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EFFECT OF SOME ORGANIC FERTILIZATION SOURCES AND MICRONUTRIENTS APPLICATION METHODS ON YIELD AND QUALITY OF POTATO (*Solanum tuberosum*, L.)

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ABSTRACT

Two field trials were conducted on potato plants cv. Spunta, in the vegetable private farm at Kafr Meet Faris, Dakahlia Governorate, during 2004/2005 and 2005/2006 seasons to study the effect of some organic fertilization sources, either single and/or in combination with micronutrients application methods on plant growth, yield and its components, as well as chemical constituents and storability of tubers.

In general, results showed that the plants fertilized by organic fertilization sources were better than those of the unfertilized ones. Fertilization with poultry manure (PM) followed by 50% FYM + 50% PM significantly increased plant stem length, number of leaves, leaf area and foliage dry weight as well as total yield, number of tubers/plant and average of tuber weight, Moreover, application PM significantly increased TSS%, ascorbic acid, concentrations of (N, P & K), micronutrients (Fe, Zn & Mn), starch% and reducing sugars in tubers. While, non-reducing sugars was not affected. This source of organic fertilization (PM) had the most interesting observation was the enhancing of storability and reducing sprouting% at the end of storage period. Also, foliar application method of micronutrients caused significant increases in the most studied parameters as comparing with those of the other treatments. However, weight loss percent of tubers and sprouting% was significantly reduced during and at the end of storage period.

The combined treatments of organic fertilization sources and micronutrients application methods were generally more effective on the most studied parameters than with single ones. The best results were obtained by PM with foliar application method of micronutrients. This treatment achieved increases in vegetative growth characters, total tubers yield (tons/fed), number of tubers/plant, average of tuber weight, tuber dry weight%, T.S.S% of tuber, concentrations of N, P, K, micronutrients (Fe, Zn and Mn), ascorbic acid, starch%, reducing sugars in tubers and enhanced the tubers storability comparing with the other ones.

Therefore, this treatment could be recommended for raising potato yield and improving tuber quality during the storage period under similar conditions to this work.

INTRODUCTION

Potato (*Solanum tuberosum*, L.) is a major world food crop. Potato is exceeded only by wheat, rice, and maize in world production for human consumption. In Egypt, it has been generally cultivated for both local consumption and export. Therefore, increasing potato yield and improving tuber quality are essential aims for both growers and consumers, but it usually depends on many factors especially that influence the plant growth throughout the growth period. Application of organic fertilization s improved the physical conditions, chemical and biological properties of the soil as well as through its effect as source of essential nutrients, increased nutrient supply and improved the efficiency of macro elements as well as its ability to meet some micronutrients requirements such as P, Fe, Zn, Mn and Cu which were reflected on plant uptake and plant growth, in addition to the positive

effect on the environment and public health (Cooke, 1982; Giusquiani *et al*., 1988; Kolbe *et al*., 1995 and El-Nagar, 1996). Also, El–Shafie and El–Shekha (2003) observed that application of organic fertilization increased the soil fertility through increasing the soil acidity due to formation of CO_2 and other organic acids.

Several investigators reported that potato plants growth, yield and its quality as well as N, P, K, Fe, Zn, and Mn content in the plant tubers were affected by organic fertilization. In this respect, Abou-Hussein (1995), Abdel-Ati (1998), Abou-Hussein *et al* (2002a and b) and Awad *et al* (2002). Recently, Abou-Hussein *et al* (2003) indicated that applying cattle manure combined with chicken manure increased tuber dry matter, total carbohydrates, specific gratify and potato tuber yield. In the same manner, Radwan and Tawfik (2004) reported that organic manuring improved plant growth characters, yield and its quality and the content of Fe in potato tuber, El-Kassas *et al* (1999), El-Kassas (2005) and El-Morsy *et al* (2006) found that using chicken manure increased all vegetative growth characters, number of tubers/plant, average tuber weight, total tuber yield and chemical constituents in tubers.

Regarding to micronutrients application methods, Hrynczuk (1996) and Attia (2001), studied the methods of (soil dressing and foliar spray) on the yield and nutrient content on potato and on onion, they reported that the foliar spray method of micronutrients significantly enhanced growth, yield, dry matter% and total N, P, K, Fe, Zn and Mn contents in tubers or bulbs. However, Saravanan and Nambisan (1994) indicated that the soil dressing of ZnSO4 at 25 kg gave the highest yields of garlic. Also, several investigators indicated that foliar spraying potato plants with micronutrients enhanced plant growth, stimulated dry matter accumulation and increased tuber yield and quality (Abdel–Razik and Gabar, 1994; Abou Sedera and shehata, 1994 and Nofal, 1998). On the other hand, Abdel-Razik and Gaber (1994) indicated that vegetative growth rate, the total tubers yield, tuber dry matter, specific gravity and starch in tubers and micronutrients contents in potato leaves and tubers were generally increased as a result of foliar spray of micronutrients. Abdel-Fattah *et al*. (2002) and El-Morsy *et al*. (2004) on garlic, found that weight loss percent of bulbs was significantly reduced during the storage period with plants sprayed by micronutrients.

