster, 10 berries per cluster were randomly taken to determine average fresh and dry weight of berries.

Chemical characters of berries.

Total sugars percentage and total acidity percentage were determined in berries according to **A.O.A.C. (1995).** Total soluble solids percentage (TSS) was determined by using a hand refractometer.

Statistical analysis of the data was carried out according to the method described by **Snedecor and Cochran (1980)**. Means were compared using LSD values at 0.5 level of probability.

The physical and chemical characters of the orchard soil was determined according to **Wilde *et al.*, (1985)** and the results are shown in Table (1).

Table (1): Chemical and physical analysis of the soil

Depth	Physical characteristics									
	Particle size distribution				Texture	Bulk density g/cm^3	Organic matter %	Soil moisture constant %		
	Coarse sand%	Fine sand %	Silt %	Clay %				F. C	W.P	A.W
0-30	57.24	28.99	7.07	6.60	Loamy	1.39	0.81	17.5	7.16	10.75
30-60	52.87	28.98	8.86	8.37	Sand	1.41	0.74	20.1	8.74	11.77

	chemical characteristics								
	Soluble cations (meq /L)				pH	ECe (dS/m)	Soluble anions (meq/l)		
	Ca^{++}	Mg^{++}	Na^{+}	K^{+}			Cl^{-}	Hco_3^{-}	So_4^{--}
0-30	17.65	15.88	12.23	1.31	7.21	4.49	7.67	2.82	33.44
30-60	10.20	11.81	5.01	0.62	7.45	2.63	3.65	2.95	22.46

RESULTS AND DISCUSSION

Effect of boron and molybdenum sprays on leaf area, shoot length and shoot thickness of "Superior" grapevine : Results presented in Table (2) show that all treatments increased leaf area significantly compared with control in the two seasons. Also, results indicated that treatments of boron and molybdenum significantly increased shoot length in both seasons. Also, Cane thickness increased by these treatments compared with untreated. The response to boron and molybdenum application regarding vegetative growth was in line with those observed by **Mostafa *et al.* (2006)** was found that shoot length, number of laterals per shoot, number of leaves per shoot, leaf area, leaf fresh and dry weight increased by boron sprays. **Longbottom (2007)** showed that when foliar applications of molybdenum (Mo) were applied to Merlot vines the vegetative symptoms improved. **Pawel *et al.* (2008)** in apple (*Malus domestica* Borkh.) found that soil boron fertilization improved root development and tree vigor. The response to boron application regarding vegetative growth in the line with those observed by **Ahmed and El-Morsey (1993), Azemov (1997) and Youssef (1997)** on grapes.

Table (2): Effect of spraying Boron and Molybdenum on leaf area, shoot length and shoot thickness of "Superior" grapevines in 2007 and 2008 seasons.

Treatments	Leaf area (cm^2)		Shoot length (cm)		Cane thickness (cm)	
	2007	2008	2007	2008	2007	2008
Control	107.17	114.73	105.5	120.17	0.90	0.95
B100 ppm	170.88	172.84	138.00	132.70	1.19	1.28
B200 ppm	137.73	140.34	150.33	158.90	1.22	1.45
Mo50 ppm	129.00	134.10	133.00	138.60	1.35	1.38
Mo100 ppm	137.73	139.67	135.96	133.97	1.77	1.66
B100ppm + Mo50ppm	162.30	171.25	146.00	139.37	1.48	1.42
B100ppm+Mo100ppm	148.33	149.71	135.67	139.00	1.42	1.38
B200ppm+Mo50ppm	151.10	156.17	146.00	148.47	1.28	1.37
B200ppm+Mo100ppm	142.16	147.23	146.67	150.20	1.65	1.72
L.S.D $_{0.05}$	**19.86**	**16.84**	**11.79**	**11.45**	**0.30**	**0.32**

Data in Table 3 obviously reveal that spraying "Superior" vines with boron and molybdenum either singly or in combination using different concentrations significantly increased yield (kg.) per vine compared with control in both seasons except treatment Mo 50 ppm. Also, results indicated that cluster weight (g.), fresh and dry weight of 100 berries (g.) increased significantly compared with control. The treatments of B 200 ppm, B100ppm + Mo50ppm and B200ppm + Mo50ppm gave 19.17, 18.56, 18.12, 19.89 and 18.08, 19.95 kg. compared with 18.06 and 19.75 kg. for the untreated vines in 2007 and 2008 seasons, respectively.

The pronounced increase in the yield due to the application of boron and molybdenum could be attributed to their effect on increasing cluster weight and berry weight as noticed in Table 3.

One can say that application of boric acid alone or with molybdenum effectively increased berry weight. Significant differences were observed between treated and untreated vines in this connection. The best results concerning cluster weight and berry fresh weight was obtained on vines received B200ppm.

