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EFFECT OF BIO AND CHEMICAL FERTILIZERS ON GROWTH, YIELD AND CHEMICAL COMPOSITION OF POTATO (*Solanum tuberosu*) UNDER SAND SOIL CONDITION.

BY

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ABSTRACT

Two field experiments (two summer seasons of 2002 and 2003) were carried out on a sand soil at a farm in Salhia area, Ismailia, Governorate for study the effect of combination three rates (per feddan) from bio-fertilizers (without "B0"), (500g of inoculums of a mixture PDB (P-dissolving bacteria) and (NFB) N-fixation bacteria + 300g of PDB inoculums + 2 L. of SF (spray fertilizer liquid containing 24% K + 5% N "B1") and (double the amounts of inoculums + 1.5 the amount of spray liquid "B2") and three levels (kg/fed.) NPK (75 + 7 + 60 "L1", (100 + 14 + 80 "L2") and (125 + 21 + 100 "L3" kg/fed.) and their interaction on yield, vegetative growth and chemical composition of potato plants. Bio-fertilization increased yields of tubers with main effects as follows (metric ton/fed.): B0:12.08, B1: 13.22, B2: 13.75 (average of 2 seasons). Mineral fertilization increased yields with main effect of L1: 12.42, L2: 13.23, L3: 13.39.

Total yield of potato tubers was highest by the B1 L3 treatment. The results showed also that using B2 significantly increased the plant height, number of branches/ plant, fresh and dry weight of plant foliage, number and weight of tubers/ plant, total yield, marketable yield percentage, large tuber percentage and chemical composition of potato plant and tubers. The L3 mineral fertilization treatment increased all parameters under investigation.

Regarding the interaction between bio and mineral fertilizers; results indicate that B2 L2 significantly increased plant height, number of branches/plant, fresh weight, number and weight of tubers/plant, total yield, marketable yield percentage, percentage of large tuber and chemical composition of plant foliage and tubers.

Increases in contents of N, K, Fe, Mn, and Zn in plant foliage increased by up to 60 %, 29 %, 88 %, 69 % and 70 % for each nutrient respectively as a result of applying (L2 B2), (L2 B2), (L3 B1), (L2 B2) and (L2 B2), respectively. Comparable values content in tubers were 32 %, 27 %, 62 %, 79 % and 57 % for each nutrient respectively and as a result of applying (L3 B1), (L2 B2), (L3 B1), (L2 B2) and (L2 B2), respectively.

Foliage N, K, Fe and Zn contents were higher than in tubers, but foliage P and Mn were lower than in tubers.

Key words: Bio and chemical fertilizers, yield, N, P, K, Fe, Mn, Zn, sand soil, potato (*Solanum tuberosum* L.)

INTRODUCTION

Potato (*Solanum tuberosum*) is among the most important crop grown in Egypt, whether regarding domestic consumption or exportation. In recent years attention has been done to use bio-fertilizers through inoculation as well as using organic fertilizers, in order to reduce plant and soil contamination with some elements and also to reduce the use of mineral fertilizers.

Soil micro organisms play a fundamental role in overcoming the problems of immobilization fixation and precipitation of soluble micronutrients the solubility problem in many soils, by releasing the immobilized, fixed, or precipitated forms of nutrients thus transforming then into soluble forms to be ready for plant nutrition, such as phosphate dissolving bacteria and inoculums of a mixture "P-dissolving bacteria and N-fixation bacteria" would give the same effect of nitrogen and would reduce the amount of fertilizer nitrogen and increase the growth characteristics of plant foliage and produce large potato tubers, and bean yield (Ghosh and Das, 1998, Abou-Hussein, 2001 and Abdalla *et al.*, 2001).

Utilization of bio fertilizers mixed with N and K nutrients applied through spray on haulm of plant proved useful on increasing yield and its components by enhancing storage of carbohydrates in potato tubers (Mahendran and Chandramani, 1998) and in onion (El-Sheekh, 1997). Also, bio-fertilizers had a marked effect on nutrient contents of potato foliage and tubers (Mahendran and Chandramani, 1998).

The balance between N, P and K and increasing their levels had an important role for increasing vegetative growth (Reisi and Khajehpour, 1992, Juzl, 1994), yield and its components (Azad *et al.*, 1996, Arisha and Bardisi, 1999), potato tuber size (Rabie, 1996, Arafa, 1999), as well as the chemical composition of all plant parts, foliage and tuber (Arisha and Bardisi, 1999).

The combination between NPK and bio-fertilizers was reported to be more effective in increasing vegetative growth (Rahman *et al.*, 1992, El-Gamal, 1996), yield and its components, tuber size (El-Gamal, 1996, Mahendran and Chandrmani, 1998, El-Dsouky and Attia, 1999) and chemical contents of different plant parts, (Hauka *et al.*, 1990 on barly and tomato, El-Sheekh, 1997 on onion).

