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RESPONSE OF POTATO PLANTS FOR DIFFERENT SOURCES OF POTASSIUM WITH DIFFERENT FOLIAR RATES OF BORON AND MOLYBDENUM

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ABSTRACT

Two field experiments were conducted during the two successive fall seasons of 2002/2003 and 2003/2004 on potato cv. Spunta at EL-Zahraa village, Mansoura, Egypt, to study effect of two potassium sources (sulphate or chloride) at the recommended rate and so different foliar spraying rates of boron (50 and 75 ppm) or/plus molybdenum (25 and 50 ppm) twice at 60 and 75 DAP, in addition to their interactions on vegetative growth characters, tubers quality, tuber minerals content and total tuber yield.

The results indicated – generally – that K_2SO_4 application was more effective than KCL on the vegetative growth parameters, tuber quality characters and the yield and its components. Application of K_2SO_4 led to higher tubers yield production (8.95-11.33 %) than KCL application during the 1st and 2nd seasons, respectively.

Foliar spraying of potato plants with (B at 75 ppm + Mo at 50 ppm) twice at 60 and 75 DAP was significantly increased most vegetative growth parameters and led to in improve the tuber quality parameters i.e. dry matter, starch, specific gravity and the protein of tuber, as well as, the tuber weight and total tuber yield compared with the other treatments in both seasons.

In general, application of K_2SO_4 to the soil and spraying potato plants twice at 60 and 70 DAP with boron and molybdenum together at rate of (75 ppm and 50 ppm, respectively) recorded maximum values of plant growth parameters, improved tubers quality characters and highest tuber yield/fed. On the other hand, recorded lowest concentration of nitrate in potato tuber was produced.

INTRODUCTION

Potassium is one of the essential nutrients for photosynthesis, acts as activator for more than 6 enzymatic systems, promotes translocation and storage assimilates, enhances N uptake, promotes protein and starch synthesis, plant growth and vital for sustaining modern high-yield agriculture (Marschner, 1995). Allison *et al* (2001) found that KCL application caused occasional reduction in most of vegetative characters and tuber dry matter content.

Martin-Prevel (1989), reported that size of tubers was increased by K application. Specific gravity of tuber was clearly reduced with potassium chloride application in compared with potassium sulphate application (James *et al*, 1990 and Panique *et al*, 1997).

Potassium application is more effective for improving vegetative plant parameters, tuber quality and tuber yield. Perrenoud (1993) indicated that using K_2SO_4 fertilizer usually gives a higher dry matter and starch content of tuber than KCL fertilizer. Oktay *et al*, (1997) reported that positive significant correlations between leaf and tuber K contents with K_2SO_4 application.

Total yield and specific gravity were generally (5 to 10 % and 0.001 to 0.004 units) higher with K_2SO_4 than with KCL at the optimum fertilization rate (Westermann and Tindall, 1998). In the same trend, Davenport and Bentley (2001) observed that total tuber yield was reduced with potassium chloride application.

When pH is higher than 7 as in case of the most Egyptian Delta soils, many nutrients such as P, B and Zn are most likely to be deficient (Mengel, 1972). Boron plays an important role in many essential processes in plant, including the cell wall formation, cell division, membrane integrity, translocation of sugar and bio-chemicals, protein synthesis and regulation of carbohydrate metabolism (Shorrocks, 1990).

Kamar and Omar (1987) found that application of microelements (Zn and B) improved total tuber yield, average of tuber weight and dry matter content of tuber. Boron concentrations were increased in hole plant with increasing application rate, whereas, plant height was not affected with boron application (Prengo and Armour, 1992).

Afkar *et al* (1995) illustrated that boron fertilizer with or without farmyard manure increased total tuber yield over the control. Similar results were obtained by Lozek and Fecnko (1996) who mentioned that the total tuber yield was increased by 15.7 % with boron foliar application. Porter *et al* (2000) found that fertilizing with K_2SO_4 + microelements (Zn, B and Mn) led to significant increase in plant vigor, yield, tuber size and specific gravity of tuber.

Regarding the effect of boron on potato plant, Bari *et al* (2001) reported that application of boron (as a borax form) increased fresh haulum weight/plant, No. of tubers/plant, dry matter of tuber and total yield as compared with control. Using boric acid in potato fertilization caused an increase in tuber size and weight by increasing of cell diameter in the tuber perimedullary zone (Puzina, 2004).

