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EFFECT OF APPLICATION METHODS OF POTASSIUM AND SOME MICRONUTRIENTS ON YIELD AND QUALITY OF POTATO

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ABSTRACT

Two field experiments were carried out at Ali Moubark Agric., Res. Station during two successive seasons 2007/2008and 2008/2009 on potato cv. Diamant to study the vegetative growth characters, tuber quality, tuber minerals content and total tuber yield as affected by the application methods of K-fertilizer (soil application, foliar application and soil + foliar application, either single and /or in combination with foliar application of zinc or manganese or boron) three times during plant growth i.e. at 45, 60 and 75 DAP.

Almost all the parameters of the potato plants which received 50% soil application K-fertilizer + 50% foliar application significantly increased as compared with other application methods.

On the other hand, most vegetative growth parameters were significantly increased by foliar spraying of potato plants with micronutrients and led to improve the tuber quality parameters i.e. all carbohydrate fractions, the protein of tuber, the tuber weight and total tuber yield as compared with the control.

In general, application of K-fertilizer as 50% of the recommended rate used as soil application + 50 % of that added as foliar application in combination with foliar spray of micronutrients recorded maximum values of plant growth parameters, improved tuber quality characters and obtained highest tuber yield/fed. Therefore, this treatment could be recommended for raising potato yield and improving tuber quality and reducing the productive cost under similar conditions.

INTRODUCTION

Potato is one of the most important vegetable crops all over the world. In Egypt the policy of the country aims to improve potato production so as to meet the increasing demand of the local consumption and to increase the amount of potato for exporting. Fertilization especially with potassium is considered as one of the most important factors affecting the growth and the yield of potato.

Potassium is an essential element for all living organisms. In plants, it is an important cation involved in physiological pathways (Beringer *et al*., 1983; Duke and Collins, 1985 and Stedle, 1994). In particular, the ability of ATPases in membranes to maintain active transport is highly dependent on adequate K supply. Thus, efficient cell development and growth of plant tissues, translocation, storage of assimilates and other internal function, which are based on many physiological, biochemical and biophysical interaction, require adequate K in the cell sap (Marschner, 1995 and Ruggiero *et al*., 1999).

Potassium is an essential element and plays an important role in protein and starch formation, activation of many enzymes, cations, anions balance, cell extension and osmoregulation (Marschner, 1995).

Potassium application is more effective for improving vegetative plant parameters, tuber quality and tuber yield. Davenport and Bently (2001) indicated that using K_2SO_4 fertilizer usually gives a higher dry matter and starch content of tuber, and increased the contents of total soluble sugars fractions, starch and total carbohydrates in potato tubers.

Micronutrients play a very important role in vital processes of plants. They increase the chlorophyll content of leaves, improve photosynthesis which intensify the assimilating activity of the whole plants (Marschner, 1995). Spray of micro-element solution (B,Cu, Mn, Zn and Mo) on potato leaves increased the uptake of N, P, K, content of chlorophyll and photosynthesis in leaves, promote the expansion of tuber and increase potato yield (Meng *et al*., 2004).

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). 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).

As for the effect of manganese on potato growth, yield and quality of potato Radwan and Tawfik 2004 stated that increasing concentrations of manganese added as foliar application to certain limit, significantly increased potato vegetative growth, total yield, tuber weight, and tuber quality.

In a study on potato crop, El-Morsy *et al*. (2006) indicated that foliar spray of zinc increased significantly the total tubers yield, tuber dry matter and tuber content of zinc and protein.

The objective of the present work was to study the influence of application methods of K-fertilizer, either single or in combination with foliar application of zinc, or manganese or boron on the growth, productivity, yield characters and quality of potato plants under sandy soil conditions.