Concerning, the interaction between applied organic fertilization s and micronutrients was beneficial to plant growth and yield, El–Morsy *et al* (2006) found that using chicken manure interaction with foliar spraying chelated micronutrients (Fe, Zn and Mn) enhanced the vegetative growth characters, total tubers yield, number of tuber/plant, average tuber weight, percentage dry weight and T.S.S of tuber were significantly affected by using chicken manure with foliar spraying chelated micronutrients (Fe , Zn and Mn).

The present study was carried out to indicate response potato plants in clay loamy soil to some organic fertilization sources and some micronutrients application methods in addition to their interactions on potato productivity and storability under the conditions of North Delta region, Dakahlia District.

MATERIALS AND METHODS

Two field experiments were carried out in vegetable private farm at Kafr Meet Faris, Dakahlia Governorate, during two winter growing seasons of 2004/2005 and 2005/2006, to study the effect of some organic fertilization sources i.e. farmyard manure (FYM) and poultry manure (PM) and 50% FYM + 50% PM and some micronutrients application methods viz., (soil dressing, foliar spray and soil dressing + foliar spray) using mixture of chelated microelements (Fe,Zn and Mn) in addition to their interactions growth, yield and its components, as well as tuber quality, chemical constituents in tuber and storability of potato cv. (Spunta). The soil of the experimental field texture was clayey loamy with pH 7.9, available N, P and K contents were 21.6 - 25.3, 15.6 - 17.9 and 290-310 ppm during the first and second seasons, respectively. The organic fertilization s used analysis are shown in Table (1) as follows:

Table (1): Analysis of organic fertilization s used in the experiment soil .

Organic fertilization analysis	Macroelements(%)			Microelements (ppm)		
	N	P	K	Fe	Zn	Mn
Farmyard manure (FYM)	1.580	0.553	1.625	346	210	185
Poultry manure(PM)	2.965	1.180	2.348	187	168	146

According to methods of (Jackson,1973) .

The experimental design used was split plots with three replicates. Tuber seeds were planted on 20th and 15th of October in the first and the second seasons, respectively. Organic fertilization s occupied the main plots which were subdivided to 4 sub plots each contained one of the micronutrients application methods. The plot area was 17.5 m^2 (1/240 feddan) which contained 5 ridges, each 5m long and 0.7m width. Each experiment included 16 treatments which were 4 sources of organic fertilization and 4 levels of micronutrients as follows:

a- Organic fertilization sources:

1- Control treatment (unfertilized) .
2- Farmyard manure (FYM) at 20 m3/fed.
3- Poultry manure (PM) at 10 m3/fed.
4- 50% of (FYM) + 50% of (PM).

Organic fertilization sources were distributed, spreaded and thoroughly mixed with the surface soil layer (0-20 cm) before planting.

b- Micronutrients application methods:

1- Control (untreated).
2- Soil dressing.
3- Foliar spray.
4- Soil dressing (5 kg of mixed micronutrients) + Foliar spray.

In both growing seasons, soil dressing of micronutrients as a mixed of Fe, Zn and Mn sulphate at 10 kg/fed was applied as a two equal doses at 30 and 45 days after planting, and foliar spray as a mixture of chelated micronutrients Fe, Zn and Mn (1:1:1) was supplied as a foliar application in 150 ppm at 45, 60 and 75 days after planting (DAP) in the rate of 400 L/fed.

All treatments were fertilized with the recommendation rates of NPK , 180 kg N/fed (ammonium nitrate, 33.5% N) was added at three equal doses after 3, 5 and 7 weeks from planting, 75 kg P_2O_5/fed (Superphosphate 15.5% P_2O_5) was added once before planting and potassium sulphate (48% K_2O) was added once at 96 kg K_2O/fed after 7 weeks from planting date. The other cultural practices were applied according to the instructions laid down by the Ministry of Agriculture, Egypt.

Data recorded:

1- Growth parameters:

A random sample of three potato plants were taken from each plot after 90 DAP to estimate the plant stem length (cm), number of main stems/plant, number of leaves/plant, leaf area and foliage dry weight/plant (gm).

2- Yield and its components:

At harvest time, yield of each plot weighted in kg and converted to total yield (tons/fed), number of tubers/plant, average of tuber weight (gm) and tuber dry weight (%).

3- Chemical analysis:

Nitrogen, phosphour, potassium, iron, zinc and manganese concentrations were determined after harvest in the digested dry matter of tubers according to Rangana methods (1979). Percentage of total soluble solids (TSS%) was determined a hand refractometer, ascorbic acid, Starch%, reducing and non-reducing sugars of tuber were determined according to Mondy and Ponnampalam (1986), Smogyi (1952), A.O.A.C (1990) and Dubois *et al.* (1956).

4- Storability:

After curing, random samples (5 kg of marketable yield from every plot) were taken, stored in case of paper under normal room conditions. The percentage of weight loss was recorded monthly during the storage period (four months). At the end of storage period, sprouting% was determined.

Data were subjected to the statistical analysis and means were compared using new L.S.D according to (Gomez and Gomez 1984).

