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Incorporated Use Impact of Organic, Bio and Mineral Fertilizers on Potato (*Solanum tuberosum*. L) Productivity and Quality

El-Zehery, T. M.*

Soils Dept., Fac. of Agric., Mansoura Univ., Egypt.

ABSTRACT

A field experiment was implemented in 2015/2016 winter season at the Experimental Farm, Faculty of Agriculture, Mansoura University, Mansoura, Egypt, to study the effect of organic, biological and mineral fertilizers on the productivity and quality of potato plant. The experimental design was split-plot design with four replicates. The main treatment (control=without organic and bio(O_0B_0)- Organic fertilizer(O_1B_0)- bio-fertilizer(O_0B_1)- organic fertilizer+bio-fertilizer(O_1B_1) while the sub-main treatment was mineral fertilization at rates of (100%,75% and 50%of fertilizer recommendation dose). The obtained results were: Biological and organic fertilization (B_1O_1)+75% of mineral fertilization resulted in a significant increase in the yields of fresh and dry weight, 17100 and 3099.38 kg.fed^{-1}, respectively. Also, (B_1O_1) led to a significant increase in the (%) of N,P and K in potato tubers, where it gave the highest content of nutrients 1.03, 0.4788 and 2.3%, respectively. While 100% of NPK fertilizers led to a significant increase in the N,P and K percentage(%), they were 0.92, 0.3667 and 1.97%, respectively. There were insignificant differences between the means of B_1O_1+75% and B_1O_1+100%. Therefore, the treatment of bio+ organic fertilizers with 75% of mineral fertilizers may be simulated with the treatment of 100% of mineral fertilizers, it means that may be saving in mineral fertilization by 25%. With regard to the quality parameters for potato, it was found that for total soluble solids (TSS), protein%, starch%, and %dry matter, the effect of treatment of organic+bio-fertilization (B_1O_1) together was the best treatment for the quality characteristics as well as 100% of the recommended fertilizers dose.

Keywords: Organic fertilizer, Biofertilizers (phosphorin and Microbin), Mineral fertilization, Starch%, Protein%, Potato plant.

INTRODUCTION

Potatoes (*Solanum tuberosum* L.) is one of the most important vegetable crops in the world. It ranks fourth globally after wheat, corn and rice in terms of nutritional importance (Hassan, 2003 and Muthoni and Nyamango, 2009). Egypt ranks first in the Arab World and Africa in terms of potato production, with a cultivated area of 381,000 feddans with a production of 4113,000 tons (A.O.D.A., 2018). Potato is one of the most reliable commodities for solving the food problem. It is characterized by the relative abundance of feddan yields when compared to cereal crops. In addition, potatoes are grown in more than once a year.

Potatoes are a stressful crop of soils, as they require large quantities of nutrients (Abdel Salam and Shams, 2012), so the use of biofertilizers which considered environmentally safe and no harmful fertilizers for humans and animals is a supportive technology for plant growth as well as vital stimuli that stimulate plant growth as well as the ability to improve plants absorption of nutrients and improve plant growth It also contributes to increasing plant production and improving its quality, as some of them increase the plants tolerance to extreme weather conditions

Using only mineral fertilizers may not keep rate with time in preserving the soil health in addition to sustaining the productivity. This is also bad with regard to human health and typically the environment (Arisha and Bardisi, 1999). The conventional use of mineral fertilizer can increase the tubers yield but inordinate use of nitrogen has a negative effects on tubers quality, environment pollution, public health and economical losses (Najm *et al*., 2011), reduces starch, dry matter and sugar contents in tubers and potatoes go bad more rapidly during the storage (Balemi, 2012).

The random use of fertilizers results in several fertilizer problems. Once the fertilizer is added, some problems start to appear, such as the loss of fertilizers in various ways, such as volatilization, washing and stabilization according to the prevailing cations and different soil properties. The high price of these fertilizers increases the cost of producing agricultural crops and thus the use of organic and biofertilizers reduces these problems (Abdel-Ati *et al*., 1996 and Zaghloul, 2002).

