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INFLUENCE OF MINERAL FERTILIZER, ORGANIC FERTILIZER AND BIOFERTILIZERS ON GROWTH, YIELD AND QULITY OF POTATO (*Solanum tuberosum*, L.).

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ABSTRACT

Two experiments were conducted during the two successive seasons of 2001/2002 and 2002/2003 at a private farm near El-Mansoura -Dakahlia Governorate, Egypt to investigate the effect of mineral fertilizers, organic fertilizers (i.e. compost , rock phosphate) and phosphorus soluble bacteria (PSB) (*Bacillus megaterium var. Phosphatium*) on the plant growth, yield, and chemical constituents of potato tubers (cv.Slaney). This study was laid out in a randomized complete block design with 8 treatments, three replicates were used.

Obtained results could be summarized as follows:

- Mineral fertilizer(NPK) treatment recorded the highest values of vegetative growth characters and yield characters follwed with mineral fertilizer (NK) and compost plus rock phosphate or PSB either alone or in combinations. The lowest values of vegetative growth parameters were recorded with application of compost alone. Concerning chemical composition and quality parameters, the highest values of N,Pand K percentages were found in the mineral fertilizer treatments, while the lowest values of nitrate and nitrite concentration(ppm) were recorded with compost treatments either alone or in compination with rock phosphate and PSB also recorded higher values of specific gravity,starch %,T.s.s.% and ascorbic acid(mg/100g fresh weight) in both seasons.

INTRODUCTION

Potatoes are cropped continuously in Egypt from August to June. Potato is considered as one of the major important vegetable crops in Egypt. There is high demand on potatoes for local market, processing as well as exportation. Mineral fertilizers play a good deal in potato production. In this respect, El-Etriby (1997) Found that number of leaves/ plant, leaf area, fresh and dry weights of plant foliage were increased significantly with increasing NPK fertilizers up to 180 kg N+ 60 kg P_2O_5 + 100 kg K_2O/fed. Also, Arisha and Bardisi (1999) reported that the application of NPK fertilizers (60 + 45 + 75) kg/fed. increased number of branches per plant , leaves number per plant, dry weight of the shoots per potato plant, chlorophyll a, b , total chlorophyll (a+b), carotenoids in leaf tissue, NPK contents and uptake in different plant parts, specific gravity and tuber DM%. Application of 80kg N + 60 kg P_2O_5 + 100 kg K_2O / fed increased tuber dry matter from 20.88 to 28.12%,.In addition, Al-Moshileh and Moftah (2005) found that application the commercial chemical fertilizer NPK (300 kg N, 300 kg P_2O_5, 200 kg K_2O/ ha) to potato plant increased numbers of branches and leaves per plant and dry weight of the shoots. Recently, Abd Elal *et al.* (2008) found that the addition of NPK at rates of 120 – 90 –90 units/fed., resulted in the best values of plant

growth, average number of shoots, leaves number ,fresh , dry weight and tuber yield.

But, mineral fertilizer is one of the most pollutants that affect environment and public health concern in numerous areas of the world. Badiane *et al.* (1994) reported that Egypt's consumption of fertilizers is more than 10 times as much of all nutrients per hectare as dose the average for the whole world. So, a great attention has been paid to the use of bio agriculture in potato production and using organic fertilizers in order to reduce plant and soil contamination and to reduce the mineral fertilizers usages. Organic manures through its effects on physical, chemical and biological properties of the soil as well as through its effects as a source of essential nutrients can affect potato production. In this respect, Abou – Hussein *et al.* (2002) reported that using compost manure at levels (40 to 60 m^3/fed.) increased plant vegetative growth parameters expressed as number of leaves and branches as well as dry matter of potato plant foliage. More, Kabeel and Hasanin (2006) found that the addition of compost at rate of 15 tons per feddan gave significantly greater total yield of potatoes compared with other levels at 10 and 20 tons/feddan and the highest values of N and K in potato plants with significant effect compared with the control (chicken manure at rate of 15 t/fed.) and other compost levels of 10 and 20 t/feddan.

In recent years, bio-fertilizers have emerged as an important component of the integrated nutrients supply system and hold a great promise to improve crop yields through environmentally better nutrient supplies.phosphorus chemical fertilizer are commonly used, but with application of these fertilizer to the soil, some problems could be arise. More, Ouda (2000) found that inoculated tomato seedling with mixture of phosphorein + microbein + rhizobacterein (at the rate of 1,2 or 3 kg/fed each of one) and fertilization with 50% of recommended NPK (120 kg N, 45 kg P_2O_5 + 96 kg K_2O/fed) produced the highest growth parameters, i.e., plant height, leaves number, leaf area and dry matter content comparing with 100% of the recommended NPK alone without biofertlizers.Also, application of 15m^2 chicken manure plus the three mentioned biofertilizers with the rate of 3 kg from each per feddan produced high total yield with the best quality of tomato fruits.