RESULTS AND DISCUSSIONS

1- Vegetative growth characters:

Data in Table (2) show that all vegetative growth characters were affected by the different sources of organic fertilization. Using the poultry manure (PM) increased stem length (cm), number of main stems/plant, number of leaves/plant, leaf area and foliage dry weight/plant significantly in both seasons. This result may be due to the higher contents of macro-elements (NPK) in PM and this led to an increase of the metabolism activity and consequently increasing of plant growth. These are in agreement with those reported by Radwan and Tawfik (2004), El-Kassas *et al* (2005) and El-Morsy *et al* (2006) found that using chicken manure increased all vegetative growth characters.

Table (2): Vegetative growth characters of potato plants as affected by organic fertilization sources, micronutrients application methods and their interactions during 2004/2005 (S1) and 2005/2006 (S2) winter seasons.

Characters / Treatments		Stem length (cm)		No. of main stems/plant		Number of leaves/plant		Leaf area		Foliage dry weight (gm)	
		S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Organic fertilization sources											
Control		53.48	59.96	1.92	1.61	25.20	18.09	0.387	0.413	27.18	27.98
Farmyard manure (FYM)		55.12	62.67	1.99	1.86	26.29	18.77	0.437	0.456	28.42	29.73
Poultry manure (PM)		61.35	67.00	2.36	2.28	31.07	20.57	0.488	0.494	32.78	32.98
50% FYM + 50% PM		56.41	65.00	2.31	2.06	29.15	20.58	0.486	0.485	31.67	32.43
LSD at 5%		02.17	01.02	0.45	0.58	02.12	00.69	00.01	00.03	1.120	3.399
Micronutrients app. methods											
Control		53.71	60.58	1.80	1.67	23.98	18.02	0.416	0.426	27.63	28.74
Soil dressing 1		55.38	62.79	2.03	1.89	26.88	18.82	0.444	0.452	29.28	29.58
Foliar spray 2		60.68	67.33	2.51	2.31	31.98	21.43	0.476	0.495	32.48	33.97
1 + 2		56.58	63.92	2.22	1.94	28.86	19.74	0.462	0.474	30.66	30.83
LSD at 5%		01.97	01.68	0.36	0.31	01.18	00.92	00.03	00.02	0.834	2.413
Interactions:											
O.F.S	**Micro. app. methods**										
Control	Control	51.90	57.33	1.55	1.22	22.00	16.77	0.363	0.358	24.93	27.31
	Soil dressing 1	51.83	59.17	1.89	1.56	24.20	17.30	0.395	0.414	26.33	27.59
	Foliar spray 2	56.43	63.00	2.22	2.00	28.20	19.47	0.398	0.449	30.20	28.70
	1 + 2	53.73	60.33	2.00	1.67	26.40	18.83	0.391	0.429	27.27	28.29
FYM	Control	53.40	60.00	1.55	1.78	22.06	17.20	0.419	0.445	26.23	27.79
	Soil dressing 1	54.77	61.67	1.89	1.78	23.97	18.10	0.421	0.428	27.53	28.00
	Foliar spray 2	57.37	66.33	2.44	2.00	31.16	20.90	0.472	0.496	30.77	32.64
	1 + 2	54.93	62.67	2.11	1.89	27.97	18.87	0.437	0.453	29.13	30.49
PM	Control	55.00	63.67	2.00	1.89	26.67	19.07	0.433	0.444	29.40	29.28
	Soil dressing 1	58.57	65.67	2.11	2.11	30.87	19.87	0.492	0.477	32.17	31.95
	Foliar spray 2	69.60	71.33	2.77	3.00	35.63	22.73	0.510	0.534	35.87	37.91
	1 + 2	62.23	67.33	2.55	2.11	31.15	20.60	0.516	0.523	33.70	32.79
50% FYM + 50% PM	Control	54.53	61.33	2.11	1.78	25.20	19.03	0.448	0.457	29.97	30.58
	Soil dressing 1	56.33	64.67	2.22	2.11	28.50	20.00	0.469	0.488	31.06	31.77
	Foliar spray 2	59.33	68.67	2.66	2.22	32.93	22.60	0.524	0.503	33.10	36.63
	1 + 2	55.43	65.33	2.22	2.11	29.97	20.67	0.502	0.492	32.53	31.74
L.S.D. at 5%		03.94	03.36	0.71	0.62	02.36	01.84	00.06	00.04	1.667	4.825

O.F.S = organic fertilization sources , FYM = Farmyard manure, PM = Poultry manure, 1 = Soil dressing and 2 = Foliar spray

Concerning the effect of micronutrients application methods, Data in Table (2) also, reveal that foliar application method of micronutrients resulted in significant increases on all studied parameters of vegetative growth in both seasons of the study. 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. The obtained results are in harmony with those reported by Abdel-Razik and Gabar, 1994; Hrynczuk (1996), Abou Sedera and Shehata (1994) and Nofal (1998).

With regard the interaction, data in the same Table, indicated that the vegetative growth characters i.e. stem length, number of main stems/plant, number of leaves/plant, leaf area and foliage dry weight/plant were

significantly affected by using the PM with foliar spraying method of micronutrients. These results are in harmony with those reported by El–Morsy *et al* (2006).