Molybdenum is an essential nutrient for plants, although the plants requirement is so low, an essential elements for plant synthesis and activity of enzyme nitrate reductase, which reduces nitrate and converting nitrates to ammonium and protein within plant (Chairidchai; 2000).

Kluge (1985) found that the low concentrations of molybdenum increased dry matter and tubers yield, whereas, high concentrations above 150 ppm caused reduction of tubers yield and toxicity of potato plant.

Marchand and Schenk (1985) reported that application of molybdenum fertilization slightly increased yield of potato tuber as compared with the unfertilized control. Shehata *et al* (1990) indicated that spraying micronutrients including molybdenum increased number of stems, fresh and dry weight of plant foliage, number of tuber/plant and tuber yield as compared with an untreated control.

Abo-Sedera and Shehata (1994) found that spraying with molybdenum at 5 ppm increased plant height, fresh and dry weight of plant foliage, number of tubers/plant, tuber weight, total yield, tuber dry matter, specific gravity and starch content as compared with unspraying control.

Williams *et al* (2004) observed that nitrate concentration was declined in the grape bunch and total yield was increased after molybdenum spraying. Liu *et al* (2005) showed that Mo and/or B increased antioxidant enzyme activities and protein content in soybean seeds.

The present investigation was carried out to study the effect of potassium sources and different foliar concentrations of boron or/plus molybdenum on growth, chemical composition, tuber quality and tuber yield.

MATERIALS AND METHODS

Two successive fall seasons were conducted at EL-Zahraa Village, Mansoura, Dakahlia Governorate. Potato cv. Spunta was planted on 10^{th} and 15^{th} October 2002 and 2003, respectively. The investigation was performed to study response of potato plants to potassium sources i.e. potassium sulphate and potassium chloride, in addition to foliar spraying at 60 and 75 DAP with boron or/plus molybdenum.

A split-plot design with four replicates was used. Potassium sources occupied the main plots; while the foliar spraying of boron or/plus molybdenum concentrations were assigned to the sub-plots. The sub-plots treatments were as follows :

1- Boron 50 ppm.
2- Boron 75 ppm.
3- Molybdenum 25 ppm.
4- Molybdenum 50 ppm.
5- B 50 ppm + Mo 25 ppm.
6- B 50 ppm + Mo 50 ppm.
7- B 75 ppm + Mo 25 ppm.
8- B 75 ppm + Mo 50 ppm.

Each subplot consisted of 4 ridges 5 m. long and 0.75 m. apart occuping an area of 15 m^2. Some physical and chemical analysis of the experimental soil are shown in Table (1) :

Table (1) : Physical and chemical properties of the experimental soil.

Physical properties				Chemical properties			
Sand	Silt	Clay	Texture	pH	Available nutrient (ppm)		
					N	P	K
32.7	26.2	38.4	Clay loam	7.9	83.2	34.2	378

According to method of Jackson (1973).

Nitrogen was added at three equal portions, the 1^{st} was applied after emergence in the form of ammonium sulphate (20.5 % N), then two and four weeks later in the form of ammonium nitrate (33.5 % N) at rate of 180 kg N/fed. Phosphorus was applied during the soil preparation in the form of calcium super-phosphate (15.5 % P_2O_5) at rate of 75 kg P_2O_5/fed.

Potassium sources were applied before the first irrigation at rate of 96 kg K_2O/fed. in the two forms potassium sulphate and potassium chloride.

Plants were sprayed with an aqueous solution of boron or/plus molybdenum two times at 60 and 75 days after planting (DAP).

Other agriculture practices were carried out according to the recommendations of the Ministry of Agriculture.

Data recorded :

1- Vegetative growth :

Four plants were taken from each plot at 90 DAP as a representative sample to measure vegetative parameters i.e. plant height (cm), number of main stems/plant, fresh weight (g)/plant, dry matter (%) and leaf area (cm^2)/plant.

2- Tubers yield, quality and their components :

At harvest the following items were determined; number of tubers/plant, average of tuber weight (g) and tuber yield (ton/fed.). Dry matter (%), starch (%) and specific gravity of tuber were also determined according to (A.O.A.C, 1990).

3- Chemical determinations :

At harvest, a random sample of eight tubers were selected/plot to determine N, P and K content (%) in tuber according to the methods described by Rangana (1979), moreover, the protein content in tuber dry matter was calculated. Nitrate and nitrite concentrations were determined according to (Singh, 1988) method.