In addition, Singh (2002) found that crop yield, tuber size increased with increasing rates of P, and were higher with phosphate-solubilizing bacteria inoculation. Recently, Kushwah and Banafar (2003) found that application of Azotobacter and PSB culture is beneficial in increasing dry matter, N and P contents and uptake by haulm and tuber. Finally, Sud and Jatav (2007) found that a significant response to P application as well as PSB applied through seed tuber inoculation was observed. Their combined application resulted in higher yield of medium sized tubers, total tuber yield.

The objective of this research was to study the response of potatoes (cv.Slaney) to some different sources of fertilizers, i.e., mineral (NPK), organic (compost and rock phosphate), phosphate soluble bacteria(PSB) and their effects on growth, productivity, and tuber quality.

MATERIAL AND METHODS

Two field experiments were carried out in a private farm at Al Mansoura, Dakahlia Governorate, (North Nile delta region) Egypt during the winter seasons 2001/2002 and 2002/2003 to study the response of potato to different sources of fertilizers, i.e., mineral, organic, phosphate soluble bacteria(PSB) (*Bacillus megaterium var. Phosphatium*). The soil texture was almost clay loam. The organic matter and total nitrogen amounted to 1.84 % and 0.18, respectively. The soil PH was 7.3. The experiments were laid out in a randomize complete block design with 8 treatments, three replicates were used. The plot area was 10.5 m^2 which contained 3 rows, 5m long and 0.8 m wide.

Treatments were as follows:-

1- Mineral(NPK)at recommended rate(150N,75P_2O_5 and 96 K_2O kg/fed) according to Ministry of Agriculture.
2- NK + Rock phosphate.
3- NK + (PSB).
4- NK + Rock phosphate + (PSB).
5- Compost.
6- Compost + Rock phosphate.
7-Compost + (PSB).
8- Compost + Rock phosphate+ (PSB).

Table (1): Chemical composition of compost during the two growing seasons of 2002 and 2003.

Parameter	Values	Parameter	Values	Parameter	Values
pH	7.81	N	2.22%	Fe	1.7%
TSS	0.33 %	C/N ratio	10:24	Zn	150 ppm
Organic matter	39.2%	K_2O	1.52%	Mn	850 ppm
Organic arbon	22.74%	P_2O_5	1.03%	Moisture	14.6%

The recommended chemical fertilizers rate (150 N, 75 P_2O_5 and 96 K_2O kg/fed) was applied using ammonium nitrate, super phosphate, and potassium sulfate. Ammonium nitrate were divided and applied at two equal rates with the first and second irrigation while, super phosphate applied before cultivating, and potassium sulfate was added at two times before second and third irrigation. The compost fertilizer was added at the rate of 7.5 ton/fed. , determined according nitrogen percentage in used compost under study (chemical analysis of compost is shown in Table 1). Rock phosphate (22 %, P) was added at the rate of 340 kg/fed. Live cells of efficient phosphorus soluble bacteria strains (*Bacillus megaterium var. Phosphatium*) (PSB) were obtained from Laboratories of Ministry of Agriculture. It was mixed with potato tuber seeds before cultivation.

Data recorded were: -

A. *Vegetative growth characteristics:*

1. Number of (leaves/plant) at 90days after planting.
2. Shoot fresh weight at 90days after planting.
3. Shoot dry weight at 90days after planting.

B. *Yield.*

2.4. Total yield (Ton/fed).

3. Chemical and quality constituents:-

1. N, P and K contents % in tuber.
2. Nitrate and nitrite content (ppm).
3. Specific gravity of tubers (g/cm^3).
4. Total soluble solids (T.S.S.) %.
5. Starch content in tubers %.
6. Ascorbic acid (Vitamin C) (mg/100g).
8. Dry matter percentage %.

The obtained data were subjected to statistical analysis using technique of the randomized complete block design according to Snedecor and Cochran (1982).The treatment means were compared using Duncan's multiple range test as described by Steel and Torrie (1980).