MATERIALS AND METHODS

Two field experiments were conducted in sandy soil at Ali Moubark Experimental farm, Moderitt El-Tahrir, Egypt, during two successive winter seasons of 2007/2008 and 2008/2009 to study the influence of application methods of K-fertilizer, either single or in combination with foliar application of zinc,or manganese or boron on the growth, productivity, yield characters and quality of potato plants cv. Diamant. The physical and chemical properties of the experimental site are presented in Table (1).

Potato tubers cv. Diamant was planted on October in the first season and on November in the second one respectively.

A split-plot design with three replicates was used. Potassium application methods occupied the main plots; while different foliar sprays with the micronutrients were allocated in the sub-plots. Each experiment included 12 treatments.

a-Potassium application methods

1- Soil application, full recommended rate of K-fertilizer(96kg K_2O/fed as potassium sulphate 48% K_2O) was added in two equal doses 45 and 60 days after planting (DAP)
2- Foliar application of 2%K_2O solution (as potassium sulphate 48%K_2O) added in four times 45, 60, 75 and 90 days after planting in the rate of 400L/fed in each.
3- 50% soil application (48% kg K_2O) + 50% foliar application of 2% K_2O (as potassium sulphate 48% K_2O), in two times at 45 and 60 days after planting in the rate of 400L/fed in each.

b- Micronutrients

The micronutrients of Zn or Mn or B were sprayed individually three times during plant growth i.e., at 45, 60 and 75 days after planting. The sub-plots treatments were as follow:

1- control
2- Zn 100 ppm
3- Mn 100 ppm
4- B 75 ppm

The corresponding sources were Zn -EDTA, Mn-EDTA, and Borax

Each subplot consisted of 4 ridges 3.5m long and 0.75 m apart occupying an area of 10.5m^2 all the plants were fertilized with 180 kg N /fed in the form of ammonium sulphate (20.5%N). Nitrogen was added at three equal portions, the 1st was applied after emergence, then two and four weeks later. Phosphorus was applied during the soil preparation in the form of calcium superphosphate (15%P_2O_5) at the rate of 75 kg P_2O_5/ fed.

Data recorded:

1- Vegetative growth

10 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 and dry weight (g)/plant.

2-Tubers yield, quality and their components:

At harvest (120DAP) the following: items were determined, number of tubers/plant, average of tuber weight (g) and tuber yield (Ton/fed), dry matter (%), specific gravity.

Specific gravity of tuber was estimated by the following formula according to Murphy and Govern(1959)

$$SG = \frac{\text{Tuber weight in the air}}{\text{Tuber weight in the air} - \text{Tuber weight in the water}}$$

3- Chemical determinations:

Tuber parts were dried at 70 ˚C for 48 h and then wet digested using sulphuric and perchloric acids mixture according to Chapman and Pratt (1961). Nitrogen was determined by micro-Kjeldahl method. Phosphorus was determined calorimetrically and potassium was determined by using a flame photometer as described by Jackson (1967). Protein content in tuber dry matter was calculated. Zinc, manganese and boron concentration were determined in the digested dry matter of tuber according to Rangana methods (1979). Carbohydrate fractions were determined in tuber according to the method described by Miller (1959).

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

Table (1): Some physical and chemical properties of the used soil

Property	Value	Property	Value
Physical analysis		**Soluble cations (meq/100g soil)**	
Sand%	93.22	Ca^{++}	0.75
Silt %	3.17	Mg^{++}	0.22
Clay %	3.61	Na^{+}	0.11
Texture class	Sandy	K^{+}	0.33
Chemical analysis		**Soluble anions (meq/100g soil)**	
OM%	0.30	Cl^{-}	0.69
pH (1:2.5)	7.95	HCO_3^{-}	0.34
EC (dSm^{-1})	0.23	$SO_4^{=}$	0.38
		$CO_3^{=}$	--

RESULTS AND DISSCUSSION

1-Vegetative growth characters

1-1. Effect of k-fertilizer application methods

Data presented in Table (2) show that plant height, No. of leaves/plant, foliage fresh weight/plant and foliage dry weight/plant were significantly increased with the plants received 50% of recommended K-fertilizer rate as a soil application +(16 kg K_2O/fed.) foliar application as compared with other treatments except No. of main stems/plant, which had an insignificant. This increase may be attributing to the main role of potassium in meristimatic activity of plant cells and its role in many processes in plant cells. El-Sawy *et al*. (2000b), Allison *et al*. (2001) and Saha *et al*. (2001) confirmed these results.