Boron and molybdenum were determined in dry matter of tuber according to the methods described by (A.O.A.C, 1990).

All collected data obtained were subjected to statistical analysis according to Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Data presented in Table (2) show the effect of potassium sources and foliar spray with boron or/plus molybdenum and their interactions on vegetative growth parameters of potato plants expressed as plant height, number of main stems, leaf area, fresh and dry weight/plant.

With an exception of the number of main stems/plant, which was not significantly affected, plant height, leaf area, fresh and dry weight were significantly increased with application of K_2SO_4 during the two seasons. Similar results were reported by Marschner (1995) and Alison *et al.* (2001).

As for the effect of foliar spray with boron or/plus molybdenum and their interactions, the plant height, leaf area, fresh and dry weight/plant were significantly increased with applying (boron 75 ppm + molybdenum 50 ppm). These results might be due to role of boron and molybdenum in plant metabolism and to the suitable concentration, then, boron is an essential for cell division and helps in nitrogen absorption, while, molybdenum is an essential for nitrogen assimilation in plant, (Shehata *et al*, 1990; Shorrocks, 1990; Abo-Sedera and Shehata, 1994 and Bari *et al*, 2001).

Data in Table (2) also reveal that the interaction between K_2SO_4 and the foliar spray with (B 75 ppm + Mo 50 ppm) had significant effects on all parameters of vegetative growth, except the number of main stems/plant in both seasons. These results are in agreement with those obtained by Abo-Sedera and Shehata (1994), Porter *et al.* (2000) and Bari *et al.* (2001).

Table (2): Effect of potassium sources and foliar spray by boron, molybdenum and their interactions on vegetative growth characters of potato during fall seasons of 2002/2003 and 2003/2004.

Treatments	Vegetative growth characters									
	Plant height (cm)		No. of main stems/plant at 90 DAP		Leaf area/plant (cm^2)		Fresh weight/plant (g)		Dry weight (%)	
	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Potassium sources:										
K_2SO_4	40.37	40.87	2.50	3.11	530.93	570.41	275.95	378.08	13.38	14.26
KCL	39.28	40.03	2.50	3.10	481.72	533.59	261.62	364.24	13.27	14.14
L.S.D at 5 %	**2.04**	**1.46**	**N.S**	**N.S**	**27.16**	**31.08**	**22.73**	**20.36**	**0.09**	**0.15**
Foliar treatments:										
B 50 ppm	39.66	40.83	2.46	3.09	478.64	518.69	294.99	391.83	13.14	14.10
B 75 ppm	41.33	41.83	2.51	3.12	525.01	564.69	305.33	407.50	13.23	14.17
Mo 25 ppm	39.00	39.49	2.50	3.07	415.26	454.28	238.83	339.49	13.15	14.00
Mo 50 ppm	40.49	40.99	2.50	3.09	433.96	472.15	240.66	343.16	13.28	14.08
B 50 + Mo 25 ppm	37.99	38.99	2.55	3.12	501.26	539.26	232.83	333.83	13.30	14.17
B 50 + Mo 50 ppm	39.16	39.83	2.49	3.12	508.03	548.56	243.83	346.83	13.37	14.19
B 75 + Mo 25 ppm	39.99	40.33	2.49	3.13	572.85	613.08	290.33	400.50	13.41	14.39
B 75 + Mo 50 ppm	40.99	41.33	2.55	3.14	615.59	705.31	303.50	406.16	13.70	14.50
L.S.D at 5 %	**1.29**	**0.80**	**N.S**	**N.S**	**18.16**	**17.48**	**12.85**	**11.66**	**0.05**	**0.09**
Interaction :										
Foliar Trt. X K_2SO_4										
B 50 ppm	40.66	41.33	2.45	3.10	511.96	551.66	305.33	401.33	13.21	14.16
B 75 ppm	42.00	42.33	2.52	3.12	552.40	592.13	309.33	414.04	13.28	14.25
Mo 25 ppm	39.00	39.66	2.50	3.08	427.73	465.60	241.33	343.33	13.18	14.05
Mo 50 ppm	41.33	41.66	2.50	3.10	458.93	496.61	245.00	348.00	13.31	14.13
B 50 + Mo 25 ppm	38.33	39.33	2.55	3.13	526.10	566.11	244.66	343.33	13.32	14.22
B 50 + Mo 50 ppm	39.33	40.00	2.49	3.12	532.33	572.63	245.00	348.66	13.44	14.23
B 75 + Mo 25 ppm	40.66	41.00	2.51	3.14	597.60	637.56	306.00	410.11	13.48	14.48
B 75 + Mo 50 ppm	41.66	41.66	2.55	3.14	640.43	681.06	311.31	416.00	13.84	14.57
Foliar Trt. X KCL										
B 50 ppm	38.66	40.33	2.47	3.09	445.33	485.73	284.66	382.33	13.08	14.04
B 75 ppm	40.66	41.33	2.51	3.12	497.63	537.26	301.33	401.00	13.19	14.09
Mo 25 ppm	38.50	39.33	2.52	3.07	402.80	442.96	236.33	335.66	13.12	13.96
Mo 50 ppm	39.66	40.33	2.49	3.09	409.00	447.70	236.33	338.33	13.26	14.04
B 50 + Mo 25 ppm	37.66	38.66	2.55	3.11	476.43	512.43	221.02	324.33	13.29	14.13
B 50 + Mo 50 ppm	39.00	39.66	2.50	3.12	483.73	524.51	242.66	345.03	13.31	14.16
B 75 + Mo 25 ppm	39.33	39.66	2.48	3.13	548.10	588.63	274.66	391.20	13.35	14.31
B 75 + Mo 50 ppm	40.33	41.00	2.55	3.14	590.76	729.56	296.12	396.33	13.57	14.43
L.S.D at 5 %	**3.82**	**3.16**	**N.S**	**N.S**	**38.48**	**47.20**	**30.65**	**32.21**	**0.75**	**0.28**

