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EFFECT OF FOLIAR-SPRAYED WITH CALCIUM AND SOME MICRONUTRIENTS ON POTATO PRODUCTION, AND QUALITY

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ABSTRACT

The main purpose of this work was to study the effect of foliar nutrition with calcium and some micronutrients (Fe, Zn, Mn) on potato (*Solanum tuberosum*, L.) production and quality. Two successive field experiments were conducted at Met-Antar village Talkha, Dakahlia Governorate, during the two summer seasons of 2000 and 2001. The experimental design was a split plot with four replications.

The obtained results show marked and significant increases in tuber yield per fed. with foliar spraying treatments.

Foliar spraying by calcium and micronutrients caused also increases in N, P, K and Ca percentage in leaves during the two seasons. The results indicate that Fe, Zn and Mn content in potato leaves were increased with foliar spraying by Fe, Zn and Mn separately or together.

There was a tendency towards increasing N, P and K content in tubers with foliar spraying by Ca, Fe, Zn and Mn separately or together.

As for specific gravity of potato, foliar spraying by Ca and micronutrients caused an obvious reduction in the two seasons. On the other hand, starch content in potato tuber was not affected by foliar spraying.

Keywords: Foliar fertilization, calcium, micronutrient, potato, yield, quality.

INTRODUCTION

Potato (*Solanum tuberosum*, L.) is one of the most important vegetable crop not only in Egypt, but also all over the word. It is the third export crop, preceded only by cotton and rice in Egypt. Potato yield per feddan may be increased by many factors including the application of suitable nutrition. Veleuthambi and Poovaiah (1984) indicated that foliar application of calcium activated a number of enzymes which including cyclic nucleotide phosphodiesterase and membrane bound Ca^{2+}-ATPase.

Tandon (1992) stated that, calcium is a part of the architecture of cell walls and membranes, is involved in cell-division, growth, root lengthening and activation or inhibition of enzymes.

Karmakar *et al.* (1988) found that foliar spray of agromin (a chelated mixture of Zn, Fe, Cu, Mg, Mo and B) gave the highest average yields of 20.63-21.57 t/ha compared with 16.15 t/ha without trace elements. Stashauskaite *et al.* (1979) found that Mn increased the shoot: tuber ratio of potatoes. Locacsio and Rhue (1990) mentioned that application of Mn did not increase yield over treatment without micronutrients. Medvedev *et al.* (1981)

found that application of Mn increased the starch and carbohydrate contents of tubers.

Zinc is required in the synthesis of tryptophan (Tsui, 1948). As tryptophan is also a precursor of indole acetic acid, the formation of this growth substance is also indirectly influenced by Zn. Abdel-Hadi *et al.* (1986) found that foliar spraying with Zn chelate caused yield increases of 1-51%. Karmaker *et al.* (1988) reported that foliar spray by zinc sulphate gave highest average yields of 20.64 to 21.57 t/ha. compared with 16.15 t/ha without Zn. Sanderson and Gupta (1990) found that Zn as foliar application at 1-2 kg Zn/ha reduced specific gravity of tubers.

Awad (1997) concluded that foliar spraying of potato plants with micronutrients leads to improve potato production and quality.

MATERIALS AND METHODS

Two successive field experiments were conducted at Met-Antar village, Talkha, Dakahlia Governorate, during the two summer seasons of 2000 and 2001 using potato (*Solanum tuberosum*, L.) variety Diamont to study the effect of foliar application of Ca, Fe, Zn and Mn separately or combined on yield, quality and chemical composition of potato. These nutrients were applied as chelated sources (12% concentration) at rate of 200 gm/fed. The foliar application were sprayed two times, the first spray started after six weeks from planting date and the second one was ten days after the first spray.

The N, P and K fertilization, pests and diseases control, irrigation and the other agricultural practices were carried out according to the Ministry of Agriculture recommendations. Tuber seeds were planted on 25th of January in the first year and on 23rd of January in the second one.