Inoculation of potatoes with Plant Growth Promoting Rhizobacteria (PGPR) improves the qualities of growth, dry matter, carbohydrate content and thus potato productivity. These organisms also increase the availability of macronutrients in soil, improvement of the biological activity of the soil, increasing the binding of free nitrogen from the air, reducing the erosion and loss of nutrients. (Mahendran and Chandramani ,1998; Mayer *et al*., 2008; and Mayer *et al*., 2010).

It was found that inoculation of potatoes with bio-fertilizer improves the growth, dry matter and carbohydrate content of potatoes and thus potato productivity.

* **Corresponding author.**
E-mail address: trk_rgb@yahoo.com
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(Mahendran and Kumar, 1998; Mahendran and Chandramani, 1998 and Sangakkara *et al.*, 2011).

There is a recent trend towards clean farming technologies while minimizing pollution and hence The use of natural materials such as organic fertilizers and bio-fertilizers is a suitable alternative to the use of chemical fertilizers (El-Akabawy, 2000)

On the other hand, the emergence of concepts of clean agriculture free of chemicals and organic agriculture has encouraged using of biological agents in the soil that can equip the elements and nutrients of the plant, including bacteria *Pseudomonas*, *Azospirillum* and *Bacillus*, which can be found in the soil naturally and may contribute to increasing plant growth and yield (Lenin and Jayanthi, 2012 and Sekar and Kandavel, 2010). Also these microbes have the potential to increase the availability of the elements in the soil for the plant (Hari and Pal, 2012).

The use of organic fertilizers in agriculture increases the soil content of organic matter (Hanafy *et al.*, 2002). It also promotes the activity of microorganisms in the soil and therefore the activity of microbial enzymes and improves the physical and chemical properties of the soil (Neweigy *et al*., 1997 and Darzi, 2012).

However, organic fertilizers increase the nitrogen levels in some crops such as potatoes. So, an alternative to mineral and organic fertilizers is bio-fertilizers derived from microorganisms. Bio-fertilizer using Mycorrhiza and Azospirillum was found to reduce nitrate and nitrite contents of potato tubers (Hammad and Abdel-Ati 1998 and Abou-Hussein *et al.*, 2002).

Addition of farmyard manure into the soil increased the total and available N, phosphorus and potassium in the soil. On the other hand, organic fertilizers elevated yield, moisture of tubers, crude protein content and starch content of potato tubers. As the concentration of compost increased as nitrogen, phosphorus and potassium contents of tubers, dramatically, increased. (El-Tantawy *et al*., 2009).

Ju *et al*., (2009) reported that total nitrogen losses increased significantly with increasing nitrogen inputs, by exceeding optimum nitrogen fertilizer rates. The over application of nitrogen also represents environmental pollution. ecological damage and increased production cost.

Several studies confirmed that bio-fertilizer increased the production of some vegetable crops, reduced the use of mineral fertilizer to 25-50%, and increased the yield of potato tubers by about 17%. The addition of organic fertilizers led to an increase in the crop, especially when adding quantities that meet the requirements of plants for nutrients. Especially the nitrogen component. Through the integrated fertilization between chemical, organic and biological species, it is possible to maintain soil productivity and ensure sustainable crop productivity (Tyagi *et al.*,1999 and Datta *et al.*, 2009)

Biological fertilization contributed to the increase in the growth of plants, the amount of nitrogen in the leaves, the formation of root nodules, and the increase in the amount of nitrogen in the soil. The bacteria also contribute to increase the concentration of plant hormones in plants, which improve the growth of the root system, and thus increase their absorption of mineral elements and their accumulation in plants. The use of biological fertilization as a substitute for mineral fertilization also contributed to increase soil fertility and to improve the rate of plant growth and productivity, moreover raising its content of mineral elements NPK as well as its contribution to improving other soil properties (Wu, *et al.*, 2005)

When adding biofertilizers to the potato plant, they gave taller plants and tubers of greater average weight (Mbouobda et al., 2014) and contributed to increasing plant height and plant biomass as well as improving root growth (Javaid and Mahmood, 2010; javaid, 2011 and Dadashzadeh *et al.*, 2013)

Due to the fact that potato plants need large quantities of nutrients (Abdel Salam and Shams, 2012), and because of the high prices of mineral fertilizers and their transportation costs, the focus in recent years has been towards the use of biological fertilizers as they are inexpensive nutrients sources, as they work to fix nitrogen by using soil inoculation with bacterial strains as well as they working as a stimulant for plant growth, which constitutes a positive role in increasing the rate of growth and quantity of production and improving the quality of tubers. So, the main objective of this research is initiated to test the effect of organic and bio-fertilizer on potato plant productivity. Furthermore, it was hoped that the results may lead to reduce the use of chemical fertilizers under field condition.