RESULTS AND DISCUSSION

A- Vegetative growth characteristics:

Results in Table (2) indicated that NPK treatment gave the highest values of leaves number, shoot fresh weight and shoot dry weight in both seasons. There were no significant differences of leaves numbers among all treatments under study in both seasons. Also, no significant differences of shoot fresh weight and dry weight between NPK and other treatments under study only in the second season

The increases occurred in potato plant vegetative growth parameters(i.e,shoot fresh weight, shoot dry weight, leaves numbers/plant) as a result of application of mineral fertilizers (NPK) could be attributed to that the mineral (NPK) fertilizers contain essential elements witch has a great role on stimulating cell division elongation and activation of photosynthesis process and metabolic witch reflected increases in plant growth parameters. (Marchner, 1995).

The obtained results are in agreement with several investigators who reported that treating potato plants with mineral fertilizers (NPK) led to a significant increase in plant growth parameters expressed as plant height, number of leaves, fresh and dry weights of foliage / plant (Posta and Berar , 2005 and Singh *et al.*2005 and Abd Elal, *et al.* 2008).

Many investigators reported that application of phosphorus solubilizing microorganism to the soil or inoculation of potato tuber before planting increased plant height, number of leaves as well as fresh and dry weights of the shoot system (Sallam, 2002and Metwally, 2004).

The combined effect of compost application and rock phosphate plus PSB was more effective on potato plant growth than using each of them in individual application.(Elgala *et. al.*,1995) concluded that with microbial inoculation rock phosphate could be used as a cheap source of P in alkaline soils and that combined inculation could reduce the rate of fertilizer required to maintain high productivity.Also,Abdel Mouty *et.al.*(2001) inoculated potato plants with bio fertilizer microbein (contained N_2 fixer and P solubilizing

bacteria accompanied with organic fertilizer. and showed that microbein solely or combined with manure improved plant growth parameters as plant length ,plant fresh and dry weights and chlorophyll content compared to control treatment

Table (2):Averages of leaves number /plant , shoot fresh weight (g) and shoot dry weight (g) as affected by mineral, organic and biofertilizer in 2001/2002 and 2002/2003 seasons.

Characters / Treatments	Leaves number/ plant		shoot fresh weight (g)		Shoot dry weight (g)	
	1 st season	2 nd Season	1 st season	2 nd season	1 st season	2 nd season
NPK	35.33a	32.67a	198.00a	201.00a	20.60a	20.43a
NK +Rock phosphate	31.00a	31.33a	191.33ab	198.00a	19.80abc	19.70a
NK + PSB	32.67a	32.00a	193.00ab	198.33a	19.86abc	19.93a
NK +Rock phosphate + PSB	32.67a	32.00a	194.00ab	198.67a	20.33ab	20.30a
Compost	28.89a	30.33a	182.00c	194.67a	18.63c	19.06a
Compost+Rock phosphate	29.33a	30.67a	185.33bc	195.81a	19.03bc	19.40a
Compost + PSB	30.33a	31.00a	188.33abc	196.53a	19.33abc	19.50a
Compost+Rock phosphate+ PSB	30.67a	31.00a	189.33abc	197.33a	19.76abc	19.60a

B- Yield and yield components:

Data presented in Table (3) showed that NPK recorded the highest values of potato yield (kg/plant and ton/fed). But no significant differences of potato yield were observed among NPK , NK + Rock phosphate , NK + PSB and NK + Rock phosphate + PSB, compost + PSB and Compost + Rock phosphate + PSB in both seasons.

The obtained increase in tuber yield of potato due to application of NPK fertilizer(Table12) may be attributed to the solubility and the availability of N,P and K and their supply to plant.

The obtained results are in the same line with those reported by(Arisha and Bardisi ,1999 and Chmura *et al.* 2004 Abd El Aal *et al.*,2008) .They indicated that application of NPK fertilizers caused significant increases in potato yield.

Application of organic manure has a superior effect on soil and plant so it plays an important role for improving soil physical, chemical and biological properties (Abou elmagd *et al.*,2003) Using biofertilization for plant production could constitute about 25% of plant requirement nutrient (El-hadad *et al.*1993)

The present data are in harmony with many investigators who reported that potato plants were given organic manure and inoculated with phosphate solubilizing bacteria gave higher total and marketable yield(Kamla and Singh ,1999 on potato and Ouda, 2000 on tomato).

Table (3): Total yield of potato plants (kg/plant and ton/fed) as affected by mineral, organic and biofertilizer in 2001/2002 and 2002/2003 seasons.