The current study was carried out to investigate the influence of different combinations of mineral fertilization levels (NPK) and combinations of biofertilization (of several groups of microorganisms "inoculums of a mixture P-dissolving bacteria and N-fixation bacteria", phosphate dissolving bacteria and K-

spray fertilizer "24% K + 5% N") on growth, yield and its components, tuber size and chemical composition of potato grown on a sand soil.

MATERIALS AND METHODS

Two field experiments were carried out during the two summer growing seasons of 2002 and 2003 on a sand soil at a farm in Salhia area in Ismailia, Governorate, Egypt, using potato plants (*Solanum tuberosum* cv. Hermis) for response to mineral fertilization with (NPK) and biofertilization. Soil properties of the experimental site are present in Table (1).

Representative soil samples were taken from the experimental field before initiating the experiment and analyzed for soil properties. Soil particle size distribution was done without $CaCO_3$ removal using the pipette method Piper (1950). Water holding capacity, field capacity, wilting point, $CaCO_3$ content, pH, salinity, and organic matter percent were determined methods cited in Black *et al.* (1965). Salinity and soluble ions were determined in the soil water paste extract (SO_4^{--} was calculated by subtracted). Available macronutrients (NO_3-N, P and K) and available micronutrients (Fe, Mn, and Zn) were extracted by ammonium bicarbonate-diethylenetriaminepentaacetic acid (NH_4HCO_3-DTPA) and determined according to Soltanpour (1985).

The experiment was a factorial in a randomized complete block design. It included 9 treatments, which were the combination between three rats of (NPK) mineral fertilization and three rats of biofertilization (of several groups of microorganisms "inoculums of a mixture P-dissolving bacteria and N-fixation bacteria", phosphate dissolving bacteria and K-spray fertilizer "24% K + 5% N") as follows:

A- Levels of N P K mineral fertilization.

1. 75 + 7 + 60 kg N P K respectively/ fed., referred to as "L1"
2. 100 + 14 + 80 kg N P K respectively/ fed., referred to as "L2"
3. 125 + 21 + 100 kg N P K respectively/ fed., referred to as "L3"

(1P=2.29 P_2O_5; 1K=1.25 K_2O)

B- Biofertilization rates:

1- Non-biofertilization referred to as "B0"

2- Biofertilization 1 (referred to as "B1") using the following substances and rates/fed.
500g of inoculums of a mixture PDB (P-dissolving bacteria) and (NFB) N-fixation bacteria + 300g of PDB inoculums + 2 L of SF (spray fertilizer liquid containing 24% K + 5% N).

3- Biofertilization 2 (referred to as "B2") using the above-mentioned components at rates of 1000g + 600g + 3L per feddan.

Bib-fertilizer inoculums materials are produced by General Organization for Agricultural Equalization Fund, Ministry of Agriculture and Land Reclamation, Egypt.

The mineral fertilizer materials were ammonium nitrate (33.5 % N), added as triple super phosphate (16.3 % P) potassium sulphate (40% K). The bio-fertilizers contained several groups of microorganisms "inoculums of a mixture P-dissolving bacteria and N-fixation bacteria" and phosphate dissolving bacteria were mixed with potato tuber seeds while the spray fertilizer was sprayed on potato plant in two equal portions after 60 and 80 days after seeding.

Phosphorus fertilizer was added during the soil preparation before planting. Mean while, the amounts of nitrogen and potassium fertilizer were divided into three equal portions and added at 10 days intervals beginning after completely emergence.

A randomized complete block design (factorial) with three replications was used. Plot area was 9.45 m^2, which included 3 rows of 3.5 m long and 0.9 m wide. Tuber seeds were sown on 16th January in the two seasons of growth and spaced at 25 cm apart. Other agricultural practices required for potato production were done as commonly followed in the region.

Table (1): Soil properties of the experimental site.

A: Particle size distribution, calcium carbonate and organic matter (OM) contents:

Particle fraction (%)			Textural Class	$CaCO_3$ %	OM %
Sand	Silt	Clay			
93.8	3.2	3.0	Sand	1.70	0.22

B: Soil moisture parameters (w/w %):

Water holding capacity %	Field capacity %	Wilting point %	Available water (%)
18.5	9.98	3.08	6.90

C: Available nutrients (Am.bicarbonate DTPA extract):

Available macro-nutrients mg/kg soil			Available micro-nutrients mg/kg soil		
NO_3-N	P	K	Fe	Mn	Zn
6.1	1.8	46	3.3	0.5	1.0

D: Soil pH and chemical analysis of the soil paste extract:

pH (1 - 2.5 soil water susp.)	EC dS/m	Soluble anions			Soluble cations			
		mmol$_c$/L						
		HCO_3^-	Cl^-	$SO_4^=$	Ca^{++}	Mg^{++}	Na^+	K^+
7.70	1.20	3.97	1.5	6.65	5.77	3.97	1.89	0.49

Data recorded:

I- Vegetative growth:

Two plants from each treatment were randomly pulled out of the soil (75 days after planting) to determine the following parameters:

1- Plant height.
2- Number of branches / plant
3- Fresh weight of plant foliage.
4- Dry weight of plant foliage.