Moreover, B 200ppm gave also the best results regarding berry dry weight.

The enhancing effect of boron on the uptake of nutrients, supplying the available organic nitrogen and promoting cell division may give a reasonable explanation for the improving effect of boron on the weight and dimension of berries (**Nijjar**, **1985**).

Boron is a vital element in the development and growth of new cells, in the fertilization of flowers, in the carbohydrate metabolism, and in the translocation of starch and sugars. It is indispensable in the nitrogen and phosphorus metabolism, in the synthesis of aminoacids and proteins. It has a role in the RNA and DNA synthesis, in the embrionary development, and in the hormonal regulation (**Bergmann 1979, Keller 2005**).

The favorable effect of boron on growth characters and berry set could mainly attributed to its important role in metabolism of N, biosynthesis, translocation of carbohydrates and fruiting processes.

These results are in accordance with those by **Sharrock & Portch (1992), Ali (2000), Ahmed and Abd-El Hameed (2003), Zhang (1989)** and **Mostafa *et al.* (2006)**.

The application of Mo can increase yield as a result of increased bunch weight. **Williams *et al.* (2004), Longbottom *et al.* (2005)** also reported an increase in crop yield as a result of Mo application, through increased fruit set. **Longbottom (2007)** found that when sodium molybdate was applied to Mo-deficient Merlot, grapevines yield improved; a function of increased bunch weight brought about by bigger berries and found that Mo-treated vines had significantly higher yields (approximately double) than the Mo-deficient controls and bunches from Mo-treated vines had significantly better fruitset resulting in more berries per bunch.

Table (3): Effect of spraying Boron and Molybdenum on yield and some physical properties of "Superior" grapevines in 2007 and 2008 seasons.

Treatments	Yield vine^{-1} (Kg)		Cluster wt.(g)		Fresh wt.of 100 berries(g)		Dry wt. of 100 berries (g)	
	2007	2008	2007	2008	2007	2008	2007	2008
Control	12.04	13.17	393.75	442.67	209.64	217.18	66.42	69.38
B100 ppm	16.07	17.79	655.75	671.67	279.80	273.85	88.48	91.09
B200 ppm	19.17	18.56	778.33	778.00	342.52	352.70	129.0	131.50
Mo50 ppm	13.27	14.46	558.75	595.33	284.84	296.56	83.64	90.66
Mo100 ppm	14.28	15.29	502.50	570.00	290.62	294.88	85.40	87.18
B100ppm + Mo50ppm	18.12	19.89	691.67	706.67	260.95	272.79	82.00	83.76
B100ppm+Mo100ppm	17.03	17.56	631.33	688.00	226.80	225.43	70.37	71.72
B200ppm+Mo50ppm	18.08	19.25	506.25	591.00	250.94	250.54	77.03	78.15
B200ppm+Mo100ppm	17.01	18.10	564.33	589.67	224.19	227.86	72.44	72.47
L.S.D $_{0.05}$	**1.39**	**1.41**	**32.28**	**51.63**	**6.81**	**7.80**	**1.39**	**2.12**

Table (4): Effect of spraying Boron and Molybdenum on some fruit chemical properties of "Superior" grapevines in 2007 and 2008 seasons.

Treatments	TSS (%)		Total acidity (%)		Total sugars %	
	2007	2008	2007	2008	2007	2008
Control	14.83	14.83	0.57	0.55	17.62	17.89
B100 ppm	16.83	16.89	0.53	0.52	20.84	21.68
B200 ppm	16.47	17.0 7	0.50	0.51	22.07	22.56
Mo50 ppm	14.17	14.67	0.46	0.45	13.07	14.25
Mo100 ppm	15.50	15.83	0.43	0.42	16.81	16.65
B100ppm + Mo50ppm	16.50	17.00	0.43	0.43	20.47	20.99
B100ppm+Mo100ppm	16.55	16.60	0.44	0.43	21.88	22.78
B200ppm+Mo50ppm	16.76	16.51	0.41	0.40	19.76	19.22
B200ppm+Mo100ppm	16.80	16.67	0.44	0.43	19.23	20.05
L.S.D $_{0.05}$	**1.44**	**1.01**	**0.03**	**0.02**	**1.20**	**1.16**

The obtained results in Table (4) showed that the total soluble solids (TSS) of berries were increased significantly by spray of B 100ppm, B200 ppm, (B100 ppm + Mo50 ppm), (B100ppm + Mo100ppm), (B200ppm+ Mo50ppm) and (B200ppm + Mo100ppm) in the two studied seasons. While, spraying treatment of Mo 50 ppm reduced TSS non significantly (14.17% and 14.67%) in the two seasons. Meanwhile, spraying with Mo 100 ppm increased TSS (15.50% and 15.83%), the differences were also non significant. This finding agreed with, **Mostafa *et al.* (2006)** reported that boric acid treatments progressively increased the percentage of total soluble solids (TSS) as well as total sugars and decreased total acidity, compared with unsprayed vines.