The favorable effect of potassium on vegetative growth may be due to that potassium is an essential element for growing plants, where it plays an important role in protein and starch formations, activation of many enzymes, cations - anions balance, cell extension and osmoregulation (Marschner, 1995).

1- 2 Effect of micronutrients:

The results in Table (2) indicated that the vegetative growth characters of potato plants were significantly increased with foliar spraying by micro-nutrients Zn or Mn or B. whereas, No. of main stems/plant was not affected with foliar spraying by micronutrients. These results could be attributed to the effective role of such micronutrients in controlling various enzymes activities and photosynthetic pigments formation, consequently affecting plant growth (Devlin and Witham, 1993). The obtained results are in harmony with those reported by Bari *et al.* (2001) and Abdel-Fattah *et al*. (2002).

The enhancement effect of manganese on vegetative growth of potato may be due to that manganese plays an important roles in carbohydrates, lipids, chlorophyll and lignin formations, activation of several enzymes especially superoxide dismutase and cell division and extension (Marschner, 1995). Zn element has a promoting effects on the growth regulators and enzymes, enzymatic activities, photosynthetic processes as well synthesis of protein, carbohydrates and libieds (Marschner, 1995). Also, boron is an essential for cell division and helps in nitrogen absorption, (Abo-Sedera and Shehata, 1994 and Bari *et al*., 2001).

Table (2): Effect of potassium application methods and micronutrients on vegetative growth characters of potato plants (Combined analysis of 2007/2008 and 2008/2009 seasons)

Application methods	Micro-nutrients	Plant height (cm)	No. of main stems/plant	No. of leaves/plant	Foliage of fresh weight/plant (g)	Foliage dry weight/plant (g)
Soil application	0	60.8	3.0	52.00	319.70	24.61
	Zn	65.5	4.33	59.67	342.21	30.62
	Mn	64.3	3.33	56.33	333.53	26.93
	B	62.7	3.67	58.67	336.50	28.86
	Mean	63.33	3.58	56.67	332.99	27.76
Foliar application	0	55.4	2.67	49.00	301.62	22.52
	Zn	62.6	3.67	56.67	331.20	28.29
	Mn	59.7	3.67	53.00	316.14	24.80
	B	57.3	3.67	55.33	327.53	26.62
	Mean	58.75	3.42	53.50	319.12	25.56
Soil + foliar application	0	62.2	3.33	57.33	326.80	27.33
	Zn	69.1	4.67	65.33	355.92	35.82
	Mn	68.3	3.67	60.00	335.85	30.43
	B	64.6	4.33	63.67	339.30	32.61
	Mean	66.05	4.00	61.58	339.47	31.55
Average of micro-nutrients	0	59.45	3.00	52.78	316.04	24.82
	Zn	65.73	4.22	60.56	343.11	31.58
	Mn	64.1	3.56	56.44	328.51	27.39
	B	61.53	3.89	59.22	334.44	29.36
L.S.D (0.05) For						
a-application method		0.821	n.s	1.306	3.12	0.885
b-micronutrients		1.329	n.s	0.800	4.06	1.324
a x b		n.s	n.s	n.s	6.51	n.s

1-3 Effect of interaction between K-application methods and micronutrients:

It is obvious from the same data in Table (2) that all vegetative growth characters are not affected by interactions, except the foliage of fresh weight/plant. In general, plants received 50% K-fertilizer rate as (soil application) + 50% of that added as foliar application which sprayed by micronutrients gave the highest values of plant growth followed by the soil application method with the same treatment of micronutrients.