Different plant parts, i.e. shoots and tubers, were oven dried at 70°C till constant weight for determining the contents of "N, P, K, Fe, Mn and Zn"

II- Yield, yield components and tuber quality:

At 120 days of planting, tubers from each plot were harvested, weighed, counted and graded for recording the following data:

1. Number of tubers / plant. 2. Average weight of tuber.
3. Average yield of tubers / plant.
4. Yield
5. Tuber size: Potato tubers of each plot were graded into three sizes as follows:

I. The large size tuber (more than 55mm diameter).
II. The medium size tubers (35-55mm diameter).
III The small size tubers (less than 35mm diameter).

Tubers of each size were weighed and its percentage of the total marketable yield was calculated.

III- Chemical composition of plant foliage and tubers:

Total nitrogen, phosphorus, and potassium, in the digested dry matter of each plant foliage and tubers N was determined by the Kjeldahl method according to methods cited by Pregl (1945), Murphy and Riely (1962) and Brown and Lilleland (1946)

Micronutrients of Fe, Mn and Zn were determined in the digests using the atomic spectro photometer (Philips) according to Chapman and Pratt (1961).

Results were statistically analyzed according to the methods described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

1. Vegetative growth:

a) The main effect of biofertilization:

Data in Table (2) show the, vegetative growth of potato plants expressed as plant height, number of branches/plant, fresh weight and dry weight of plant foliage as affected by the inoculation of different biofertilization compounds. In this respect the used bio-fertilizers significantly increased all plant growth parameters. The highest values in all recorded plant growth traits were obtained by using the B2 treatment, i.e. the high level of biofertilization

(1000+600+3L/fed). The superiority of using the biofertilization compound of contained several groups of. microorganisms "inoculums of a mixture P-dissolving bacteria and N-fixation bacteria" and phosphate dissolving bacteria to the soil reflects a release of fixed P and formation of N-substances by bacteria, hence increasing availability of these two elements in the root zone. Nitrogen and phosphorus play a great role in enlargement and cell division and also enhance protein synthesis necessary for building new cells. These results are similar to those reported by Ghosh and Das, (1998), Abdalla *et al.* (2001) and Abou-Hussein (2001).

b) The main effect of mineral fertilization:

Data in Table (2) show also that, all the studied vegetative growth parameters significantly increased with increasing the combination mineral fertilizes (NPK) levels up to the highest used level (125 + 21+100 kg NPK/ fed) in both growing seasons. For some parameters, differences between L1 and L2 were slight and not statistically significant. These results agree with those reported by Reisi and Khajehpour (1992) and Juzl (1994).

Table (2): Effect of different combinations biofertilization rates, combinations of mineral fertilization and their interaction on vegetative growth of characteristics of potato plants.

Treatment		2002				2003			
		Plant height (cm)	No. of branches /plant	Fresh weight plant(g)	Dry weight/ plant "g"	Plant height (cm)	No. of branches /plant	Fresh weigh plant (g)	Dry weight/ Plant "g"
Biofertilization (B)	B0	57.0	2.9	485	73.8	50.0	2.1	350	81.0
	B1	62.1	3.1	542	86.5	52.0	2.3	643	102.9
	B2	63.0	3.2	546	87.8	53.0	2.3	647	104.3
	LSD at 0.05%	0.6	0.2	3	3.2	0.9	0.1	2	2.0
NPK-mineral fertilization (L)	L1	60.0	2.9	462	75.4	50.0	2.1	582	95.0
	L2	60.6	3.0	548	84.7	51.0	2.2	617	96.0
	L3	62.6	3.3	563	88.0	52.0	2.5	622	97.1
	LSD at 0.05%	0.9	0.3	1	2.5	1.1	0.1	3	1.0
Level L1	B0	56.0	2.8	443	70.9	48.0	2.0	488	78.1
	B1	60.0	3.0	446	72.7	51.0	2.1	620	101.1
	B2	62.7	3.1	497	82.5	53.0	2.2	638	105.9
Level L2	B0	55.0	2.8	503	67.9	48.0	2.1	513	69.2
	B1	60.3	3.0	540	86.4	50.0	2.2	660	105.6
	B2	66.5	3.2	601	99.8	53.0	2.3	678	113.2
Level L3	B0	60.0	3.0	510	82.6	52.0	2.2	591	95.7
	B1	66.0	3.4	640	100.5	53.0	2.7	650	102.0
	B2	60.0	3.2	540	81.0	50.0	2.5	625	93.7
	LSD at 0.05%	1.1	0.3	5	5.1	1.5	0.2	4	6.0

c) Effect of the interaction:

The higher rate of biofertilizer (B2) was superior to the lower rate (B1) only in presence of the high level of mineral fertilizer (L3). The lower rate of biofertilizer giving more vegetative growth characteristics over the higher rates of bio-fertilizer during both growing seasons. Also, L2 was much superior to L1 in presence of B2. These results are in agreement with those reported by Rahman *et al.* (1992) and El-Gamal (1996).

2-Chemical composition of potato plants foliage:

a) The main effect of biofertilization:

Data in Table (3) show significant differences due to biofertilization. The high B2 rate was superior in N, K, Fe, Mn and Zn content. However, analyses of variances generally revealed that mean value of P-content in potato foliage was not significantly affected by biofertilization. These obtained results may be due to the main role of such studied biofertilizers increasing the solubility of determined macro and micro-elements at the root zone and consequently increasing their availability. Nitrogen fixing-bacteria may have increased the synthesis of the endogenous phytohormones such as Indole Acetic Acid (IAA), Gibbrelic Acids (GA_3) and Cytokinones (CK_s). These substances play an important role in formation of active root systems that allow more of nutrients for uptake and hence promote photosynthesis and translocation. These results are agreement with those reported by El-Sheekh (1997) and Mahenadran and Chandramani (1998).

b) The main effect of mineral fertilization:

The same data in Table (3) also indicate that, contents of macro and micronutrients mean values significantly increased by mineral fertilizer use. These results confirm those reported by Arisha and Bardisi (1999).

There were increases in P-content due to biofertilization as well as mineral fertilization although such differences were not statistically significant.

c) Effect of the interaction:

A occurred with N, K, Fe, Mn and Zn content in potato foliage, high rate of biofertilizers was superior to low rate only where L1 or L2 were used giving average increases (two seasons) in N, K, Fe, Mn and Zn amounting to 15.5%, 12.0%, 44.5%, 17.0% and 13.5% respectively under conditions of L1 or 40.0%, 9.0%, 6.5%, 16.5% and 13.0% respectively under conditions of L2. However, the high rate was inferior to the low rate giving 19.0%, 6.5%, 27.5%, 8.0% and 6.5% (average of two seasons), less N, K, Fe, Mn and Zn contents respectively than the low rate under conditions of L3. Phosphorus content in foliage was not significantly affected by the interaction caused by the combination of mineral fertilizer (NPK) and biofertilizers. These results are in the same line with those reported by Hauka *et al.* (1990) and El-Sheekh (1997).

Table (3): Effect of different combinations biofertilization rates, combinations of mineral fertilization and their interaction on chemical composition of potato foliage.

Treatment		2002					
		N %	P %	K %	Fe mg/kg	Mn mg/kg	Zn mg/kg
Biofertilization (B)	B0	2.88	0.284	6.3	52	16	79
	B1	3.21	0.377	7.0	63	18	87
	B2	3.36	0.398	7.4	67	19	89
	L.S.D at 0.05	0.05	ns	0.1	2	1	2
NPK-mineral fertilization (L)	L1	2.67	0.262	6.6	54	16	84
	L2	3.31	0.348	7.0	65	18	80
	L3	3.46	0.484	7.2	67	19	90
	L.S.D at 0.05	0.07	ns	0.1	2	1	3
Level L1	B0	2.41	0.205	5.7	40	15	80
	B1	2.67	0.227	6.6	50	16	83
	B2	2.94	0.356	7.4	65	18	90
Level L2	B0	3.02	0.205	7.3	60	16	66
	B1	3.32	0.356	7.0	66	18	83
	B2	4.60	0.485	7.7	70	20	90
Level L3	B0	3.20	0.442	6.9	63	18	90
	B1	3.64	0.549	7.4	73	20	93
	B2	3.55	0.355	7.2	65	18	86
	L.S.D at 0.05	0.08	ns	0.2	3	2	4
		2003					
Biofertilization (B)	B0	2.35	0.055	6.2	48	13	50
	B1	2.91	0.212	7.4	71	18	74
	B2	3.14	0.402	7.6	74	20	81
	L.S.D at 0.05	0.09	ns	0.4	1	1	2
NPK-mineral fertilization (L)	L1	2.72	0.184	6.5	58	14	66
	L2	2.81	0.250	7.2	66	18	69
	L3	2.87	0.236	7.4	69	19	70
	L.S.D at 0.05	0.07	ns	0.5	1	1	2
LevelL1	B0	2.52	0.034	5.4	37	12	46
	B1	2.55	0.155	6.7	53	14	70
	B2	3.08	0.362	7.5	84	17	83
Level L2	B0	2.04	0.055	6.3	53	13	50
	B1	2.67	0.333	7.4	70	18	72
	B2	3.74	0.462	8.0	75	22	85
Level L3	B0	2.50	0.067	6.9	53	15	53
	B1	3.51	0.248	8.0	90	21	80
	B2	2.61	0.384	7.3	63	20	76
	L.S.D at 0.05	0.16	ns	0.7	2	2	3