MATERIALS AND METHODS

A field experiment was carried out in the Experimental Farm at Faculty of Agriculture Mansoura University, Mansoura, Egypt during winter season of November, 2015 to investigate the effect of bio-organic and mineral fertilizers on potato plant (*Solanum tuberosum* L, cv. Spunta). Before planting, the main physical and chemical properties of the experimental soil were determined on the surface (0-20 cm) samples collected from the experimental soil using the methods described by Kim, (1996); Page *et al.*, (1982) and Jackson (1973). The obtained data are illustrated in Table 1. The experiment area was divided into 12 sectors and each sector was divided into 4 experimental units. Cultivation was carried out at 1st November 2015 on rows with 4.0 m length and 0.75 wide as well as leaving a distance of 1 m between the experimental units and sectors for the purpose of preventing the transfer of fertilizers. Also, 0.25 m distance was leaving between each plant. Each experimental unit consists of four rows.

Table 1. Some characteristics of the experimental soil

pH in 1:2.5 soil	EC. $dS.m^{-1}$ In 1:5	Soluble anions, $meq.L^{-1}$								Particle size distribution %				Soil texture	OM.	Available nutrients $mg.kg^{-1}$		
paste	extract	Ca^{2+}	Mg^{2+}	K^{+}	Na^{+}	CO_3^{-2}	HCO_3^{-}	Cl^{-}	SO_4^{-2}	C.sand	F.sand	Silt	Clay		%	N	P	K
7.8	1.37	5.2	3.2	1.0	4.3	0	3.3	7.1	3.3	2.7	25.4	32.5	39.4	Clay loam	1.25	42	7	224

The experimental design includes two factors with four replicates. The first factor represents treatments of an interaction biological and organic fertilizer, without bio or organic fertilizer (B_0O_0), with organic fertilizer only (B_0O_1), with bio-fertilizer only (B_1O_0) and with organic and bio fertilizers (B_1O_1). The second factor represents the

used mineral fertilizer, which was added in three rates (50%, 75% and 100% of the recommended dose of potato plant. So, the experiment had 12 treatments which arranged within the experimental units in a split plot design in four replicates. The area of each experimental unit was 12 m^2.

The used biological fertilizer was prepared in the Microbiological Laboratory, Sakha Research Station, Kafr El-Sheikh Governorate, which contain phosphorin and Microbin. The phosphorin inoculants contains Bacillus megatherium var. phosphaticum, and Microbin contains four bacterial species-Azospirillum brasilienses, Azotobacter vienlandi, Bacillus megatherium var. phosphaticum and Pseudomonas aurantiaca. The bio-fertilizer was added in two doses, first immediately after cultivation and the second at 50% of flowering stage. The bio-fertilizer was added at the rate of 100ml/plant (200 g powder/100 L water as recommended).

Organic fertilizer (farmyard manure from the Experimental Research Farm of the Faculty of Agriculture, Mansoura University) was added before planting by two weeks, at a rate of 20 ton.fed^{-1} ,(feddan=4200 m^2), where it was spread on the soil surface and mixed in the soil at depth of 20 cm. Organic fertilizer analysis were carried out according the methods described by Page *et al.,* (1982) and Black (1983). The obtained data are illustrated in Table 2. The NPK fertilizers recommended dose was 150 Kg N, 80 Kg $P_2O_5$and 96 Kg K_2O. The source of phosphorus fertilizer was ordinary super phosphate (15.5% P_2O_5) which was applied before planting with adding organic fertilizer. The nitrogen fertilizer was added in three equal doses 1st and 2nd doses were added as urea (46% N) after 3 weeks and 6 weeks of planting, respectively, while the 3rd dose was applied after 60 days of planting in a form of calcium nitrate (15.5% N). The source of potassium fertilizer was potassium sulphate (48% K_2O) which added in two equal doses, 1st dose was added after 6 weeks of planting, while the 2nd dose was applied after 60 days of planting. The ordinary cultivation practices such as irrigation, weed management ect., were done according to the commercial potato production, recommended by Agriculture Ministry of Egypt.