The experimental design was a split plot with four replications. Micronutrients (Fe, Zn and Mn) were allocated at sub-plot, where as main plots were assigned to calcium foliar spray. The experimental treatments in sub-plot were conducted as follow:

1. Control = without spraying.
2. Fe = spraying with Fe.
3. Zn = spraying with Zn.
4. Mn = spraying with Mn
5. Fe + Zn.
6. Fe + Mn.
7. Zn + Mn.
8. Fe + Zn + Mn.

Mixed soil samples were taken before planting to determine the soil properties according to Black *et al.* (1965).

Data of soil analysis are illustrated in Table (1). Samples of leaves and tubers of potato plants were taken for analysis according to the method described by Chapman and Pratt (1961).

Specific gravity was determined according to the methods of Murphy and Goven (1959) by the following formula:

$$\text{Specific gravity} = \frac{\text{The tubers weight in air}}{\text{The tubers weight in air - the tubers weight in water}}$$

Starch content was determined in dry matter of tubers according to A.O.A.C. (1975). Statistical analysis was carried out according to Snedecor and Cochran (1980).

Table (1): Mechanical and chemical analysis of the experimental soil during two seasons.

Soil properties	2000	2001
Clay %	45.9	44.4
Silt %	31.8	32.2
Sand %	22.3	23.4
Texture	Clay loam	Clay loam
pH (1: 2.5)	7.87	7.79
E.C dSm^{-1}	1.70	1.60
Total N %	0.11	0.12
Available P (ppm)	11.00	12.00
Available K (ppm)	385	398
Available Ca (ppm)	420	409
Available Fe (ppm)	15	13
Available Zn (ppm)	3.4	2.9
Available Mn (ppm)	9.5	8.8

RESULTS AND DISCUSSION

Data presented in Table (2) indicate that potato foliar spraying with Ca and Micronutrients caused an increase in tuber yield per/fed. However, the highest values were obtained with foliar spray with both Ca^{+} and micronutrients (Fe + Zn + Mn) compared with control in the two seasons. The average increase in tuber yield amounted to be about 19.7 and 17.6%, in the two seasons respectively. Such favourable effect on tuber yield after spraying could be due to the activation of many enzymes related to auxin and protein synthesis. Several researchers came to similar conclusion, Malik *et al.*, 1978, Abdel-Hadi *et al.*, 1986; Karmaker *et al.*, 1988).

Table (2): Tuber yield per feddan (ton) as affected by spraying treatments.

Treatments	2000		2001	
	Without Ca	With Ca	Without Ca	With Ca
Control	14.29	15.22	13.67	14.39
Fe	15.26	16.48	14.42	15.39
Zn	15.11	16.33	14.23	15.78
Mn	14.30	15.24	13.89	14.24
Fe + Zn	15.87	16.98	14.68	15.79
Fe + Mn	15.34	16.51	14.46	15.62
Zn + Mn	15.28	16.34	14.37	15.46
Fe + Zn + Mn	15.97	17.11	14.96	16.08
Mean	15.18	16.28	14.34	15.34
L.S.D. at 5%	0.74			

The results presented in Table 3 clear that the foliar spraying with Ca and micronutrients (Fe, Zn and Mn) separately or together increased the percentage of N, P, K and Ca in leaves. The increase in percentages of N, P, K and Ca in potato leaves due to foliar spraying could be due to sufficient amount of Ca, Fe, Zn and Mn reaching to plant vegetative growth.

Table (3): Percentage of N, P, K and Ca in leaves of potato plants as affected by spraying treatments at 75 days after planting.