3- Yield and its components:

Total yields (metric ton/fed.) are presented in table (4). The non-treated treatments gave total yields of potato of 12.171 ton/fed., but the bio or mineral-fertilized ones gave increases of 33.4% for (L3 B1); 29.8% for (L1 B2); 23.4% for (B2); 22.8%.for (L2 B2); 17.7% for (L3 B2); 17.5% for (L3); 16.2% for (L2); 15.5% for (B1); 14.6% for (L2 B1) and 5.0% for (L1). A marked increase in yield occurred by fertilizers application, increase ranged between from 5.0% - 33.4% in first season, but second season giving less percent than first season. The combination of biofertilizers rate showed higher yield compared with combination of mineral fertilizers giving a mean of 14.54 ton/fed. "giving 19.5% more yield" as compared with 13.74 ton/fed. "giving 12.9% more yield" given by mineral fertilizers. This effect could be due to that biofertilizers which plays a fundamental role in releasing nutrients and making then ready for plant nutrition. Biofertilizers would increase microorganisms in soil; the microorganisms would produce growth promoting substances which increase the plant growth. This increase in plant growth would increase the photosynthetic rates leading to an increase of the assimilation rates.

a) The main effect of biofertilization:

Data in Table (4) show that the numbers of tubers per plant, average tuber weight, yield of tuber/plant, total and marketable yield significantly increased with addition of biofertilizers in both growing seasons. Tubers yield per plant and unmarketable yield percentage significantly increased in the second season only. These results are in agreement with those reported by El-Sheekh (1997) and Mahenadran and Chandramani (1998).

b) The main effect of mineral fertilization:

The same data in Table (4) show also that the number and weight of tubers /plant and total yield as well marketable yield significantly increased with increasing levels combination of (NPK) fertilizer. These results are in agreement with those reported by Azad *et al.* (1996) and Arisha and Bardisi (1999).

c) Effect of the interaction:

Data in Table (4) show that the bio-fertilizer in combination with the highest L3 (NPK) fertilizers increased the number of tubers per plant, tuber weight, total and marketable yield. However tuber yield per plant significantly increased in second season only. The high total yield obtained from using the combination of bio and (NPK) fertilizers may be due to the increase of these attributes in plant foliage and significantly increased fresh weight of potato plant and its organs leading to a large increase in production of potato. Also, biofertilization may have increased absorption of nitrogen and phosphorus by plant. The role of nitrogen in the formation of chlorophyll molecule and other component of all proteins. Phosphorus is important for production and maturing. It functions as a part of the enzyme system in plant. These results are reported by El-Gamal (1996), Mahendran and Chandrmani (1998) and El-Dsouky and Attia (1999).

Table (4): Effect of different combinations biofertilization rates, combinations of mineral fertilization and their interaction on potato tuber yield and its components.