2- Yield and its components:

Data in Table (3) indicated that the total tubers yield (tons/fed), number of tubers/plant, average tuber weight and T. S.S% of tuber were significantly

Table (3): Total yield and its components of potato plants as affected by organic fertilization sources, micronutrients application methods and their interactions during 2004/2005 (S1) and 2005/2006 (S2) winter seasons.

Characters / Treatments		Total yield (ton/fed)		Number of tubers /plant		Average tuber weight (kg)		Dry weight of tubers %		T.S.S. %	
		S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Organic fertilization sources											
Control		8.754	9.937	3.7	4.1	0.175	0.197	21.2	20.7	5.88	5.96
Farmyard manure (FYM)		14.004	13.771	4.8	4.7	0.206	0.250	21.7	21.4	5.950	6.17
Poultry manure (PM)		16.271	16.717	5.1	5.2	0.334	0.361	24.2	23.5	6.483	6.39
50% FYM + 50% PM		15.962	16.113	5.4	4.9	0.275	0.277	23.5	22.6	6.517	6.36
LSD at 5%		00.136	00.081	0.7	0.7	0.052	0.065	01.2	N.S	0.41	0.66
Micronutrients app. methods											
Control		13.137	13.629	4.3	4.3	0.225	0.242	20.8	20.7	5.80	5.96
Soil dressing 1		13.617	13.979	4.5	4.6	0.231	0.255	22.6	22.6	6.23	6.09
Foliar spray 2		14.317	14.742	5.6	5.3	0.290	0.311	23.9	22.6	6.57	6.57
1 + 2		13.921	14.187	4.6	4.7	0.244	0.274	23.1	22.2	6.24	6.25
LSD at 5%		00.132	00.165	0.8	0.6	0.036	0.049	01.1	N.S	0.69	0.37
Interactions:											
O.F.S	**Micro. app. methods**										
Control	Control	8.200	9.117	3.7	4.1	0.150	0.186	19.2	19.60	5.60	5.94
	Soil dressing 1	8.483	9.733	3.4	3.9	0.175	0.180	20.5	22.00	5.90	5.94
	Foliar spray 2	9.333	10.933	4.5	4.4	0.194	0.220	22.4	17.47	6.20	6.00
	1 + 2	9.000	9.697	3.3	3.9	0.181	0.200	20.5	17.67	5.83	5.95
FYM	Control	13.283	13.250	4.3	4.3	0.169	0.216	21.3	19.73	5.50	6.06
	Soil dressing 1	13.917	13.633	4.6	4.3	0.197	0.242	20.8	15.40	6.00	6.00
	Foliar spray 2	14.667	14.367	5.3	5.2	0.261	0.281	20.9	16.53	6.33	6.45
	1 + 2	14.150	13.833	5.1	4.9	0.199	0.260	22.4	16.47	5.97	6.17
PM	Control	15.750	16.433	4.9	4.3	0.309	0.321	23.3	21.87	6.07	6.00
	Soil dressing 1	16.233	16.650	4.4	5.1	0.323	0.335	23.5	13.40	6.53	6.22
	Foliar spray 2	16.717	17.017	6.4	6.3	0.380	0.413	24.6	13.93	6.60	6.95
	1 + 2	16.383	16.767	4.7	5.0	0.325	0.374	22.6	14.13	6.73	6.33
50% FYM + 50% PM	Control	15.317	15.717	4.2	4.3	0.272	0.246	19.2	17.07	6.03	5.78
	Soil dressing 1	15.833	15.900	5.6	4.8	0.228	0.265	25.4	14.80	6.47	6.22
	Foliar spray 2	16.550	16.650	6.2	5.3	0.327	0.331	22.5	16.47	7.13	6.89
	1 + 2	16.150	16.183	5.5	5.0	0.272	0.264	23.4	13.60	6.43	6.56
L.S.D. at 5%		00.265	00.329	1.6	1.1	0.072	0.099	02.3	N.S	0.69	0.74

O.F.S = organic fertilization sources , FYM = Farmyard manure, PM = Poultry manure, 1 = Soil dressing and 2 = Foliar spray

affected by organic fertilization sources in both seasons. The highest records were obtained with applying the PM followed by (50% FYM + 50% PM) in both seasons. while the dry weight of tuber% was affected significantly in the first season only. The positive effect of this organic sources increased the soil fertility through increasing the soil acidity that improved soil structure, soil chemical properties and increased the availability of certain plant nutrients such as P and several micronutrients i.e. Fe, Zn and Mn (Cooke, 1982; Giusquiani *et al*., 1988; Kolbe *et al*., 1995; El-Nagar, 1996 and El–Shafie and El–Shekha, 2003). The obtained results are in accordance with those of Abou-Hussein (1995), Abdel-Ati (1998), Arisha and Bardisi (1999); Abou-Hussein *et al* (2002a and b) and Awad *et al* (2002).