Characters / Treatments	Kg /plant		Ton/fed	
	1st season	2nd season	1st season	2nd season
NPK	1.173a	1.195a	19.555a	19.930a
NK +Rock phosphate	1.047a	1.066a	17.460a	17.770a
NK + PSB	1.059a	1.093a	17.650a	18.230a
NK +Rock phosphate + PSB	1.087a	1.138a	18.120a	18.970a
Compost	0.863b	0.895b	14.390b	14.930b
Compost+Rock + phosphate	0.948b	0.984a	15.800b	16.400a
Compost + PSB	1.002a	1.036a	16.700a	17.280a
Compost+Rock phosphate+ PSB	1.026a	1.075a	17.100a	17.920a

C-Chemical and quality constituents:

Data in Table (4) indicated that highest values of N%,P %, K %, Nitrate (ppm) and Nitrite (ppm) were obtained by NPK treatment. No significant differences of Nitrite (ppm) between NPK and NK + Rock phosphate in both seasons. In Table (5), no significant differences of specific gravity (g/cm^3) and starch % among all treatments under study in both seasons and T.S.S % only in the first season. Compost+Rock phosphate+ PSB reccorde the highest values of specific gravity (g/cm^3) , starch % and T.S.S % in both seasons. No significant differences of specific gravity (g/cm^3) , starch % , T.S.S % , ascorbic acid (mg/100g) and dry matter % were observed between NPK and NK + Rock phosphate in both seasons. NPK gave the highest values of dry matter % in both seasons, but there were no significant differences of dry matter % between NPK treatment and other treatments under study.

Chemical composition and tuber quality of potato expressed as N, P and K%, dry matter, total soluble solids, specific gravity, ascorbic acid, starch% and nitrate and nitrite were clearly affected with different treatments.

It was noticed that mean values of tuber N,P and K%, specific gravity, starch% and dry matter % took the same manner with control treatment(NPK) and other treatments where no significant differences were recorded among these treatments.

One of the major inputs required for clean and safe organic food production is organic manure in all over the world. The organic fertilizers,i.e, cattle, sheep chicken manure and agricultural compost, play an important role for improving soil chemical and biological properties which lead to increase the vegetative growth, yield and quality(Abdallah *et.al.*,2003 and Ghanem *et al.*,2006).Concerning the effect of organic fertilizers on potato tuber quality many researchers showed that better quality was maintained with use of composted manures (Kotbe *et al.*,1995;Raupp,1996;Abou-Hussein *et al.* ,2002; Mkhabela and warman, 2005; Kabeel and Hasanin, 2006; Awad,2007).

Concerning the combined effect of bio and organic fertilizer on the chemical composition and quality parameters,many authors found that using phosphate solubilizing bacteria in combination with organic fertilizers significantly increased chemical composition and quality parameters of potato

tubers(Abdulla ,1999 and Ouda 2000).Moreover, organic manure plus biofertilization (PSB) and rock phosphate had significant reduction in nitrate and nitrite content and higher values of T.s.s. and Ascorbic acid in both seasons.

Utilization of biofertilizer (PSB) in combination with organic manure and rock phosphate could be important for production of potato with high quality (reduce No_3 ,No_2)and at the same time environment pollution could be reduced. (Abdulla, 1999).Our results came to the same conculusions.

Table (4): N %, P %, K %, Nitrat (ppm) and Nitrite (ppm) as affected by mineral, organic and biofertilizer in 2001/2002 and 2002/2003 seasons.

Characters / Treatments	N %		P%		K%		Nitrate (ppm)		Nitrite(ppm)	
	1st Season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd Season	1st season	2nd Season
NPK	2.28a	2.57a	0.46a	0.39a	2.30a	2.54a	67.28a	64.7 a	0.45a	0.44 a
NK +Rock phosphate	2.02a	2.01b	0.42a	0.30b	2.04a	1.96b	65.30b	62.58ab	0.45a	0.44 a
NK + PSB	2.10 a	2.01b	0.40a	0.30b	2.12a	1.99b	61.58c	62.08 b	0.40a	0.39b
NK+Rock phosphate + PSB	2.11a	2.05b	0.42a	0.31b	2.13a	1.99b	58.6 d	58.7 c	0.39a	0.40b
Compost	1.93a	1.92b	0.38a	0.29b	1.95a	1.90b	59.8cd	54.9 d	0.40a	0.34 c
Compost+Rock + phosphate	1.97a	1.92b	0.39a	0.29b	1.99a	1.96b	53.1 e	54.2 d	0.35a	0.33c
Compost + PSB	1.97a	1.98b	0.40a	0.30b	1.99a	1.90b	54.7 e	53.3 e	0.36a	0.33c
Compost+Rock phosphate+ PSB	2.00a	1.98b	0.40a	0.30b	2.02a	2.03b	53.4 e	52.1 e	0.37a	0.34c

Table (5): Specific gravity (g/cm^3), TSS % , starch % , Ascorbic acid (mg/100g) and dry matter % as affected by mineral, organic and biofertilizer in 2001/2002 and 2002/2003 seasons.