2-Yield and its components

2-1 Effect of K-fertilizer application methods:-

Data in Table (3) indicated that No. of tuber/plant, average weight of tuber, tuber weight/plant and tuber yield were significantly increased with application methods of K-fertilizer. Quality of tubers expressed as dry matter content and specific gravity showed a positive response to potassium fertilizer, where the highest values were recorded with the plants received 50% K-fertilizer rate as a soil application + 50% of which used as foliar application.

Table (3): Effect of potassium application methods and micronutrients on potato yield and its components (Combined analysis of 2007/2008 and 2008/2009 seasons)

Application methods	Micro-nutrients	No. of tuber/plant	Average weight of tuber (g)	Tuber weight/plant (g)	Tuber yield Ton/fed.	Tuber dry matter (%)	Specific gravity
Soil application	0	4.67	106.65	498.06	13.54	22.61	1.03
	Zn	6.00	114.43	686.58	15.55	23.29	1.07
	Mn	5.33	110.02	586.41	14.59	22.70	1.04
	B	5.67	112.54	638.10	14.72	23.02	1.05
	Mean	5.42	110.91	602.29	14.6	22.91	1.05
Foliar application	0	4.33	98.31	425.68	13.32	21.75	1.02
	Zn	5.67	107.87	611.62	14.92	22.15	1.05
	Mn	5.00	100.30	501.50	13.99	21.99	1.03
	B	5.33	103.52	551.81	14.59	22.13	1.04
	Mean	5.08	102.50	522.65	14.21	22.01	1.04
Soil + foliar application	0	5.00	110.53	552.65	14.00	23.75	1.04
	Zn	6.33	119.35	755.49	16.32	24.37	1.07
	Mn	5.67	113.71	644.74	15.09	23.92	1.06
	B	6.00	116.76	700.56	15.42	24.03	1.07
	Mean	5.75	115.09	663.36	15.21	24.02	1.06
Average of micro-nutrients	0	4.67	105.16	492.13	13.62	22.70	1.03
	Zn	6.00	113.88	684.56	15.60	23.27	1.06
	Mn	5.33	108.01	577.55	14.56	22.87	1.04
	B	5.67	110.94	630.16	14.91	23.06	1.05
L.S.D (0.05) For							
a-application method		0.43	3.15	4.884	0.45	0.051	0.013
b-micronutrients		n.s	4.91	7.805	0.555	0.068	n.s
a x b		n.s	n.s	8.309	n.s	0.091	n.s

Potassium increased the average tuber weight and number of tubers/plant resulting in high total yield. This effect might be due to the fact that potassium plays an important role in the transport of assimilates and nutrients (Mengel, 1997). It was added that potassium promotes phloem transport of photosynthates (mainly sucrose and amino acids) to the physiological sinks of the tuber. In addition, Marschner (1995) reported that potassium has a crucial role in the energy status of the plant, translocation and storage of assimilates and maintenance of tissue water relations. Other workers found significant tuber yield response to K-fertilizeration (Westermann *et al*., 1994 a, Panique *et al*., 1997, Saha *et al*., 2001 and Khandakhar *et al*., 2004). They found that application of potassium increased CO_2 assimilation and photosynthetic rate. Moreover application of K increased photosynthesis translocation from the upper parts of plant to be accumulated in the tubers (El-Sawy *et al*., 2000b).

Effect of micronutrients:-

Data in Table (3) indicated that total yield and its components, except No. of tuber/plant and specific gravity were better with spraying the plants with micronutrients. These increases might be ascribed to the favorable role of the used micronutrients in pigments formation, photosynthesis activation and carbohydrates assimilation diverted to the tuber which represent to economic part of plant (Marschner, 1995, Srivastava and Gupta, 1996). These results are in correspondence with those obtained by Sarma *et al*.