Concerning the effect of micronutrients application method on total yield and its components, data in Table (3) revealed that the maximum total tubers yield (ton/fed), number of tubers/plant, average tuber weight, tuber dry weight% and T.S.S% were obtained by foliar application method of micronutrients in both seasons.

These increases might be ascribed to the favorable role of the used micronutrients in pigments formation, photosynthesis activation and carbohydrates assimilation diverted to the tubers which represent the economic part of plant (Hilman and Asandhi, 1987). Similar results were reported by Abdel-Razik and Gabar (1994), Abou Sedera and Shehata (1994) and Nofal (1998).

The interaction between organic fertilization sources and the micronutrients application methods had significant effect on total yield and its components. Total yield, number of tubers/plant, average tuber weight, tuber dry weight% and T.S.S% of tuber were increased with applying the PM and foliar spraying of micronutrients in the two study seasons. Similar conclusions were obtained by Shehata *et al* (1990), Abdel-Razik and Gaber (1994), Abo-Sedera and Shehata (1994), Meng *et al.* (2004), El-Kassas *et al.* (2005) and El-Morsy *et al*. (2006).

3. Chemical constituents:

Data in Table (4) indicated that the contents of N, P, K (%), Fe, Zn and Mn (ppm) in tuber increased significantly during both study seasons by using the poultry manure (PM). These obtained results may be related to the use of organic fertilization s along with chemical fertilizers gives the soil rich in nutrients with good physical and microbiological properties, this will increase the availability of nutrients and consequently increase the macro and micronutrients concentrations in tuber. These results are in agreement with those obtained by Obukhov *et al*. (1985), Srikumar and Okerman (1990), Kolbe *et al*. (1995), Saleh and Abd El-Fattah (1997), Abdel-Ati (1998) and Arisha and Bardisi (1999).

With respect to effect of micronutrients application method, results in Table (4) showed that the contents of N, P, K (%), Fe, Zn, and Mn (ppm) in tubers increased significantly by using micronutrients as a foliar application. With the same treatment, tuber content of ascorbic acid was increased (Table 5). Similar results were reported by Hrynczuk (1996), Attia (2001), Abdel-Razik and Gaber (1994) and Meng *et al*. (2004).

Table (4): Chemical constituents in potato tuber as affected by organic fertilization sources, micronutrients application methods and their interactions during 2004/2005 (S1) and 2005/2006 (S2) winter seasons.

Characters		Macro elements						Micro elements					
		N%		P%		K%		Fe ppm		Mn pm		Zn ppm	
Treatments		S1	S2	S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Organic fertilization sources													
Control		1.44	1.41	0.250	0.248	1.68	2.70	14.46	14.26	4.58	4.55	10.43	10.39
FYM		1.74	1.72	0.289	0.284	2.13	3.09	15.52	14.99	4.71	4.65	10.55	10.48
PM		1.87	1.81	0.317	0.308	2.23	3.19	16.35	15.32	4.99	4.82	11.20	10.67
50%FYM+50%PM		1.71	1.70	0.312	0.305	2.26	3.08	16.03	15.01	4.72	4.75	10.60	10.37
LSD at 5%		0.13	0.13	0.002	0.003	0.13	0.13	0.006	0.003	0.17	0.004	0.032	0.13
Micronutrients app. methods													
Control		1.53	1.51	0.271	0.264	1.75	2.76	9.99	9.86	3.10	3.01	8.38	8.27
Soil dressing 1		1.65	1.60	0.279	0.269	1.99	2.96	14.79	13.57	4.65	4.40	10.51	10.43
Foliar spray 2		1.81	1.79	0.318	0.314	2.38	3.24	20.09	19.73	5.75	5.87	12.24	11.89
1 + 2		1.77	1.74	0.301	0.298	2.17	3.11	17.51	16.40	5.51	5.49	11.64	11.32
LSD at 5%		0.11	0.11	0.001	0.006	0.11	0.11	0.007	0.007	0.159	0.007	0.025	0.11
Interactions:													
O.F .S	**Micro. app. methods**												
Control	Control	1.36	1.35	0.241	0.238	1.53	2.58	9.59	9.53	3.06	2.97	8.18	8.12
	1	1.41	1.38	0.247	0.245	1.62	2.65	13.90	13.35	4.20	4.12	10.39	10.35
	2	1.53	1.48	0.260	0.258	1.79	2.81	18.21	18.12	5.72	5.77	11.96	11.95
	1 + 2	1.46	1.43	0.252	0.250	1.77	2.77	16.15	16.02	5.35	5.35	11.20	11.13
FYM	Control	1.54	1.51	0.265	0.266	1.81	2.88	10.03	9.92	3.04	2.95	8.40	8.36
	1	1.68	1.63	0.250	0.237	2.02	3.02	14.63	13.62	4.35	4.35	10.49	10.42
	2	1.91	1.94	0.330	0.328	2.45	3.32	20.26	20.25	5.92	5.82	11.93	11.87
	1 + 2	1.82	1.79	0.312	0.307	2.25	3.17	17.17	16.15	5.52	5.47	11.36	11.28
PM	Control	1.66	1.56	0.286	0.273	1.69	2.92	10.19	10.02	3.18	3.08	8.50	8.41
	1	1.73	1.72	0.325	0.301	2.17	3.12	15.92	13.95	5.52	4.61	10.64	10.65
	2	2.14	2.06	0.339	0.339	2.70	3.43	20.95	20.43	5.68	5.98	13.09	12.08
	1 + 2	1.95	1.90	0.319	0.320	2.36	3.27	18.35	16.89	5.61	5.63	12.59	11.55
50% FYM + 50% PM	Control	1.55	1.60	0.290	0.279	1.98	2.67	10.13	9.98	3.12	3.02	8.45	8.18
	1	1.77	1.68	0.295	0.295	2.15	3.06	14.69	13.37	4.52	4.52	10.53	10.29
	2	1.68	1.68	0.342	0.332	2.59	3.38	20.92	20.13	5.69	5.93	11.98	11.98
	1 + 2	1.83	1.84	0.322	0.313	2.30	3.22	18.37	16.55	5.56	5.51	11.42	11.33
L.S.D. at 5%		0.22	0.22	0.002	0.001	0.23	0.21	0.015	0.015	0.32	0.01	0.05	0.22