Treatment		2002					
		No. of tubers/ plant	Tuber weight (g)	Tubers yield/ plant (g)	Total yield ton/fed	Market able yield ton/ fed	Unmar-ketable yield %
Biofertilization (B)	B0	6.8	124.7	848	12.171	11.749	3.6
	B1	7.4	130.3	964	14.055	13.695	2.6
	B2	7.7	131.8	1015	15.020	14.890	0.9
	L.S.D at 0.05%	0.3	1.4	7	0.550	0.320	0.2
NPK-mineral fertilization (L)	L1	6.9	125.2	864	12.766	12.155	5.0
	L2	7.3	128.0	934	14.137	14.048	0.6
	L3	7.7	133.6	1029	14.306	14.131	1.2
	L.S.D at 0.05%	0.1	2.3	4	0.580	0.220	0.3
Level L1	B0	6.0	118.8	713	10.520	9.440	11.4
	B1	7.0	127.0	889	11.850	11.205	5.8
	B2	7.7	130.0	1001	15.795	15.720	0.5
Level L2	B0	6.5	122.0	793	13.635	13.525	0.8
	B1	7.2	129.0	929	13.945	13.785	1.2
	B2	8.2	133.0	1091	14.940	14.835	0.7
Level L3	B0	8.0	133.5	1068	12.360	12.280	0.7
	B1	8.0	135.0	1080	16.235	15.995	1.5
	B2	7.2	132.4	953	14.325	14.115	1.5
	L.S.D at 0.05%	0.5	2.5	8	0.950	0.550	0.4
		2003					
Biofertilization (B)	B0	6.4	88.7	568	11.985	11.810	1.5
	B1	6.8	96.2	654	12.385	12.066	2.6
	B2	6.9	97.9	676	12.485	12.133	2.9
	L.S.D at 0.05%	0.3	1.8	3	0.100	0.150	0.9
NPK-mineral fertilization (L)	L1	6.5	90.1	586	12.066	11.827	2.0
	L2	6.8	92.0	626	12.315	11.950	3.1
	L3	6.9	100.6	694	12.470	12.200	2.2
	L.S.D at 0.05%	0.3	1.8	4	0.050	0.140	0.8
Level L1	B0	6.0	87.1	523	11.800	11.682	1.0
	B1	6.6	88.3	583	12.100	11.800	2.5
	B2	6.8	94.9	645	12.300	12.000	2.5
Level L2	B0	6.5	87.4	568	11.950	11.650	2.6
	B1	6.8	89.2	607	12.200	11.200	8.9
	B2	7.1	99.5	707	12.800	12.300	4.1
Level L3	B0	6.8	91.6	623	12.205	12.100	0.9
	B1	7.0	111.0	777	12.850	12.500	2.8
	B2	6.7	99.5	667	12.350	12.100	2.1
	L.S.D at 0.05%	0.5	3.1	4	0.180	2.250	1.5

4) Tuber size percentage:

a) The main effect of biofertilization:

The data in Table (5) show that, biofertilization significantly increased the percentage of the large tubers size in both growing seasons, mean while, the percentages of medium and small tubers size were increased with no added biofertilizers in the two seasons.

Table (5): Effect of different combinations biofertilization rates, combinations of mineral fertilization and their interaction on percentage of tubers size grades of potato.

Treatment		2002			
		Large (>55mm) %	Medium (35-55mm) %	Small (<35mm) %	DM %
Biofertilization (B)	B0	50.3	42.6	7.1	20.3
	B1	54.0	42.4	3.6	20.6
	B2	55.1	41.9	3.0	21.1
	L.S.D at 0.05%	0.5	0.5	0.3	0.01
NPK-mineral fertilization ((L)	L1	52.1	44.5	3.4	20.5
	L2	53.4	42.4	4.2	20.7
	L3	53.8	40.1	6.1	20.7
	L.S.D at 0.05%	0.7	0.4	0.3	0.02
Level L1	B0	49.4	43.2	7.4	20.0
	B1	52.0	45.8	2.2	20.6
	B2	54.9	44.6	0.5	21.1
Level L2	B0	50.3	43.6	6.1	20.4
	B1	54.0	40.9	5.1	20.6
	B2	56.0	42.5	1.5	21.1
Level L3	B0	51.3	41.0	7.7	20.5
	B1	56.0	40.6	3.4	20.6
	B2	54.3	38.6	7.1	21.1
	L.S.D at 0.05%	0.9	0.8	0.5	0.03
Biofertilization (B)		2003			
	B0	34.8	55.3	9.9	20.1
	B1	36.6	59.2	4.2	20.4
	B2	37.7	57.2	5.1	21.0
	L.S.D at 0.05%	1.2	0.5	0.2	0.01
NPK-mineral fertilization ((L)	L1	35.0	59.6	5.4	20.4
	L2	37.0	54.7	8.3	20.5
	L3	37.3	57.3	5.4	20.6
	L.S.D at 0.05%	0.7	2.2	0.3	0.02
Level L1	B0	33.3	55.0	11.7	20.0
	B1	34.8	62.1	3.1	20.4
	B2	36.8	61.7	1.5	21.0
Level L2	B0	35.2	52.7	12.1	20.2
	B1	37.1	54.9	8.0	20.4
	B2	38.6	56.6	4.8	21.0
Level L3	B0	36.0	58.1	5.9	20.3
	B1	38.0	60.6	1.4	20.4
	B2	37.8	53.3	8.9	21.1
	L.S.D at 0.05%	2.1	0.9	0.3	0.03

b) The main effect of mineral fertilization:

Data in Table (5) also show that, the percentage of large tubers size significantly increased with the highest level of (NPK) fertilizers in both growing seasons. These results are in agreement with those reported by Rabie (1996) and Arafa (1999).

c- Effect of interaction:

Data in Table (5) reveal that, the combination between biofertilization and (NPK) fertilizers significantly increased the percentage of the large tubers size, while medium size increased with the biofertilizer and lowest level of NPK (75 +7+60 NPK kg/fed.) in both growing seasons. These results are in agreement with those reported by El-Gamal (1996), Mahendran and Chandrmani (1998) and El-Dsouky and Attia (1999).