Data in Table (3) indicate that the number of tubers/plant was not significantly affected by using K sources, foliar spray treatments and their interactions. On the other hand, the average of tuber weight and total tuber yield/fed. were increased significantly by K_2SO_4 application during both seasons.

Table (3): Effect of potassium sources and foliar spray by boron, molybdenum and their interactions on yield and its components during fall seasons of 2002/2003 and 2003/2004.

Treatments	Yield and its components					
	No. of tubers/ plant		Average weight of tuber (g)		Total yield (ton/fed.)	
	S1	S2	S1	S2	S1	S2
Potassium sources :						
K_2SO_4	4.63	5.54	133.66	151.99	13.318	13.826
KCL	4.57	5.51	141.20	148.53	12.223	12.419
L.S.D at 5 %	**N.S**	**N.S**	**10.83**	**9.51**	**0.76**	**0.92**
Foliar treatments :						
B 50 ppm	4.68	5.48	112.50	145.00	12.60	12.74
B 75 ppm	4.73	5.58	146.83	152.16	13.00	13.22
Mo 25 ppm	4.43	5.54	134.83	140.66	11.70	12.14
Mo 50 ppm	4.36	5.78	115.33	143.33	12.09	12.40
B 50 + Mo 25 ppm	4.53	5.56	138.83	147.49	12.70	13.15
B 50 + Mo 50 ppm	4.48	5.30	143.99	149.33	13.00	13.36
B 75 + Mo 25 ppm	4.71	5.43	155.00	164.33	13.42	13.85
B 75 + Mo 50 ppm	4.93	5.56	152.16	159.83	13.65	14.07
L.S.D at 5 %	**N.S**	**N.S**	**12.18**	**5.82**	**0.59**	**0.48**
Interaction :						
Foliar Trt. X K_2SO_4						
B 50 ppm	4.70	5.53	93.00	146.00	13.00	13.28
B 75 ppm	4.80	5.63	148.33	154.21	13.60	13.84
Mo 25 ppm	4.51	5.56	135.01	141.33	12.25	12.83
Mo 50 ppm	4.36	5.80	95.00	144.33	12.78	13.10
B 50 + Mo 25 ppm	4.53	5.56	139.66	148.66	13.10	13.82
B 50 + Mo 50 ppm	4.56	5.30	145.66	150.33	13.42	14.00
B 75 + Mo 25 ppm	4.80	5.43	158.13	168.00	14.04	14.76
B 75 + Mo 50 ppm	4.93	5.56	154.66	163.33	14.35	14.98
Foliar Trt. X KCL						
B 50 ppm	4.66	5.43	132.00	144.00	12.20	12.30
B 75 ppm	4.66	5.56	145.33	150.33	12.40	12.60
Mo 25 ppm	4.43	5.53	134.66	140.00	11.15	11.45
Mo 50 ppm	4.31	5.76	135.66	142.33	11.40	11.70
B 50 + Mo 25 ppm	4.61	5.58	138.00	146.33	12.30	12.48
B 50 + Mo 50 ppm	4.41	5.22	142.33	148.33	12.58	12.72
B 75 + Mo 25 ppm	4.63	5.40	152.00	160.66	12.80	12.94
B 75 + Mo 50 ppm	4.83	5.65	149.66	156.33	12.95	13.16
L.S.D at 5 %	**N.S**	**N.S**	**19.79**	**16.49**	**1.05**	**1.12**