O.F.S = organic fertilization sources , FYM = Farmyard manure, PM = Poultry manure, 1 = Soil dressing and 2 = Foliar spray

With regard to the interaction between organic fertilization s and micronutrients application methods, Data in Table (4) indicated that the interaction had a significant effect on the tuber contents of N,P and K (%), Fe, Zn, and Mn (ppm). While, ascorbic acid was not affected by organic sources (Table 5). The highest values were obtained by using poultry manure with foliar spraying of micronutrients compared with the control treatment in both seasons. These results are in accordance with those obtained by El-Kassas *et al* (2005) and El-Morsy *et al* (2006).

4. Organic compositions of tubers:

Data in Table (5) revealed that the tuber content of ascorbic acid, Starch% and reducing sugars were increased significantly by using PM

followed by (50% FYM + 50% PM) in both seasons. While, non-reducing sugars was not affected by organic fertilization sources in both seasons.

Concerning the effect of micronutrients application method, results in Table (5) showed that the tuber content of organic compositions except non-reducing sugars were significantly affected by using micronutrients as a foliar application. Similar results were reported by Abdel-Razik and Gaber (1994) and Abo-Sedera and Shehata (1994).

Table (5): Ascorbic acid and organic composition in potato tuber after curing as affected by organic fertilization sources, micronutrients application methods and their interactions during 2004/2005 (S1) and 2005/2006 (S2) winter seasons.

Characters		Ascorbic acid (mg/100g fw)		Starch %		R. sugars %		Non R. sugars %	
Treatments		S1	S2	S1	S2	S1	S2	S1	S2
Organic fertilization sources									
Control		19.16	19.18	14.45	14.37	1.00	0.96	1.29	1.33
Farmyard manure (FYM)		18.18	17.03	14.64	14.58	1.12	1.02	1.26	1.29
Poultry manure (PM)		18.09	15.83	15.06	14.71	1.31	1.13	1.23	1.30
50% FYM + 50% PM		19.84	15.48	14.80	14.69	1.21	1.08	1.26	1.28
LSD at 5%		1.71	1.41	0.002	0.13	0.02	0.006	N.S	N.S
Micronutrients app. methods									
Control		21.40	19.57	13.52	13.35	0.77	0.66	1.22	1.29
Soil dressing 1		17.62	16.40	14.41	14.24	1.06	0.95	1.22	1.31
Foliar spray 2		17.91	16.10	15.83	15.66	1.53	1.37	1.33	1.33
1 + 2		18.35	15.47	15.19	15.10	1.27	1.21	1.26	1.28
LSD at 5%		2.16	1.58	0.007	0.12	0.01	0.006	N.S	N.S
Interactions:									
O.F.S	**Micronutrients app. methods**								
Control	Control	22.77	19.9	13.26	13.25	0.58	0.53	1.28	1.31
	Soil dressing 1	19.30	21.0	14.10	13.93	0.92	0.89	1.24	1.40
	Foliar spray 2	18.23	22.5	15.52	15.47	1.36	1.32	1.36	1.31
	1 + 2	16.33	21.5	14.90	14.82	1.15	1.10	1.28	1.29
FYM	Control	21.63	20.6	13.39	13.32	0.72	0.62	1.26	1.33
	Soil dressing 1	17.90	21.0	14.36	14.42	0.99	0.92	1.22	1.26
	Foliar spray 2	17.33	23.8	15.72	15.63	1.49	1.36	1.30	1.33
	1 + 2	15.87	21.3	15.08	14.96	1.23	1.19	1.27	1.26
PM	Control	18.23	22.4	13.81	13.45	0.91	0.79	1.18	1.24
	Soil dressing 1	15.43	24.1	14.74	14.35	1.21	1.02	1.22	1.31
	Foliar spray 2	19.20	25.1	16.22	15.81	1.73	1.42	1.28	1.35
	1 + 2	19.50	25.1	15.45	15.24	1.37	1.28	1.24	1.30
50% FYM + 50% PM	Control	22.97	20.6	13.63	13.39	0.85	0.71	1.17	1.28
	Soil dressing 1	17.83	24.2	14.42	14.26	1.12	0.99	1.22	1.27
	Foliar spray 2	16.87	24.5	15.84	15.72	1.53	1.39	1.39	1.32
	1 + 2	21.70	24.6	15.31	15.37	1.32	1.25	1.25	1.26
L.S.D. at 5%		4.31	3.17	0.01	0.24	0.03	0.012	N.S	N.S