(2005). Abd El-Maksoud *et a*l.(1993) and Sahu *et al*. (1994) who found that the sprayed zinc with NPK increased dry matter of plants (Lozek and Fecnko, 1996, Bari *et al*. 2001 and Puzina, 2004), who recorded a significant increase in tuber weight, tuber size and total yield This increase was observed due to spray with boron or Mn. The more absorbed Zn, Mn and B enhanced chlorophyll synthesis reflecting in stimulating assimilation and accumulation of carbohydrates, which improved both plant growth and yield.

2-3 Effect of interaction between K-application method and micronutrients

It is clear from Table (3) that there were significant interactions between application methods of K-fertilizer and micronutrients on tuber weight/plant and tuber dry matter, whereas the No. of tuber/plant, average weight of tuber, tuber yield and specific gravity were not significantly influenced. In general, plants fertilized by (K-fertilizer as soil + foliar application) and sprayed with micronutrients produced the highest values. These results are coincided with those obtained by El-Sawy *et al*. (2000b) and Porter *et al*. (2000).

3-Chemical constituents

3-1 Effect of K-fertilizer application methods

Data in Table (4) evident show that application methods of K-fertilizer had a significant effect on N, P, K, protein and micronutrients (Zn, Mn and B). All elements concentrations and protein content were significantly increased with soil+foliar application followed by soil application one. Marschner (1995) reported that adding K enhances N uptake and this may explain the increment in vegetative growth. The increment in P concentration may be attributed to the role of K-fertilizer on the growth and dry matter accumulation and uptake of phosphate. In addition, potassium fertilizer, generally enhanced K concentration in tuber. The increment in K concentration by potassium addition is expected due to the increase in K uptake and accumulation. These results are in agreement with those Davenport and Bentley (2001) and Mohamed *et a*l., (2001). This effect might be due to the fact that potassium play an important role in the transport of assimilates and nutrients.

3-2 Effect of micronutrients

Data in Table (4) showed that most nutrients and protein % in tuber were significantly increased due to spraying the plants with Zn or Mn or B comparing with the untreated plants.

As previously mentioned, Garcia-Gonzalez *et al*. (1991) reported that boron plays an important role in N-fixation through nitrogenase activity. Boron deprived plants have less nitrogenase activity and less nitrogen or crude protein. In contrast, foliar spray of boron; leads to the enhancement of N-fixation with rise in nitrogenase activity and consequently increasing N and crude protein concentration. Also, the effect of micronutrients on all elements of potato plants can be discussed on the basis of its effective role on plant growth and enzymatic functions and consequently increased the absorbing efficiency of plants. Similar results are obtained by El-Shafie (1994), Mahgoub(1995), Meng *et al*. (2004) and El-Morsy *et al*. (2006).

Table (4): NPK contents and micronutrients in potato tubers at harvest as affected by potassium application methods and micronutrients(Combined analysis of 2007/2008 and 2008/2009 seasons)

Application methods	Micro-nutrients	N %	Protein %	P %	K %	Zn ppm	Mn ppm	B ppm
Soil application	0	1.79	11.19	0.31	2.25	29	19	24
	Zn	1.86	11.63	0.35	2.38	40	22	27
	Mn	1.82	11.38	0.34	2.33	34	26	28
	B	1.89	11.81	0.33	2.30	33	24	35
	Mean	1.84	11.50	0.33	2.32	34	22.75	28.50
Foliar application	0	1.76	11.0	0.30	1.95	28	18	23
	Zn	1.80	11.25	0.32	1.98	36	21	26
	Mn	1.78	11.13	0.31	1.96	32	24	24
	B	1.85	11.56	0.30	1.95	30	20	34
	Mean	1.80	11.24	0.31	1.96	31.5	20.75	26.75
Soil + foliar application	0	1.83	11.44	0.32	2.36	30	21	24
	Zn	1.90	11.88	0.35	2.44	44	23	27
	Mn	1.88	11.75	0.33	2.40	32	28	29
	B	1.97	12.31	0.34	2.42	33	25	36
	Mean	1.90	11.85	0.34	2.41	34.75	24.25	29
Average of micro-nutrients	0	1.79	11.21	0.31	2.19	29.0	19.33	23.67
	Zn	1.85	11.59	0.34	2.27	40.00	22	26.67
	Mn	1.83	11.42	0.33	2.23	32.67	26	27.00
	B	1.90	11.89	0.32	2.22	32.00	23	35.00
L.S.D (0.05) For								
a-application method		0.027	0.173	0.015	0.028	1.368	0.999	1.498
b-micronutrients		0.029	0.184	n.s	n.s	2.77	1.386	1.585
a x b		n.s	n.s	n.s	n.s	2.90	n.s	n.s