The percentage of increment in total tuber yield as affected by K_2SO_4 and KCL application were (8.95 and 11.33 %) in the two seasons, respectively. These results are in accordance with those obtained by Westermann and Tindall (1998) and Davenport and Bentley (2001).

Data in Table (3), indicated that the spraying potato plants with (B 75 ppm + Mo 50 ppm) increased both of tuber weight and total tuber yield as compared with the other treatments. These results are in agreement with those obtained by (Kluge, 1985; Marchand and Schenk, 1985; Kamar and Omar, 1987; Shehata *et al*, 1990; Abo-Sedera and Shehata, 1994; Afkar *et al*, 1995; Lozek and Fecnko, 1996; Bari *et al*, 2001 and Puzina, 2004), who recorded significant increase in tuber weight, tuber size and total yield due to boron or/plus molybdenum application.

With respect to the interactions between K sources and foliar spray treatments, data in Table (3) indicated that foliar spray with (B 75 ppm + Mo 50 ppm) twice and in case of K_2SO_4 application recorded the highest values of average tuber weight and total tuber yield/fed. in both seasons of study. Similar conclusions were obtained by Kamar and Omar (1987) and Porter *et al*. (2000).

Data presented in Table (4) indicated clearly that application K_2SO_4 led to significant increase in the tuber quality parameters i.e. tuber dry matter, starch in tuber and specific gravity of tuber compared with KCL application in both seasons. These results are in harmony with those obtained by Marschner (1995); James *et al*, (1990); Perrenoud (1993); Oktay *et al*, (1997); Panique *et al*, (1997); Westermann and Tindall (1998) and Allison *et al*, (2001).

Regarding the effect of foliar spray treatments on the tuber quality parameters; data in Table (4), indicate that the highest values of tuber dry matter and starch in tuber were recorded by application the foliar spray with (B 75 ppm + Mo 25 ppm), while, specific gravity was significantly increased by using the foliar spray with (B 75 ppm + Mo 25 ppm) or (B 75 ppm + Mo 50 ppm) compared with the other treatments in both seasons. These results in accordance with those achieved by Kluge (1985); Kamar and Omar (1987); Abo-Sedera and Shehata (1994) and Bari *et al*. (2001).

Data in Tables (5&6) reveal that nitrate, nitrite, phosphour, boron and molybdenum in tuber were not significantly affected by neither K_2SO_4 nor KCL application in both seasons of 2003 and 2004. In the same Tables (5&6), the results indicate that application of K_2SO_4 recorded a significant increase in nitrogen, protein and potassium in both seasons of study (Oktay *et al*, 1997).

Concerning with the effect of foliar spray with boron or/plus molybdenum and the interaction with K sources on tuber content of N, protein, NO_3^-, NO_2^-, P, K, B and Mo, the results in Tables (5&6) indicated that spraying potato plants twice at 60 and 75 DAP with (B 75 ppm + Mo 50 ppm) and K_2SO_4 application, recorded the highest values of N, protein, K, B and Mo, yet recorded the lowest concentration of NO_3^- in potato tuber was recorded.

Concentrations of P and NO_2^- were not affected by the foliar spray treatments. These results are in accordance with those obtained by Shorrocks, (1990); Oktay *et al*, (1997); Chairidchai, (2000); Williams *et al*, (2004) and Liu *et al*, (2005).

Table (4): Effect of potassium sources and foliar spray by boron, molybdenum and their interactions on tuber quality parameters during fall seasons of 2002/2003 and 2003/2004.