O.F.S = organic fertilization sources , FYM = Farmyard manure, PM = Poultry manure, 1 = Soil dressing and 2 = Foliar spray

Regarding the interaction between organic fertilization s and micronutrients application methods, data in Table (5) indicated that the interaction had a significant effect on the tuber contents of starch% and reducing sugars. The highest values were obtained by using poultry manure

(PM) with foliar spraying of micronutrients in both seasons. While the non-reducing sugars was not affected. These results are in accordance with those obtained by El-Morsy *et al*. (2006).

5- Storability:

Data in Table (6) reveal that the weight loss% of tubers during the storage period and sprouting% at the end of storage period were significantly affected by organic fertilization sources during storage period in both seasons. The lowest weight loss% during the storage period was obtained by applied PM. This treatment achieved increase in yield at the end of storage period (four months) comparing to control treatment.

Table (6): Weight loss% during the storage period and sprouting% at the end of storage period in potato tubers as affected by organic fertilization sources, micronutrients and their interactions during 2004/2005 (S1) and 2005/2006 (S2) winter seasons.

Characters		Weight loss (%) during the storage period								Sprouting %	
		30 days		60 days		90 days		120 days			
Treatments		S1	S2	S1	S2	S1	S2	S1	S2	S1	S2
Organic fertilization sources											
Control		1.54	1.30	3.54	4.69	9.15	10.38	17.19	18.39	26.44	23.10
FYM		1.17	1.30	2.95	3.39	9.53	6.98	17.20	12.99	25.37	22.90
PM		1.02	1.20	3.13	2.73	9.64	5.51	15.69	11.92	24.15	22.09
50% FYM +50% PM		1.12	1.17	2.61	3.59	8.89	6.63	15.39	12.78	23.34	22.28
LSD at 5%		0.40	0.19	2.13	1.51	3.54	4.69	3.50	3.61	5.58	5.13
Micronutrients app. methods											
Control		1.35	1.30	4.58	5.32	10.20	11.21	18.18	17.08	28.72	24.52
Soil dressing 1		1.28	1.26	3.15	3.48	10.44	7.60	17.55	15.54	26.48	23.46
Foliar spray 2		1.01	1.18	2.09	2.21	7.48	4.88	14.12	11.26	19.88	20.40
1 + 2		1.22	1.22	2.41	3.40	9.09	5.81	15.63	12.20	24.22	22.00
LSD at 5%		0.23	0.15	0.63	2.05	2.29	4.13	2.38	3.84	2.98	3.96
Interactions:											
O.F.S	**Micronutrients app. methods**										
Control	Control	1.82	1.36	5.15	5.47	10.32	13.03	18.30	20.77	28.57	25.73
	1	1.63	1.32	3.90	5.65	8.77	12.95	16.68	20.73	30.30	23.27
	2	1.27	1.23	2.13	2.31	7.81	6.06	16.51	14.57	21.80	22.10
	1 + 2	1.45	1.27	2.98	5.33	9.72	9.50	17.27	17.50	25.10	21.30
FYM	Control	1.28	1.40	4.13	5.88	9.93	13.12	19.12	16.53	31.43	27.83
	1	1.20	1.32	3.28	3.33	9.74	6.11	18.25	14.21	23.20	20.57
	2	1.05	1.20	2.11	2.65	9.54	6.06	16.52	10.65	21.90	19.30
	1 + 2	1.13	1.28	2.27	1.74	8.92	2.61	14.93	10.60	24.93	23.90
PM	Control	1.08	1.25	5.92	4.71	10.98	9.06	17.33	16.93	28.50	23.30
	1	1.17	1.27	2.91	2.28	11.33	5.56	16.72	13.57	26.43	24.83
	2	0.82	1.07	1.92	1.13	6.40	1.84	12.48	6.62	18.00	20.03
	1 + 2	1.02	1.22	1.78	2.81	9.85	5.56	16.22	10.55	23.67	20.20
50% FYM + 50% PM	Control	1.20	1.19	3.13	5.22	9.58	9.61	17.98	14.07	26.36	21.20
	1	1.10	1.13	2.50	2.66	11.92	5.78	18.55	13.67	26.00	25.17
	2	0.90	1.20	2.22	2.73	6.18	5.56	10.92	13.20	17.83	20.17
	1 + 2	1.27	1.13	2.60	3.74	7.88	5.56	14.10	10.17	23.17	22.60
L.S.D. at 5%		0.46	0.31	1.27	4.11	4.60	8.26	4.77	7.69	5.96	7.92

O.F.S = organic fertilization sources , FYM = Farmyard manure, PM = Poultry manure, 1 = Soil dressing and 2 = Foliar spray

Also, the sprouting% at the end of storage period was affected by organic fertilization sources, the lowest record was obtained by using 50% FYM + 50% PM and PM in the first and the second seasons, respectively. These results may be due to increase dry matter, TSS % and chemical constituents in tubers (Table 3 & 4).