5) Chemical composition of tubers:

a) The main effect of biofertilization:

Data in Table (6) indicate that, there were significant differences among N, K, Fe, Mn and Zn values. The content of such elements increased with increased biofertilizers rates in both seasons. Applying biofertilizers must have increased microorganisms in the soil, which increase the ability of mobilizing unavailable forms of nutrients to available forms. These results are in agreement with reported by El-Sheekh (1997) and Mahendran and Chandrmini (1998).

Analysis of variance revealed that mean values of P-content was not significantly affected by treatments under the studied conditions.

b) The main effect of mineral fertilization:

Data presented in Table (5) also show that, the N, K, Fe, Mn and Zn content of tubers were significantly increased with the use of the highest level of (NPK) fertilizers. These results are in agreement with those reported by Arisha and Bardisi (1999).

C) Effect of interaction:

As occurred with N, K, Fe, Mn and Zn content in potato tubers, high rates of combination biofertilization were superior (average of two seasons) to low rates only where L1 or L2 were use giving 9%, 15%, 31%, 53% and 55% respectively under conditions of L1 or 8%, 20%, 12%, 27% and 48% respectively under conditions of L2. However, high rates was inferior to low rates giving 12%, 4%, 5%, 15% and 8% less N, K, Fe, Mn and Zn-content than low rates when the L3 was used. There were increases in P-content in potato tubers due to biofertilization as well as mineral fertilization although such differences were not statistically significant.

Table (6): Effect of different combinations biofertilization rates, combinations of mineral fertilization and their interaction on chemical composition of potato tubers.

Treatment		2002					
		N %	P %	K %	Fe mg/kg	Mn mg/kg	Zn mg/kg
Biofertilization (B)	B0	1.76	0.240	3.4	37	35	33
	B1	1.87	0.435	3.6	53	41	36
	B2	1.88	0.450	3.9	56	44	47
	L.S.D at 0.05	0.07	Ns	0.2	1	1	1
NPK-mineral fertilization (L)	L1	1.36	0.315	2.3	44	33	34
	L2	2.02	0.373	3.8	50	42	38
	L3	2.13	0.400	3.9	52	45	45
	L.S.D at 0.05	0.05	Ns	0.2	2	1	2
Level L1	B0	1.25	0.169	3.1	36	20	26
	B1	1.39	0.333	3.2	43	33	30
	B2	1.43	0.442	3.3	53	46	46
Level L2	B0	1.95	0.260	3.5	35	39	30
	B1	2.02	0.398	3.6	56	40	33
	B2	2.10	0.462	4.3	60	46	50
Level L3	B0	2.10	0.290	3.7	40	46	43
	B1	2.20	0.575	3.9	60	50	45
	B2	2.10	0.444	4.0	56	40	46
	L.S.D at 0.05	0.13	Ns	0.3	1	2	2
		2003					
Biofertilization (B)	B0	1.67	0.269	3.3	42	28	42
	B1	1.89	0.593	3.5	47	37	47
	B2	1.93	0.624	3.9	54	48	58
	L.S.D at 0.05	0.07	ns	0.1	2	3	2
NPK-mineral fertilization (L)	L1	1.55	0.469	3.3	43	33	41
	L2	1.89	0.507	3.6	50	38	50
	L3	2.06	0.510	3.8	51	42	55
	L.S.D at 0.05	0.07	ns	0.1	1	3	2
Level L1	B0	1.21	0.290	3.0	36	20	33
	B1	1.60	0.505	3.1	40	30	36
	B2	1.84	0.613	3.9	55	50	56
Level L2	B0	1.70	0.247	3.2	43	30	40
	B1	1.88	0.634	3.4	50	36	46
	B2	2.09	0.641	4.1	57	50	66
Level L3	B0	2.12	0.270	3.7	49	35	53
	B1	2.20	0.640	4.0	53	47	60
	B2	1.85	0.620	3.8	52	45	53
	L.S.D at 0.05	0.13	ns	0.1	4	5	4

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تأثير التسميد الحيوى والمعدنى على النمو الخضرى والمحصول والتركيب الكيمائى للبطاطس تحت ظروف الأراضى الرملية.