Treatments	Quality parameters					
	Tuber dry matter (%)		Starch in tuber (%)		Specific gravity	
	S1	S2	S1	S2	S1	S2
Potassium sources :						
K_2SO_4	17.28	17.59	12.89	12.98	1.064	1.067
KCL	17.08	17.35	12.79	12.80	1.060	1.064
L.S.D at 5 %	**0.27**	**0.32**	**0.11**	**0.13**	**0.003**	**0.002**
Foliar treatments :						
B 50 ppm	17.05	17.36	12.74	12.86	1.055	1.065
B 75 ppm	17.26	17.55	12.93	13.03	1.063	1.068
Mo 25 ppm	16.91	17.06	12.47	12.57	1.058	1.062
Mo 50 ppm	16.96	17.27	12.55	12.62	1.058	1.064
B 50 + Mo 25 ppm	17.23	17.54	12.87	12.94	1.064	1.065
B 50 + Mo 50 ppm	17.24	17.55	12.94	12.99	1.064	1.065
B 75 + Mo 25 ppm	17.48	17.82	13.12	13.07	1.065	1.067
B 75 + Mo 50 ppm	17.32	17.64	13.11	13.06	1.065	1.067
L.S.D at 5 %	**0.14**	**0.19**	**0.07**	**0.08**	**N.S**	**N.S**
Interaction :						
Foliar Trt. X K_2SO_4						
B 50 ppm	17.16	17.46	12.79	12.91	1.062	1.066
B 75 ppm	17.36	17.65	13.00	13.08	1.065	1.070
Mo 25 ppm	17.02	17.32	12.52	12.62	1.061	1.064
Mo 50 ppm	17.07	17.38	12.60	12.70	1.060	1.065
B 50 + Mo 25 ppm	17.34	17.64	12.92	13.04	1.066	1.067
B 50 + Mo 50 ppm	17.35	17.66	12.99	13.09	1.066	1.068
B 75 + Mo 25 ppm	17.56	17.92	13.18	13.24	1.067	1.068
B 75 + Mo 50 ppm	17.42	17.74	13.16	13.19	1.066	1.068
Foliar Trt. X KCL						
B 50 ppm	16.94	17.26	12.70	12.82	1.057	1.064
B 75 ppm	17.17	17.45	12.87	12.98	1.061	1.066
Mo 25 ppm	16.81	16.81	12.42	12.52	1.055	1.061
Mo 50 ppm	16.86	17.16	12.50	12.54	1.056	1.062
B 50 + Mo 25 ppm	17.13	17.45	12.83	12.84	1.061	1.062
B 50 + Mo 50 ppm	17.14	17.44	12.89	12.90	1.061	1.062
B 75 + Mo 25 ppm	17.40	17.73	13.06	12.91	1.063	1.066
B 75 + Mo 50 ppm	17.23	17.54	13.07	12.93	1.062	1.061
L.S.D at 5 %	**0.51**	**0.47**	**0.22**	**0.51**	**N.S**	**N.S**

Table (5): Nitrogen, protein, nitrate and nitrite concentrations in dry matter of tuber as affected by potassium sources and foliar spray by boron and molybdenum and their interaction during fall seasons of 2002/2003 and 2003/2004.