Table 2. Some characteristics of organic fertilizer

pH	EC dS.m^{-1}	Total nutrients %			OC	OM	C:N
in 1:10 suspension	In 1:10 extract	N	P	K	%	%	ratio
6.78	3.98	1.13	0.48	0.57	20.5	35.4	18:1

At harvest time (106 days after planting), tubers of each plot were collected at 14th of February, 2016. Fresh tuber yield.$plot^{-1}$ was counted, weighted and converted to kg.m^{-2} and kg.fed^{-1}. Then tuber samples from each plot were taken to the laboratory to make some analysis such as, tuber quality dry matter content in tubers(%), the content(%) of crude protein starch(%) and dry matter content. Tubers samples were taken from each experimental plot and washed with tap water followed with distilled water and cut into slices, 100 grams were taken and dried in an electric oven at 70 ° C for 48 hours until a constant weight. The weight was calculated and the percentage of dry matter was calculated by dividing (the dry weight/the fresh weight) x100 (Haase, 2003). Crude protein content(%) was calculated as "multiplying total nitrogen percentage by 6.25 ". Starch(%) was calculated using the method described in (Bruckner and Morey, 1988) on dry matter basis as Starch %= 17.55+ (0.891 * (dry weight% - 24.182)). Also, other determinations such as tubers content(%) of N,P and K which determined in the powder of tuber which digested with sulfuric and berchloric acids (Peterburgski, 1968), then were also measured using standard methods. Nitrogen was determined by Kildahl method mentioned by Black (1965), Phosphorous was determined spectro photometrically by the methods described by Cooper (1977) using ammonium molybdate and ascorbic acid. Potassium was determined by Jenway Flame photometer (Peterburgski, 1968). Nutrients uptake in tuber were calculated in kg.fed^{-1} by multiplying nutrients percentage by dry weight of tuber. Total soluble solids (TSS) was measured using digital pocket refractometer in potato juice according to A.O.A.C. (1990)

The obtained data were subjected to analysis of variance (ANOVA) based to co-state software computer system program for statistics. LSD test value had been used to test differences between treatment means with 0.05 using duncans multiples range test for presentation of results as typically mentioned by Steel and Torrie (1984)

RESULTS AND DISCUSSION

Data in Table 3 illustrated that total fresh yield of potato tuber increased with addition of bio. organic and mineral fertilizers. Adding 20 ton.fed^{-1} organic fertilizer and bio fertilizers at a rate of 100ml/plant which contain phosphorin and Microbin (B_1O_1) gave the highest fresh yield of potato's tuber, compared to the control treatment.

Table 3. Tuber fresh weight of potato (kg.fed^{-1}) as affected by additions of mineral, organic and bio fertilizers on potato plant.

Mineral fertilizer levels (M)	Bio and organic fertilizers (BO)				Means of Mineral fertilizer
	Control B_0O_0	Organic B_0O_1	Bio B_1O_0	Organic+bio B_1O_1	
50% of NPK	9496	13775	10450	13513	11808.4b
75% of NPK	12638	14300	14038	17100	14518.8a
100% of NPK	13416	15438	13688	16225	14691.6a
Means of bio-organic	11850d	14504.17b	12725c	15612.5a	
F test		**			**
LSD at 5%		466.55			708.9
LSD at 5% for interaction		BO×M=* 2835.7			

According to the obtained fresh weight of tubers the best of these treatments were the combined applications of organic and bio-fertilizers (B_1O_1) which resulted in a significant increase of tuber fresh weight compared with other treatments, by a percent increase of 31.75% over the control (B_0O_0). This increase in fresh tuber yield may return to, the effect of both organic and bio-fertilizer on improving the physical, chemical and biological properties of the soil. As well as to the role of inoculated microorganisms and phosphate-decomposing bacteria, as these organisms secrete growth stimulants such as auxins, gibberellins and cytokinins, which play an important role in stimulating plant growth and microbial activity, which is reflected in improving rhizo-sphere. These results are in harmony with those obtained by El-Morsy *et al.*(2006); Ahmed *et al.*(2009) and Mirdad (2010). Also, increasing mineral fertilizer increased fresh tuber yield of potato.