3-3 Effect of interaction between K-application method and micronutrients

It is obvious from data in Table (4) that the interaction between application methods of K-fertilizer and micronutrients had insignificant effect on all chemical concentration and protein. The highest values of all elements and protein% in tuber were recorded when K-fertilizer added as soil + foliar application and sprayed micronutrients. Similar results were obtained by Lozek and Fecnko (1996) and Meng *et al*. (2004).

3-4 Soluble, non-soluble, total carbohydrate and starch

Data presented in Table (5) showed the effect of potassium application and micronutrients on soluble, non-soluble, total carbohydrate and starch content of tubers at harvesting are Soluble, non-soluble, total carbohydrate and starch contents increased with soil + foliar application treatment in comparison with other ones. That means that the addition of potassium as foliar combined with soil K-application plays an important role in enhancing metabolic processes such as photosynthesis, starch synthesis and synthesis of protein (Ahmed and Zeidan, 2001). Potassium is required in plants for the synthesis of simple sugars and starch and translocation of carbohydrate from the leaves to tubers (El-Sawy *et al*., 2000). These results are in agreement with those reported by Shehata *et al*. (1990) and Lu-Jinwei *et al*. (2001). They emphasized the role of potassium in carbohydrate metabolism, promotion and translocation of starch. Also, spraying plants with micronutrients increased soluble, non-soluble, total carbohydrate and starch contents of tubers compared to plants fertilization with potassium only. The increments in starch contents of tuber might be attributed to the importance of micro-elements in carbohydrate metabolism, raising the intensity of photosynthesis and the activity of oxidation/reduction enzymes as mentioned by Bari *et al*. (2001). Katyal and Randhawa (1983) mentioned that boron facilitates the transport of carbohydrates through cell membranes. Thus, maximum production of starch and sugar is restricted if crops are inadequately supplied with B. Parr and Loughman (1983) postulated that boron is involved in a number of metabolic pathways sugar transport, respiration, carbohydrate, RNA, IAA and phenol metabolism or a cascade effect which is known for phyto-hormones. Also, the previous results could be related to the presence of zinc, which play an important role by activating several enzymes and hence the metabolic activities, viz auxin metabolism, protein synthesis, nucleic acid and carbohydrate metabolism and utilization of N and P (Khanda and Dixit, 1995). In this study, foliar spray of Mn resulted in the highest content of tuber carbohydrates.

Table (5): Effect of potassium application methods and micronutrients on tuber quality, (soluble, non-soluble, total carbohydrate and starch %)(Combined analysis of 2007/2008 and 2008/2009 seasons)

Application methods	Micro-nutrients	S.C	N.S.C	T.C	Starch (%)
Soil application	0	2.33	68.07	70.40	61.26
	Zn	3.65	71.77	75.42	64.59
	Mn	3.35	71.20	74.25	64.08
	B	4.72	72.28	77.00	65.05
	Mean	3.51	70.83	74.34	63.75
Foliar application	0	2.25	67.06	69.31	60.35
	Zn	3.19	70.21	73.40	63.19
	Mn	3.32	69.12	72.44	62.21
	B	4.71	69.83	74.54	62.85
	Mean	3.37	69.06	72.42	62.15
Soil + foliar application	0	2.62	69.70	72.32	62.73
	Zn	3.57	73.52	77.09	66.17
	Mn	4.02	71.78	75.80	64.60
	B	5.42	72.42	77.84	65.18
	Mean	3.91	71.86	75.76	64.67
Average of micro-nutrients	0	2.40	68.28	70.68	61.45
	Zn	3.47	71.83	75.30	64.65
	Mn	3.56	70.70	74.26	63.63
	B	4.95	71.51	76.46	64.36
L.S.D (0.05) For					
a-application method		0.029	0.051	0.062	0.047
b-micronutrients		0.035	0.063	0.069	0.0576
a x b		0.062	0.073	0.0901	0.087