Generally, results indicated that total acidity % in berries juice was decreased significantly by spraying all treatments compared with untreated (control) in both seasons. **Longbottom (2007)** stated that juice total soluble solids (TSS) and titratable acidity were not affected by Mo-treatment

Concerning total sugars, data indicated that single spray of boric acid at concentration of 100 ppm and 200ppm significantly increased total sugars of berries by about 20.84% and 22.07% in the first season, 21.68% and 22.56% in the second season. When spray mixed of boron with molybdenum at concentrations (B100ppm+Mo50ppm, B100ppm + Mo100ppm, B200ppm + Mo50ppm and B200ppm + Mo100ppm) increased total sugars in berries juice. In contrary, Mo 50ppm and Mo 100ppm reduced total sugars (%) in berries, when applied alone compared with the control.

The positive action of boron on berries quality might be attributed to vine nutritional statues, biosynthesis and translocation of carbohydrates that led to increasing yield in terms of number and weight of bunches, besides improving chemical quality of berries. These results are in harmony with these obtained by **Singh and Rethy (1996), Ali (2000), Shoeib and El-Sayed (2003), Mostafa *et al.* (2006)** and **Longbottom (2007)** in grapevines.

Results presented in Table (5) indicated that spray of boron and molybdenum on vine increased significantly total carbohydrates and total chlorophyll in leaves compared with the control in both seasons. Leaf carotenoids content significantly increased by spraying of B 200ppm, Mo 50 ppm and Mo 100ppm. This was holding true for both seasons. Obtained data also show increased. The role of boron and molybdenum in translocation of carbohydrates and increasing its content may be attributed to the increase in leaf chlorophyll and carotenoids as well as leaf area and its stimulus effect on the process of pohotosynthesis (**Niijar (1985)**.These fidings are in accordance with these recorded by **Sharrocks and Portch (1992), Mostafa *et al.* (2006).**

Table (5): Effect of spraying Boron and Molybdenum on some chemical properties of the leaves of "Superior" grapevines in 2007 and 2008 seasons.

Treatments	Total carbohydrates (%)		Total chlorophyll (mg g^{-1})		Carotenoids (mg g^{-1})	
	2007	2008	2007	2008	2007	2008
Control	10.83	11.23	2.22	2.38	1.31	1.31
B100 ppm	9.37	9.56	3.04	3.09	1.37	1.37
B200 ppm	9.99	10.06	3.41	3.49	1.49	1.50
Mo50 ppm	11.24	11.57	3.39	3.52	1.54	1.56
Mo100 ppm	9.16	9.85	3.43	3.52	1.56	1.54
B100ppm + Mo50ppm	7.29	7.92	3.27	3.32	1.39	1.35
B100ppm+Mo100ppm	9.17	9.85	2.96	2.82	1.21	1.20
B200ppm+Mo50ppm	11.66	11.95	2.44	2.71	1.45	1.48
B200ppm+Mo100ppm	11.91	11.93	3.63	3.79	1.29	1.33
L.S.D $_{0.05}$	**0.68**	**0.68**	**0.40**	**0.33**	**0.20**	**0.18**

Data in Tables (6 and 7) show that leaf mineral contents N%, P%, K%, significantly increased with applied of boron and molybdenum to vines cv. "Superior". This was holding true in both seasons. (**Robinson and Burne 2000**) applied 250 to 500mg of Mo per L of water (approximately 300g. sodium molybdate per hectare of vineyard) to the point of canopy runoff. They found petiole tests indicate high nitrate-nitrogen concentrations.

Obtained data also show significantly increase concentrations of Fe, Zn and Mn of leaves by spray of boron and molybdenum. Similar results have been discussed by **Janaki *et al.* (2004)** in grapes, emphasized that application of foliar boron significantly increased the N, P and K content. Zn, Fe and Mn content increased by boron application and **Mostafa *et al.* (2006)** boron spray in to grape vine resulted in significant increase in leaf mineral and total carbohydrate contents. Moreover, **Ali (2000) and Youssef (1997).**

Table (6): Effect of spraying Boron and Molybdenum on Nitrogen, Phosphorus and Potassium leaf content (%) of "Superior" grapevines in 2007 and 2008 seasons.