Therefore, the treatment of 100% of NPK (recommended dose of potato) gave the highest fresh yield which increased by percentage of 42.42% over the treatment of 50% of NPK. Also, the interaction effect of organic, bio and mineral fertilizers was significant in increasing tuber fresh weight of potato. The interaction between organic and bio-fertilizer (B_1O_1) in combination with 75% recommended dose of mineral fertilizer gave the highest significant fresh tuber yield (17100 kg.fed^{-1}) compared with other treatments, by a percent increase of 80.07% over the control treatment (B_0O_0+50% of the recommended dose). The increase in fresh tuber productivity as a result of the studied fertilization on treatments may be due to the availability of nutrients in the soil solution, and the ability of organic and bio fertilizers to secrete some hormones in addition to enzymes and vitamins, and this may explain the increase In tuber weight, this is what many researchers have found (Chettri et al., 2002; Kolay, 2007; Mir and Quadri, 2009 and Darzi, 2012).

Data in Table 4 show that tuber dry weight yield (kg.fed^{-1}) of potato responded high significantly affected by applications of organic and bio factors. The highest values were (2853.30 kg.fed^{-1}) was obtained with treatment B_1O_1 by an increase percent of 52.49% over the control (B_0O_0=without organic and bio fertilizers) treatment. This increase in yield of tuber dry weight obtained as a result of adding 20 ton organic fertilizer.fed^{-1} in combination with bio-fertilizer. Whereas increasing rate of added mineral fertilizer (50, 75, and 100% of the recommended dose) increased significantly potato yield of tuber dry weight. The highest yield (2615.53 kg.fed^{-1}) was found with application rate of 100% recommended dose by a percent increase of (30.96%) over the control (50% of mineral fertilization).

Although, the interaction effect between organic, bio and mineral fertilization gave insignificant effect, the highest values of tuber dry weight of potato was 3099.38 kg.fed^{-1} with an increase percent of 117.05 % over the control treatment (50% + without bio-organic fertilization). This increase, may be due to the fact that these fertilizers provided good conditions for plant growth and absorption of water and nutrients resulted from improving soil characteristics and increase their fertility and increase the nutrients availability and their absorption by plant roots and thus this reflects on increasing the average dry weight of tuber and increasing the yield. These results are consistent with those obtained with EL-Enany 2005; El-Morsy *et al.*(2006); White *et al.*(2007); Zelalem *et al.*(2009); Najm *et. al.* (2013) and Shaheen *et al.* (2014).

Table 4. Tuber dry weight yield (kg.fed^{-1}) as affected by additions of mineral, organic and bio fertilizers on potato plant.

Mineral fertilizer levels (M)	Bio and organic fertilizers (BO)				means of Mineral fertilizer
	Control B_0O_0	Organic B_0O_1	Bio B_1O_0	Organic+bio B_1O_1	
50% of NPK	1427.94	2368.35	1774.31	2418.31	1997.23b
75% of NPK	1977.13	2487.51	2384.63	3099.38	2487.16a
100% of NPK	2208.48	2745.09	2466.38	3042.19	2615.53a
Means of bio-organic	1871.18_d	2533.65_b	2208.44_c	2853.30_a	
F test		**			**
LSD at 5%		130.33			132.49
LSD at 5% for interaction		BO×M= N.S.			