Treatments	Chemical analysis of tuber							
	Nitrogen (%)		Protein (%)		Nitrate (ppm)		Nitrite (ppm)	
	S1	S2	S1	S2	S1	S2	S1	S2
Potassium sources:								
K_2SO_4	1.71	1.73	10.74	10.84	25.10	25.10	0.286	0.267
KCL	1.49	1.54	9.35	9.70	25.15	25.20	0.292	0.272
L.S.D at 5 %	0.05	0.04	0.35	0.32	N.S	N.S	N.S	N.S
Foliar treatments:								
B 50 ppm	1.53	1.54	9.57	9.82	42.51	44.54	0.378	0.358
B 75 ppm	1.55	1.60	9.74	10.04	42.53	44.91	0.386	0.374
Mo 25 ppm	1.58	1.63	9.94	10.22	11.28	11.41	0.189	0.139
Mo 50 ppm	1.62	1.67	10.16	10.47	10.81	10.51	0.153	0.118
B 50 + Mo 25 ppm	1.60	1.62	10.01	10.16	35.06	34.23	0.354	0.349
B 50 + Mo 50 ppm	1.60	1.67	10.05	10.47	14.38	13.16	0.228	0.214
B 75 + Mo 25 ppm	1.64	1.63	10.33	10.25	24.99	23.58	0.338	0.334
B 75 + Mo 50 ppm	1.69	1.72	10.60	10.76	19.43	18.86	0.288	0.273
L.S.D at 5 %	0.03	0.02	0.21	0.19	1.09	0.80	N.S	N.S
Interaction :								
Foliar Trt. X K_2SO_4								
B 50 ppm	1.63	1.64	10.21	10.27	42.46	44.53	0.376	0.353
B 75 ppm	1.68	1.70	10.52	10.63	42.50	44.80	0.383	0.373
Mo 25 ppm	1.71	1.72	10.71	10.78	11.40	11.43	0.186	0.136
Mo 50 ppm	1.75	1.76	10.95	11.00	10.93	10.50	0.153	0.116
B 50 + Mo 25 ppm	1.70	1.72	10.63	10.79	34.83	34.20	0.353	0.346
B 50 + Mo 50 ppm	1.71	1.77	10.69	11.11	14.36	13.16	0.226	0.213
B 75 + Mo 25 ppm	1.76	1.72	11.04	10.82	24.96	23.40	0.333	0.333
B 75 + Mo 50 ppm	1.80	1.82	11.24	11.38	19.36	18.83	0.283	0.270
Foliar Trt. X KCL								
B 50 ppm	1.43	1.45	8.94	9.37	42.56	44.56	0.380	0.363
B 75 ppm	1.43	1.51	8.96	9.46	42.56	45.03	0.390	0.376
Mo 25 ppm	1.46	1.54	9.17	9.66	11.16	11.40	0.193	0.143
Mo 50 ppm	1.49	1.59	9.37	9.94	10.70	10.53	0.153	0.120
B 50 + Mo 25 ppm	1.50	1.52	9.39	9.54	35.31	34.26	0.356	0.353
B 50 + Mo 50 ppm	1.50	1.57	9.42	9.84	14.40	13.16	0.230	0.216
B 75 + Mo 25 ppm	1.53	1.54	9.62	9.68	25.03	23.76	0.343	0.336
B 75 + Mo 50 ppm	1.59	1.62	9.97	10.14	19.50	18.90	0.293	0.276
L.S.D at 5 %	0.24	0.14	0.52	0.46	3.07	1.74	N.S	N.S

Table (6): P, K, B and Mo concentrations in dry matter of tuber as affected by potassium sources and foliar spray application by boron and molybdenum and their interaction during fall seasons of 2002/2003 and 2003/2004.

Treatments	Chemical analysis of tuber							
	P (%)		K (%)		B (ppm)		Mo. (ppm)	
	S1	S2	S1	S2	S1	S2	S1	S2
Potassium sources:								
K_2SO_4	0.294	0.329	2.43	2.62	29.17	30.91	13.09	13.68
KCL	0.284	0.324	2.25	2.47	29.12	30.92	13.09	13.62
L.S.D at 5 %	**N.S**	**N.S**	**0.11**	**0.12**	**N.S**	**N.S**	**N.S**	**N.S**
Foliar treatments :								
B 50 ppm	0.281	0.312	2.36	2.56	32.59	33.39	7.36	7.78
B 75 ppm	0.288	0.320	2.45	2.64	34.43	36.23	7.73	8.63
Mo 25 ppm	0.278	0.307	2.18	2.38	21.62	24.54	13.15	13.40
Mo 50 ppm	0.286	0.312	2.21	2.43	21.63	24.57	16.14	17.40
B 50 + Mo 25 ppm	0.292	0.321	2.24	2.44	26.83	28.65	13.28	13.41
B 50 + Mo 50 ppm	0.295	0.323	2.30	2.54	28.06	29.64	16.72	17.40
B 75 + Mo 25 ppm	0.303	0.353	2.40	2.64	33.33	33.92	13.59	13.47
B 75 + Mo 50 ppm	0.290	0.368	2.57	2.74	34.68	36.38	16.76	17.76
L.S.D at 5 %	**N.S**	**N.S**	**0.06**	**0.07**	**0.32**	**0.36**	**0.36**	**0.40**
Interaction :								
Foliar Trt. X K_2SO_4								
B 50 ppm	0.284	0.314	2.47	2.67	32.69	33.42	7.37	7.80
B 75 ppm	0.296	0.323	2.57	2.76	34.43	36.22	7.74	8.63
Mo 25 ppm	0.280	0.309	2.27	2.42	21.59	24.54	13.18	13.41
Mo 50 ppm	0.291	0.315	2.30	2.48	21.64	24.54	16.00	17.41
B 50 + Mo 25 ppm	0.293	0.324	2.33	2.50	26.99	28.63	13.29	13.42
B 50 + Mo 50 ppm	0.296	0.326	2.39	2.59	28.08	29.62	16.73	17.58
B 75 + Mo 25 ppm	0.306	0.356	2.42	2.73	33.36	33.93	13.60	13.48
B 75 + Mo 50 ppm	0.309	0.371	2.72	2.86	34.69	36.39	16.83	17.78
Foliar Trt. X KCL								
B 50 ppm	0.278	0.310	2.26	2.46	32.48	33.37	7.36	7.77
B 75 ppm	0.281	0.317	2.33	2.53	34.43	36.25	7.73	8.63
Mo 25 ppm	0.277	0.306	2.10	2.34	21.66	24.55	13.12	13.39
Mo 50 ppm	0.282	0.310	2.13	2.38	21.63	24.60	16.29	17.41
B 50 + Mo 25 ppm	0.292	0.319	2.16	2.38	26.67	28.68	13.27	13.40
B 50 + Mo 50 ppm	0.294	0.321	2.22	2.49	28.05	29.66	16.71	17.23
B 75 + Mo 25 ppm	0.300	0.350	2.38	2.56	33.31	33.92	13.59	13.47
B 75 + Mo 50 ppm	0.272	0.366	2.42	2.62	34.68	36.37	16.69	17.74
L.S.D at 5 %	**N.S**	**N.S**	**0.16**	**0.14**	**0.86**	**0.75**	**1.14**	**1.08**