From the above results, it could be noticed that there was a close relationship between the micronutrients, carbohydrates content in tuber. The more absorbed Zn, Mn and B enhanced chlorophyll synthesis reflecting in stimulating the assimilation and accumulation of carbohydrates which improved plant growth and yield.

It could be concluded that, using 50% of the recommended K-rate as soil application +50% of which used as foliar application combined with some micronutrients are the recommended treatments for increasing potato yield, improving tuber quality of potato and reducing cost production (as a result of saving one third of the recommended K-rate used as soil application) under similar condition of this work.

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تـأثير طـرق اضـافة البوتاسـيوم والـرش بـبعض العناصـر الصـغرى علـى جـودة ومحصول البطاطس

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اجريـت تجـربتين حقليتـين فـى محطـة بحـوث علـى مبـارك خـلال موسـمى الزراعـة الشـتويين ٢٠٠٨/٢٠٠٧ ، ٢٠٠٩/٢٠٠٨ على نبـات البطـاطس صـنف ديامونـت لدراسـة تـأثير طـرق اضـافة السماد البوتاسـى (اضـافة ارضـية ، اضـافة بـالرش، ٥٠% أرضـى +٥٠%رش كل منـه منفردا أو مشـترك مـع بعض العناصـر الصـغرى مثل الزنـك أوالمنجنيز أوالبورون والتـى رشت ثلاث مرات خلال مراحل نمو النباتات (٤٥، ٦٠، ٧٥) يوم من الزراعة على قياسـات النمو الخضـرى ، صـفات جودة الدرنة والمحصول ومكوناتة.

ويمكن تلخيص النتائج المتحصل عليها فيما يلى:

- أدت اضافة البوتاسيوم بطريقة ٥٠%أرضى + ٥٠%رش بمحلول البوتاسيوم الى حدوث زيادة معنوية فى معظم صفات النمو الخضرى للنباتات وكذلك المحصـول الكلـى ومكوناتـة مقارنة مع طرق الاضافة الاخرى.
- ومن ناحيـة اخرى أدى رش النباتـات بالعناصـر الصـغرى (زنـك أو منجنيزأوبـورون) الـى حدوث زيادة معنوية فى معظم صفات النمو الخضرى كما ساهم فى تحسين قياسـات جـودة الدرنـة مثـل المـادة الجافـة، النشـا، البـروتين بالدرنـة وكذلك زيـادة معنويـة فـى وزن الدرنـة والمحصول الكلى للدرنات مقارنة مع معاملة الكنترول.
- التفاعلات بين طـرق اضـافة البوتاسيوم والـرش بالعناصـر الصـغرى لوحظـت فـى حـالات كثيرة

وبصفة عامة كانت أفضل النتائج هـى طـرق اضـافة البوتاسيوم ٥٠%أرضـى +٥٠% رش مـع الـرش بالعناصـر الصـغرى حيـث أدت الـى تسـجيل اقصـى قـيم للقياسـات الخضـرية للنبـات وتحسـين صفات جودة الدرنات وأعلى محصول درنات للفدان.

وبناء على ما تقدم يمكن التوصية باستخدام هذه المعاملـة لرفـع انتاجيـة البطـاطس وتحسـين جودة الدرنات وكذلك تقليل تكاليف الانتاج تحت الظروف المشابهه لظروف هذا البحث.

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