Treat.	2000								2001							
	Without Ca				With Ca				Without Ca				With Ca			
	N	P	K	Ca	N	P	K	Ca	N	P	K	Ca	N	P	K	Ca
Control	3.62	0.31	5.7	1.7	3.74	0.28	5.6	2.4	3.78	0.31	5.5	1.9	3.76	0.33	6.9	2.5
Fe	3.96	0.38	5.8	1.9	3.98	0.39	5.9	2.5	3.93	0.39	6.1	1.8	3.95	0.41	6.3	2.4
Zn	3.99	0.36	6.3	1.8	4.12	0.38	6.1	2.3	3.98	0.42	6.2	1.9	4.10	0.43	6.3	2.5
Mn	3.86	0.37	5.9	2.1	3.88	0.38	5.8	2.4	3.69	0.38	5.8	1.8	3.87	0.39	6.1	2.3
Fe+Zn	4.12	0.38	6.1	1.9	4.43	0.40	6.3	2.6	4.09	0.37	6.4	1.9	4.51	0.38	6.3	2.5
Fe+Mn	3.98	0.40	6.2	1.8	4.19	0.43	6.4	2.5	3.89	0.42	5.9	1.7	4.73	0.43	6.2	2.4
Zn+Mn	3.89	0.43	6.1	2.1	3.92	0.45	6.5	2.5	3.92	0.38	6.3	1.8	4.13	0.38	6.8	2.5
Fe+Zn+ Mn	4.06	0.44	6.7	2.2	4.65	0.43	6.8	2.6	4.11	0.41	6.4	1.9	4.61	0.43	6.9	2.6
L.S.D. 5%	0.33	0.03	0.18	0.10	00.31	0.04	0.21	0.12	0.31	0.04	0.21	0.11	0.29	0.03	0.23	0.13

Data in Table 4 show the effect of foliar spraying of Ca and micronutrients on Fe, Zn and Mn contents in potato leaves during the two seasons. The results indicate that Fe, Zn and Mn content in potato leaves were increased by foliar spraying. That result was true in both seasons. These results are in agreement with those reported by Awad (1997).

Table (4): Fe, Zn and Mn content (ppm) in leaves of potato plants as affected by spraying treatment s at 75 days after planting.

Treatments	2000						2001					
	Without Ca			With Ca			Without Ca			With Ca		
	Fe	Zn	Mn	Fe	Zn	Mn	Fe	Zn	Mn	Fe	Zn	Mn
Control	89	67	69	85	69	68	91	72	70	95	73	72
Fe	105	72	74	103	73	74	102	84	82	105	87	84
Zn	98	99	88	98	97	89	97	95	86	98	96	89
Mn	94	81	101	95	85	102	98	80	95	100	83	96
Fe + Zn	103	95	97	105	98	96	104	94	97	106	96	98
Fe + Mn	108	83	98	113	84	87	105	86	99	106	92	100
Zn + Mn	103	97	101	102	99	102	98	94	96	100	98	99
Fe + Zn + Mn	112	97	104	115	98	105	106	98	99	108	102	101
Mean	3.08	2.96	3.11	3.31	3.67	3.66	3.24	3.18	2.86	3.36	3.42	2.98

Data presented in Table (5) clearly indicate that N, P and K contents of tuber were significantly influenced by foliar spraying by Ca and micronutrients in both seasons.

Generally, there was a tendency towards increasing N, P and K percentages with foliar spraying in the two seasons.

Table (5): Percentage of N, P and K content in tuber of potato as affected by spraying treatments

Treatments	2000						2001					
	Without Ca			With Ca			Without Ca			With Ca		
	N	P	K	N	P	K	N	P	K	N	P	K
Control	3.62	0.372	3.93	3.66	0.371	3.97	3.66	0.380	3.97	3.68	0.382	3.98
Fe	3.55	0.379	3.98	3.71	0.378	4.11	3.72	0.383	4.08	3.73	0.391	4.12
Zn	3.68	0.381	3.95	3.68	0.384	4.26	3.69	0.384	4.11	3.71	0.411	4.14
Mn	3.71	0.381	4.01	3.73	0.385	4.18	3.81	0.395	3.89	3.68	0.399	4.22
Fe + Zn	3.82	0.380	4.07	3.81	0.391	4.09	3.82	0.397	4.11	3.89	0.408	4.18
Fe + Mn	3.71	0.384	3.98	3.79	0.396	4.13	3.95	0.386	4.16	3.96	0.389	4.21
Zn + Mn	3.81	0.386	3.99	3.82	0.393	4.21	3.82	0.392	4.08	3.85	0.395	4.28
Fe+Zn+Mn	3.89	0.394	4.05	3.93	0.397	4.20	3.91	0.389	4.21	3.93	0.398	4.33
Mean	0.05	0.023	0.04	0.05	0.021	0.03	0.04	0.021	0.05	0.05	0.028	0.04