Characters / Treatments	Specific gravity (g/cm^3)		TSS %		Starch %		Ascorbic acid (mg/100 g F.W)		Dry matter %	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	1st season	1st season	2nd season
NPK	1.03a	1.07a	5.31a	5.33b	14.01a	13.58a	18.28b	20.11b	17.53a	17.56a
NK +Rock phosphate	1.10a	1.08a	5.29a	5.30b	13.50a	13.39a	18.44b	20.00b	16.95a	16.94a
NK + PSB	0.99a	1.03	5.31a	5.31b	12.68a	13.21a	17.27c	18.99b	17.11a	17.13a
NK +Rock phosphate + PSB	1.07a	1.08a	5.33a	5.30b	13.21a	13.50a	19.36b	20.09b	17.41a	17.45a
Compost	1.04a	1.03a	5.32a	5.33b	14.08a	14.12a	19.92b	21.02b	16.28a	16.33a
Compost+Rock + phosphate	1.12a	1.07a	5.33a	5.32b	13.58a	14.01a	21.37a	23.00 a	16.43a	16.47a
Compost + PSB	1.04a	1.09a	5.33a	5.39ab	14.44 a	14.44a	22.02a	22.10a	16.71a	16.73a
Compost+Rock phosphate+ PSB	1.09a	1.09a	5.34a	5.42a	14.51a	15.24a	21.14b	23.25a	16.83a	16.86a

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تأثير التسميد المعدني ، التسميد العضوي و التسميد الحيوي على صفات النمو ، صفات المحصول والجودة للبطاطس.

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**** وزارة العدل**

أجريت تجربتان حقليتان بمزرعة قرب مدينة المنصورة- محافظة الدقهلية في موسمي ٢٠٠١/٢٠٠٢ و ٢٠٠٢/٢٠٠٣ في تصميم قطاعات كاملة في ثلاث مكررات لدراسة تأثير التسميد المعدني (نيتروجين ، بوتاسيوم و فوسفات) ،التسميد العضوي (الكومبوست و صخر الفوسفات) و التسميد الحيوي (البكتيريا المذيبة للفوسفات) في ثمان معاملات تحت الدراسة.

و يمكن تلخيص أهم النتائج المتحصل عليها كما يلي :

١- سجلت معاملة التسميد المعدني (نيتروجين ، بوتاسيوم و فوسفات) أعلى القيم في صفان النمو و صفات المحصول و لكن سجلت المعاملة (الكومبوست + صخر الفوسفات + البكتيريا المذيبة للفوسفات) أعلى القيم في صفات الكثافة النوعية ، النسبة المئوية للنشا و النسبة المئوية للمواد الصلبة الكلية.

٢- لم تكن هناك فروق معنوية في صفة عدد الأوراق /نبات بين معاملة التسميد المعدني (نيتروجين ، بوتاسيوم و فوسفات) و باقي معاملات التميد العضوي و التسميد الحيوي تحت الدراسة.

٣- أيضا لم يكن هناك فروق معنوية في صفة المحصول / نبات و المحصول/فدان بين معاملة التسميد المعدني (نيتروجين ، بوتاسيوم و فوسفات) ومعاملات (نيتروجين و بوتاسيوم + صخر الفوسفات) ، (نيتروجين و بوتاسيوم + بكتيريا المذيبة للفوسفات) و (نيتروجين و بوتاسيوم + صخر الفوسفات + بكتيريا المذيبة للفوسفات) .

٤- لم تكن هناك فروق معنوية في صفات الكثافة النوعية ، النسبة المئوية للنشا ، النسبة المئوية للمواد الصلبة الكلية ، نسبة حمض الأسكوربيك (ملليجرام/١٠٠جم) و النسبة المئوية للمادة الجافة بين معاملة التسميد المعدني (نيتروجين ، بوتاسيوم و فوسفات) و معاملة (نيتروجين و بوتاسيوم + صخر الفوسفات).

٥- سجلت المعاملات (الكومبوست + صخر الفوسفات) ، (الكومبوست + بكتيريا المذيبة للفوسفات) و (الكومبوست + صخر الفوسفات + بكتيريا المذيبة للفوسفات) أقل القيم لتركيز النيترات (جزء/المليون)النيتريت (جزء/المليون) في كلا موسمي الدراسة.

لذلك توصي هذه الدراسة بإمكانية استخدام التسميد العضوي و الحيوي كمصادر للفوسفات و تقليل جرعات التسميد المعدني التي قد تسبب أضرار للبيئة وصحة الانسان.