Data in Table (5) show that applications of organic and bio fertilizers recorded a highly significant increase in the contents (%) of N,P and K in tubers, by an increase percentage of 37.78, 14.60 and 81.85%, respectively over the control (B_0O_0) treatment. So, the high content of N,P and K in the tubers were found when adding organic and bio fertilizer together. This may be due to the role of these fertilizers on the increase of the available amount of these nutrients, as well as to the role of organic fertilizers in improving some soil characteristics. At the same time, increasing mineral fertilizers from 50% to 100% of the recommended dose for potato plant increased significantly the percentage of NPK in tubers, where the rates of these increases were 13.46, 10.68 and 12.12% respectively, over the control (50% of mineral fertilization). It is worthily to note that increasing mineral fertilizers may led to an improvement in the characteristics of vegetative growth, which reflected in increasing the efficiency of the root system to absorb these nutrients and increase their concentration in the plant. This led to an increase in the efficiency of photosynthesis, which resulted in an increase in the amount of materials manufactured in the leafs and their transportation and storage in the tubers, and then increasing the absorbed quantities of nitrogen, phosphorus and potassium. While, the interaction effect between organic, bio and mineral fertilization gave insignificant effect with the content of N,P and K, but it gave significant increase with P% in potato tuber. These results are consistent with those obtained with Pandey *et al.* (2007); Zelalem *et al.* (2009); Baddour, (2010); Patel and Patel, (2013); Shaheen *et.al.* (2014) and Nooruldeen and Al-Juthery (2015).

Table 5. Nutrients content (%) as affected by additions of mineral, organic and bio fertilizers in potato's tubers.

Treatments	N %	P %	K %
Control B_0O_0	0.75d	0.1947c	1.26d
Organic B_0O_1	0.80c	0.3579b	1.82c
Bio B_1O_0	0.86b	0.3632b	2.03b
Organic+bio B_1O_1	1.03a	0.4788a	2.30a
F test	**	**	**
LSD at 5%	0.0344	0.0128	0.0622
50% of NPK	0.81c	0.3314c	1.75c
75% of NPK	0.85b	0.3479b	1.84b
100% of NPK	0.92a	0.3667a	1.97a
F test	**	**	**
LSD at 5%	0.0251	0.00507	0.0279
LSD at 5% for interaction	BO×M= N.S.	BO×M= **0.002	BO×M= N.S.

Data in Table 6 show that there are a significant increase in the total nitrogen absorption from 14.20 in the treatment of control (B_0O_0) to 29.66 kg.fed^{-1} in the treatment of B_1O_1 by increasing rate of 108.83%. Also, organic and bio fertilizer led to a significant increase in the absorbed phosphorus in tuber from 3.67 kg.fed^{-1} in the treatment of control (B_0O_0) to 13.69 kg P.fed^{-1} in the treatment contain organic + bio fertilizers (B_1O_1) by an increase rate of 273.52%. Concerning potassium uptake in potato tuber, the organic and bio fertilizers gave the highest value (65.73 kg K.fed^{-1}) which obtained with treatment of B_1O_1 which gave an increase rate of 174.79% over the control (B_0O_0=without organic and bio fertilizers). Whereas increasing the mineral fertilizer rates (50, 75, and 100% of the recommended dose) increased significantly nutrients (NPK) uptake of potato tuber. The highest values were 24.42, 9.89 and 52.36 kg.fed^{-1},respectively, with an increase rate of 47.68, 42.61 and 44.45% over the control (50% of mineral fertilization).

The interaction effect between organic, bio and mineral fertilization gave significant increases effect on the tubers uptake of N.P and K, the highest values of nitrogen uptake of potato was 33.49 kg N.fed^{-1}, 15.32 kg P.fed^{-1} and 72.63 kg K.fed^{-1} with an increase rate of 234.34, 479.98 and 336.10%, respectively over the control (50% + without bio-organic fertilization) as illustrated in Figs 1,2 and 3. These results indicate that, the mineral fertilizer led to an increase in the absorbed nutrients (NPK). As the cause of increased absorption of NPK with the 100% of recommended dose of mineral fertilizers can be attributed on the basis that the used mineral fertilizers are directly ready, whereas for the organic and bio fertilizer applications, although it is generally a slow-release fertilizer because it needs a mineral process first but the quality of the added organic fertilizer decomposition which contains a ratio of carbon to nitrogen is ideal (18:1) as mentioned in Table 2, which resulted in release and availability of the nutrients, especially nitrogen and phosphorus, which it contains in a good concentration, and as for bio-fertilizer, it is fertilizer that contains nitrogen-fixing and phosphate-soluble organisms that can have important roles in increasing the absorption of nutrients by improving root growth and secreting hormones and chelates. Before that similar results were obtained by Bottini *et al.* (2004); El-Morsy *et al.*(2006); Nejm *et al.* (2010); Ierna *et al.* (2011); Eliwa *et al.* (2012); and Shaheen *et al.* (2014) .