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أجريت تجارب حقليه فى مزرعه بمنطقه الصالحيه بالاسماعليه فى موسمين صيفيين زراعيين (٢٠٠٢ و٢٠٠٣) وذلك بهدف دراسه تأثير اضافه ثلاث معدلات مجتمعه من التسميد الحيوى/فدان (٥٠٠جم من مجموعه مختلطه من الكائنات الحيه الدقيقه التى "تثبت أزوت الهواء الجوى" و"مزيبه للفوسفور"+٣٠٠جم من بكتريا مزيبه للفوسفور +٢ لتر من سماد بوتاسى ورقى محتوى على ٢٤% بوتاسيوم+٥% أزوت "B1" اما المعدل الثانى عباره عن ١٠٠٠جرام + ٦٠٠جم +٣ لتر من نفس المكونات السابقه على التوالى"B2" بالإضافة إلى الكنترول"B0" بدون اضافه مع ثلاثة مستويات مجتمعه من التسميد المعدنى من النتروجين، الفوسفور، البوتاسيوم بمعدلات(٧٥+٧+٦٠"L1"؛ ١٠٠+١٤+٨٠"L2"، ١٢٥+٢١+١٠٠كجم/فدان"L3") على النمو والمحصول وجودة الدرنات والتركيب الكيماوى للمجموع الخضرى والدرنات لنبات البطاطس صنف "هيرمز" تحت ظروف الأراضى الرملية.

- بينت النتائج أن التسميد الحيوي أعطى تفوق فى المحصول الكلى للدرانات أعطت معامله الكنترول ١٢,٠٨. والمعدل الاول اعطى ١٣,٢٢ والمعدل الثانى اعطى ١٣,٧٥ طن/فدان بالمقارنه بالتسميد المعدنى فالمعدل الاول منه أعطى ١٢,٤٢ والثانى ١٣,٢٣ والثالث ١٣,٣٩ طن/فدان (كمتوسط للموسمين). كما أظهر التفاعل بين B1 L3 الحصول على أعلى محصول كلى للدرنات.

- وقد أظهرت النتائج تفوق مستوى السماد الحيوى "B2" على باقى مستويات التسميد الحيوى فى كل الصفات تحت الدراسة وهى طول النبات، عدد الأفرع/ نبات، الوزن الغض والجاف للنبات والتركيب الكيماوى للمجموع الخضرى والمحصول ومكوناته مثل عدد الدرنات/ نبات، متوسط وزن الدرنة، محصول النبات، محصول الفدان، محصول الصالح للتسويق والنسبة المئوية للدرنات الكبيرة فى الحجم وكذلك المحتوى الكيماوى للدرنات. أما التسميد المعدنى فقد أدى استخدم المستوى الثالث "L3" إلى الحصول على أعلى القيم للصفات محل الدراسة.
- أما بالنسبة لتأثير التفاعل فقد أدى استخدام مستوى التسميد الكيماوى الثانى"L2" مع المستوى الثانى من التسيمد الحيوى "B2" إلى الحصول على أعلى القيم للصفات الخضرية والمحصول ومكوناته والتركيب الكيماوى للمجموع الخضرى والدرنات.
- كما أوضحت الدراسه أن زياده المحتوى من النتروجين والبوتاسيم والحديد والمنجنيز والزنك فى المجموع الخضرى كانت كالتالى: ٦٠ % و ٢٩ % و ٨٨ % و٦٩ % و٧٠ % لصالح (L2B2), (L2B2), (L3B1), (L2B2), (L2B2) على التوالى. بالمقارنه بمحتوى هذه العناصر فى الدرنات كانت ٣٢ % و ٢٧ % و ٦٢ % و٧٩ % و٥٧% لصالح (L2B2), (L2B2), (L3B1), (L2B2), (L3B1) على التوالى.
- بينت النتائج أن التسميد الحيوى أعطى تفوق فى محتوى النتروجين والبوتاسيم والحديد والمنجنيز والزنك فى كل من المجموع الخضرى والدرنات وكذلك فى محتوى الفوسفور ولكن غير معنوى
- وبصفه عامه كان محتوى المجموع الخضرى من النتروجين والبوتاسيم والحديد والزنك أكثر من محتوى الدرنات من تلك العناصر عند جميع المعاملات ولكن كان محتوى المجموع الخضرى من والفوسفور والمنجنيز أقل من محتوى الدرنات من تلك العناصر عند جميع المعاملات.
- وبناء على ذلك يمكن التوصية باستخدام التسميد الحيوى بمعدل (١٠٠٠جم + ٦٠٠ جم + ٣ لتر/فدان) مع التسميد المعدنى بمعدل (١٠٠ +١٤ + ٨٠ كجم/ فدان) وباستخدام صنف البطاطس هيرمز للحصول على أفضل نمو خضرى ومحصول وجودة درنات البطاطس.