With respect the effect of micronutrients application methods, data in Table (6) indicate that tubers storability and sprouting % at the end of storage period were significantly affected by micronutrients application methods. Application of micronutrients as a foliar spray method gave The lowest weight loss and sprouting% compared with the other treatments. These results are in harmony with those of Abdel-Fattah *et al*. (2002) and El-Morsy *et al*. (2004) found that weight loss percent of garlic bulbs was significantly reduced during the storage period with plants sprayed by micronutrients.

Regarding the effect of interaction between organic fertilization sources and micronutrients application methods, data in Table (6) show that the positive interactions between application PM and micronutrients application methods often observed on storability of tubers. The lowest weight loss% during the storage period and sprouting% at the end of storage period (four months) were obtained from application of PM with foliar spray of micronutrients in both seasons.

From the results of this study, it could be concluded that, application of poultry manure (PM) with micronutrients as a foliar spraying method are the recommended treatments for increasing potato yield, improving tuber quality and storability of potato under similar conditions to this work.

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تأثير بعض مصادر التسميد العضوى وطرق إضافة العناصر الصغرى على إنتاجية وجودة البطاطس

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نُفذت تجربتان حقليتان على نباتات البطاطس صنف اسبونتا فى قرية كفر ميت فارس - المنصورة، محافظة الدقهلية خلال موسمى الزراعة الشتويين ٢٠٠٤/٢٠٠٥ و ٢٠٠٥/٢٠٠٦ م وذلك لدراسة تأثير استخدام بعض مصادر الأسمدة العضوية (سماد المزرعة، سماد الدواجن و خليط بنسبة ٥٠% من كل منهما) وطرق إضافة العناصر الصغري (إضافة أرضية، الرش الورقى و إضافة أرضية + رش ورقى) بالإضافة إلى تفاعلاتهم على النمو الخضرى، المحصول ومكوناتة وكذلك جودة الدرنات وبعض المكونات الكيميائية بالدرنة، وكذلك القدرة التخزينية للدرنات خلال فترة التخزين (٤ شهور). وقد وزعت المعاملات فى قطع منشقة مرة واحدة فى ثلاثة مكررات. ويمكن تلخيص النتائج المتحصل عليها فيما يلى:-

أوضحت النتائج أن طول النبات، عدد الأوراق/نبات، الوزن الجاف للنبات، المحصول الكلى/فدان، عدد الدرنات/نبات ومتوسط وزن الدرنة قد زادت معنوياً خلال موسمى التجربة باستخدام سماد الدواجن متبوعا بـ (٥٠% سماد بلدى+٥٠% سماد دواجن). ومن ناحية أخرى، فإن النسبة المئوية للمادة الجافة بالدرنة والمادة الصلبة الكلية وكذلك محتوى الدرنة من النيتروجين و الفوسفور و البوتاسيوم والعناصر الصغري (حديد- زنك – منجنيز) وكذلك محتوى الدرنة من حمض الأسكوربيك والنشا والسكريات المختزلة قد زادت معنويا خلال موسمى الدراسة باستخدام سماد الدواجن، أيضاً فقد أدى استخدام سماد الدواجن إلى انخفاض نسبة نقص وزن الدرنات ونسبة التزريع خلال وعند نهاية فترة التخزين فى كلا الموسمين.

وقد أدت إضافة العناصر الصغرى بطريقة الرش الورقي إلى زيادة معنوية فىصفات النمو الخضرى المدروسة وكذلك زيادة المحصول الكلى وتحسين صفات الجودة للدرنات. أيضاً زاد محتوى الدرنة من النيتروجين، الفوسفور ، البوتاسيوم ، الحديد، الزنك، المنجنيز و حمض الأسكوربيك، النشا والسكريات المختزلة وبجانب ذلك أدت إلى انخفاض نسبة نقص وزن الدرنات عند نهاية فترة التخزين فى كلا الموسمين.

أوضح التفاعل بين الأسمدة العضوية وطرق إضافة العناصر الصغرى تأثيراً معنوياً على معظم الصفات المدروسة. كانت أفضل النتائج باستخدام سماد الدواجن مع طريقة الرش الورقي بخليط من العناصر الصغري المخلبة (حديد- زنك – منجنيز)، حيث أدى هذا التفاعل إلى زيادة فى صفات النمو الخضرى وكذلك المحصول الكلى للفدان وتحسين صفات جودته، وقد أدى التفاعل أيضاً إلى تحسين القدرة التخزينية للدرنات فى كلا موسمى الدراسة.

وبناءً على ماتقدم، يمكن التوصية باستخدام هذه المعاملة (سماد الدواجن مع الرش الورقى للعناصر الصغرى) لرفع إنتاجية البطاطس وتحسين جودة الدرنات وقابليتها للتخزين تحت الظروف المشابهة لظروف هذا البحث.

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