Data given in Table (6) show the effect of spraying treatments by Ca and micronutrients on the specific gravity and starch content. The results indicate that the spraying treatments cause an obvious reduction of the specific gravity in the two seasons. On the other hand, starch content in potato tuber was not affected by the spraying treatments in the two seasons.

Similar conclusion were obtained by Kiryukhin and Bezzvbtseva (1980) and Medvedev *et al.* (1981).

Table (6): Specific gravity and starch content (%) of tubers as affected by spraying treatments at harvest.

Treatments	2000				2001			
	Without Ca		With Ca		Without Ca		With Ca	
	Specific gravity	Starch content	Specific gravity	Starch content	Specific gravity	Starch content	Specific gravity	Starch content
Control	1.079	16.30	1.078	15.78	1.071	16.12	1.069	15.77
Fe	1.075	16.52	1.072	15.96	1.068	16.10	1.064	15.98
Zn	1.076	15.98	1.073	16.12	1.067	15.99	1.065	16.18
Mn	1.075	16.18	1.074	16.11	1.067	16.03	1.063	16.14
Fe + Zn	1.075	16.42	1.072	15.98	1.068	15.98	1.065	15.99
Fe + Mn	1.076	15.79	1.073	16.01	1.066	16.11	1.065	16.03
Zn + Mn	1.075	15.98	1.073	15.96	1.066	16.18	1.066	15.88
Fe+Zn+Mn	1.076	16.32	1.074	16.28	1.067	15.99	1.064	16.11
L.S.D. 5%	0.003	NS	0.003	NS	0.003	N.S	0.003	N.S

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أثر الرش بالكالسيوم وبعض المغذيات الصغرى على إنتاجية وجودة محصول البطاطس

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أقيمت تجربتان حقليتان لدراسة أثر الرش بالكالسيوم وبعض المغذيات الصغرى (الحديد ، الزنك والمنجنيز) على إنتاجية وجودة محصول البطاطس.

تمت الدراسة بناحية قرية ميت عنتر - مركز طلخا - محافظة الدقهلية. فى موسمين ناجحين موسم صيفى 2000 ، 2001م وكان تصميم التجربة القطع المنشقة فى 4 مكررات حيث تم رش الكالسيوم فى صورة مخلبية 12% بمعدل 200جرام/فدان فى القطع الرئيسية ورش عناصر الحديد والزنك والمنجنيز فى صورة مخلبية بتركيز 12% بمعدل 200جرام/فدان لكل منها وأضيفت منفردة أو مجتمعة. وأشارت النتائج إلى ما يلى:

1) أدى الرش بعناصر الكالسيوم والعناصر الصغرى منفردة أو مجتمعة إلى زيادة محصول درنات البطاطس وكانت أعلى النتائج المعاملة بالرش بالكالسيوم والعناصر جميعا مجتمعة حيث حققت زيادة المحصول بنسبة 19.7 ، 17.6% للموسمين على التوالى.
2) أدى الرش بالعناصر الكالسيوم والعناصر الصغرى إلى زيادة محتوى أوراق البطاطس فى النسبة المئوية لكل من عناصر النيتروجين والفوسفور والبوتاسيوم والكالسيوم ونفس الاتجاه كان فى محتوى الأوراق من العناصر الصغرى الحديد والزنك والمنجنيز.
3) أظهرت النتائج أن الرش بالعناصر السابقة أدى إلى زيادة محتوى درنات البطاطس من النيتروجين والفوسفور والكالسيوم بينما أدى الرش بهذه العناصر إلى نقص فى قيمة الكثافة النوعية للدرنات ولم يتأثر محتوى الدرنات من النشا بهذه المعاملة.