Table 6. Nutrients uptake (kg.fed^{-1}) as affected by additions of mineral, organic and bio fertilizers in potato's tubers.

Treatments	N	P	K
	kg.fed^{-1}		
Control B_0O_0	14.20c	3.67d	23.92c
Organic B_0O_1	20.50b	9.07b	46.28b
Bio B_1O_0	19.18b	8.06c	45.18b
Organic+bio B_1O_1	29.66a	13.69a	65.73a
F test	**	**	**
LSD at 5%	1.7834	0.543	3.039
50% of NPK	16.54c	6.94c	36.25c
75% of NPK	21.70b	9.03b	47.21b
100% of NPK	24.42a	9.89a	52.36a
F test	**	**	**
LSD at 5%	1.1622	0.429	2.187
LSD at 5% for interaction	BO×M= **4.649	BO×M= **1.716	BO×M= **8.747

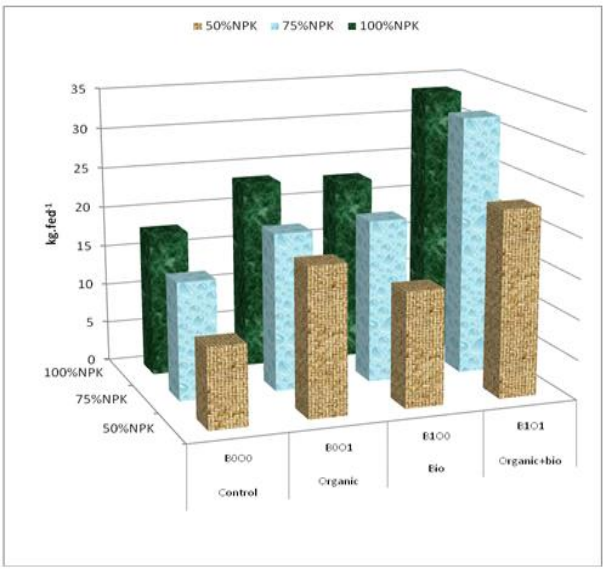

Figure 1. Nitrogen uptake in tubers yield (kg.fed^{-1}) as affected by additions of mineral, organic and bio fertilizers treatments

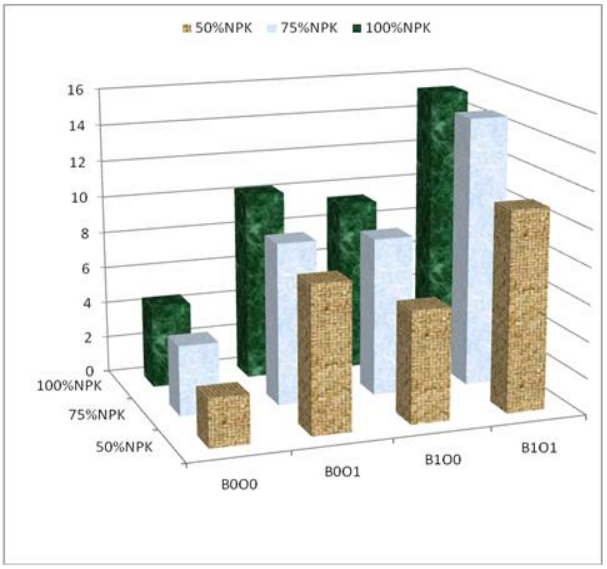

Figure 2. Phosphorus uptake in tubers yield (kg.fed^{-1}) as affected by additions of mineral, organic and bio fertilizers treatments