Treatments	Nitrogen (%)		Phosphorus (%)		Potassium (%)	
	2007	2008	2007	2008	2007	2008
Control	2.21	2.28	0.32	0.31	1.22	1.25
B100 ppm	2.79	2.71	0.41	0.39	1.36	1.38
B200 ppm	2.57	2.52	046	0.44	1.39	1.36
Mo50 ppm	2.57	2.43	0.38	0.36	1.33	1.37
Mo100 ppm	2.53	2.69	0.35	0.33	1.34	1.36
B100ppm + Mo50ppm	2.57	2.49	0.40	0.39	1.41	1.39
B100ppm+Mo100ppm	2.48	2.51	0.38	0.41	1.43	1.41
B200ppm+Mo50ppm	2.57	2.65	0.36	0.37	1.43	1.42
B200ppm+Mo100ppm	2.48	2.49	0.38	0.37	1.44	1.41
L.S.D $_{0.05}$	**0.18**	**0.18**	**0.03**	**0.03**	**0.10**	**0.10**

Table (7): Effect of spraying Boron and Molybdenum on Fe, Zn and Mn (ppm) leaf content of "Superior" grapevines in 2007 and 2008 seasons.

Treatments	Fe (ppm)		Zn (ppm)		Mn (ppm)	
	2007	2008	2007	2008	2007	2008
Control	45.89	47.98	42.16	45.55	32.6	33.15
B100 ppm	54.12	56.58	48.11	57.92	34.51	36.25
B200 ppm	53.96	56.01	47.90	56.12	35.02	37.01
Mo50 ppm	53.16	52.12	48.23	52.63	35.50	36.15
Mo100 ppm	54.25	57.01	47.88	57.21	35.72	37.52
B100ppm + Mo50ppm	57.41	58.95	49.01	58.95	35.98	37.98
B100ppm+Mo100ppm	55.61	57.10	50.01	56.54	37.25	38.12
B200ppm+Mo50ppm	57.26	59.45	49.15	60.00	36.56	37.89
B200ppm+Mo100ppm	58.01	57.52	50.22	58.92	36.12	36.98
L.S.D $_{0.05}$	**3.94**	**3.99**	**3.39**	**4.01**	**2.49**	**2.60**

Finally, from the results of the present investigation, it could be concluded that the application of boron and molybdenum with different concentrations increased growth and grapevine yield as well as improved fruit quality and its chemical constituents. The constituents of these substances participate in the different metabolic processes which increased syntheses of chlorophyll, carbohydrates, total sugars, so that the use of boron and molybdenum could increase grape productivity with high fruit quality.

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تأثير الرش بالبورون والمولبدنيم على النمو الخضرى والمحصول وصفات الحبات والمحتوى الكيماوى لكرمات العنب صنف " سوبريور"

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أجرى هذا البحث خلال موسمين متتاليين 2007، 2008 في أرض رملية طمييـة بمزرعـة التجارب بكلية الزراعة بالفيوم – مصر لدراسة تأثير رش كرمات العنب صنف "سوبريور" بكل من البورون والمولبدنيم على النمو الخضرى والمحصول وجودة الثمار والمحتوى الكيماوى لـلأوراق بالمعاملات التالية:

1- الكنترول (رش بالماء)
2- بورون بتركيز 100 جزء فى المليون.
3- بورون بتركيز 200 جزء فى المليون.
4- مولبدنيم بتركيز 50 جزء فى المليون.
5- مولبدنيم بتركيز 100 جزء فى المليون.
6- بورون بتركيز 100 جزء فى المليون + مولبدنيم بتركيز 50 جزء فى المليون.
7- بورون بتركيز 100 جزء فى المليون + مولبدنيم بتركيز 100 جزء فى المليون.
8- بورون بتركيز 200 جزء فى المليون + مولبدنيم بتركيز 50 جزء فى المليون.
9- بورون بتركيز 200 جزء فى المليون + مولبدنيم بتركيز 100 جزء فى المليون.

ولقد أوضحت النتائج المتحصل عليها أن المعاملة بالبورون والمولبدنيم منفردا أو معا أدت الى زيادة كل من مساحة الورقة وطول وسمك القصبة وكذلك زيادة وزن محـصول الكرمة من الثمار ماعدا معاملة الكرمات بالمولبدنيم بتركيز 50 جزء فى المليون.

أدت المعاملات الى زيادة وزن العنقود والوزن الطازج والجاف لكـل 100 حبـة عنـب ونقص فى حموضة الثمار.

إضافة المولبدنيم (50 و 100 جزء فى المليون) أدى الى نقص فى محتوى الثمـار مـن السكريات الكلية والمواد الصلبة الذائبة (TSS) مقارنة بمعاملة الكونترول.

أدى إضافة البورون والمولبدنيم رشا على كرمات العنب الى زيادة محتوى الأوراق من كل من الكربوهيدرات والكلوروفيل الكلـى والكاروتينـات والنيتـروجين والفـسفور والبوتاسيوم والحديد والزنك والمنجنيز.

وبذلك نوصى بأستخدام كل من البورون والمولبدنيم منفردا أو مخلوطين معا رشا على كرمات العنب لتحسين النمو الخضري والمحصول والمكونات الكيماوية للحبات.