In conclusion, this study demonstrated that is possible production of high potato tubers yield with good quality could be obtained by adding K_2SO_4 at the recommend rate with foliar spray of (B 75 ppm + Mo 50 ppm) twice at 60 and 75 DAP, moreover, potato tuber with lower concentration of nitrate could be produced.

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إستجابة نباتات البطاطس لمصادر مختلفة من البوتاسيوم مع معدلات رش مختلفة من البورون والموليبدنم

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أجريت تجربتان حقليتان ناجحتان خلال موسمين خريفيين ٢٠٠٢/٢٠٠٣ ، ٢٠٠٣/٢٠٠٤ على صنف البطاطس إسبونتا بقرية الزهراء – المنصورة – محافظة الدقهلية – مصر وذلك لدراسة تأثير مصدرين من البوتاسيوم (السلفات والكلوريد) بالمعدل الموصى به وكذلك معدلات رش ورقى مختلفة من البورون (٥٠ ، ٧٠ جزء/المليون) والموليبدنم (٢٥ ، ٥٠ جزء/المليون) مرتين عند عمر ٦٠ ، ٧٥ يوم من الزراعة ، بالإضافة إلى تفاعلاتهم على صفات النمو الخضرى ، جودة الدرنات ، محتوى الدرنة من العناصر ومحصول الدرنات الكلى . وقد أوضحت النتائج بصفة عامة أن إستخدام سلفات البوتاسيوم كان أكثر تأثيراً من كلوريد البوتاسيوم على قياسات النمو الخضرى ، صفات جودة الدرنة والمحصول ومكوناته .

أدى إستخدام سلفات البوتاسيوم إلى إنتاج أعلى محصول كلى للدرنات بزيادة قدرها (٨,٩٥ – ١١,٣٣ %) عن إستخدام كلوريد البوتاسيوم وذلك خلال موسمى الدراسة على التوالى .

أدى إستخدام الرش الورقى لنباتات البطاطس بـ (البورون بمعدل ٧٥ جزء/المليون + الموليبدنم بمعدل ٥٠ جزء/المليون) مرتين عند ٦٠ ، ٧٥ يوم من الزراعة إلى زيادة معنوية لمعظم صفات النمو الخضرى كما ساهم فى تحسين قياسات جودة الدرنة مثل المادة الجافة ، النشا ، الكثافة النوعية والبروتين بالدرنة .. كذلك أعطت زيادة معنوية فى وزن الدرنة والمحصول الكلى للدرنات مقارنة بباقى المعاملات خلال موسمى الدراسة .

بصفة عامة أدت إضافة سلفات البوتاسيوم للتربة مع رش نباتات البطاطس مرتين بعد ٦٠ ، ٧٥ يوم من الزراعة بالبورون والموليبدنم معاً بمعدل (٧٥ جزء/المليون + ٥٠ جزء/المليون) بالترتيب إلى تسجيل أقصى قيم للقياسات الخضرية للنبات وتحسين صفات جودة الدرنات وأعلى محصول درنات للفدان ، من ناحية أخرى أعطت أقل تركيز للنيترات بدرنة البطاطس .