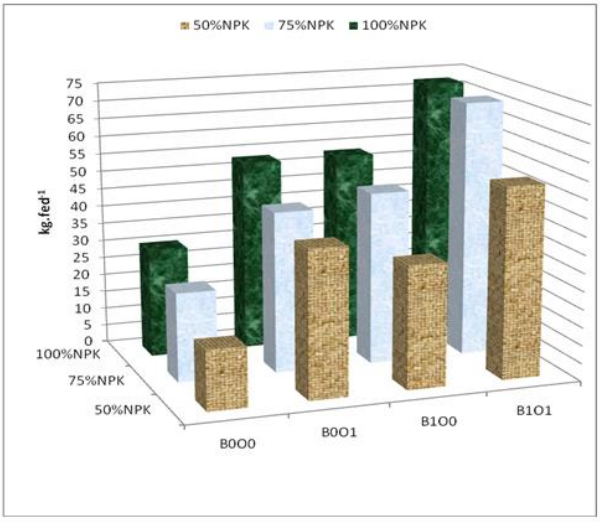

Figure 3. Potassium uptake in tubers yield (kg.fed^{-1}) as affected by additions of mineral, organic and bio fertilizers treatments

The statistical analysis for the data of quality parameters i.e. TSS, dry matter%, starch%, and protein% of tubers affected by the studied fertilization treatments of mineral, bio and organic fertilizers presented in Table 7 showed the positive effect of organic and bio fertilizers (B_1O_1) in a significant increase on the studied qualities parameters of tubers compared to the control treatment (B_0O_0). The highest values of dry matter%, starch%, protein% and total dissolved solids (TSS) in tubers of potato were 18.25%, 12.26, 6.46 and 6.05 respectively which found with the treatment of B_1O_1 recorded increases percentage of 16.24, 22.74, 37.78 and 39.25 over the control (B_0O_0 = without organic and bio fertilizers). Also, mineral fertilizers as the sub-main factor improved these tuber's qualities especially with applications of recommended dose. The highest values of dry matter%, starch%, protein% and total dissolved solids (TSS) in tubers of potato were 17.76%, 11.82%, 5.76% and 5.43 respectively which, obtained with treatment of 100% of recommended dose of mineral fertilizers gave an increase percentage of 5.97, 8.15, 13.46 and 4.80 over the control treatment (50% of recommended dose of mineral fertilizers). While the interaction effect of organic, bio and mineral fertilizers treatments gave insignificant increase.

The increase in the percentage of dry matter and starch in the tubers may be due to the role of added organic and biofertilizers in forming a strong vegetative growth that has a role in increasing the carbohydrate and protein stored in the tubers. The increase in dry matter means an increase in total dissolved solids in the tubers. The increase in the amount of starch in the tubers is due to the high content of leaves from the phosphorous and potassium elements that contribute effectively to the starch composition. Also, the increase in the percentage of protein affected by this treatment is explained to the availability of nutrients such as NPK from different sources organic and inorganic, nitrogen is directly involved in the synthesis of amino acids, which are the basic compounds for protein synthesis, while phosphorous enters into the synthesis of RNA and DNA, which directly affects protein synthesis. While potassium increases the efficiency of nitrogen absorption and thus an increase in protein synthesis. These results are also confirmed with other investigators such as Erdogan *et al.* (2010); Ahmed *et al.* (2009); Yassen *et al.* (2011); Abdel Salam and Shams (2012); Mirshekari and Alipour (2013); Baddour (2014) and Said *et. al.*(2016).

Table 7. Some quality characters in potato's tubers as affected by additions of mineral, organic and bio fertilizers.

Treatments	TSS	Dry matter	Crude protein	Starch
			%	
Control B_0O_0	4.34d	15.70c	4.69d	9.99c
Organic B_0O_1	5.63b	17.44b	5.03c	11.54b
Bio B_1O_0	5.24c	17.33b	5.39b	11.45b
Organic+bio B_1O_1	6.05a	18.25a	6.46a	12.26a
F test	**	**	**	**
LSD at 5%	0.0716	0.507	0.215	0.452
50% of NPK	5.18c	16.76b	5.08c	10.93b
75% of NPK	5.34b	17.03b	5.33b	11.18b
100% of NPK	5.43a	17.76a	5.76a	11.82a
F test	**	**	**	**
LSD at 5%	0.071	0.403	0.1567	0.359
LSD at 5% for interaction	BO×M= N.S.	BO×M= N.S.	BO×M= N.S.	BO×M= N.S.

CONCLUSION

In general, the results indicate the possibility of partial or total compensation for mineral fertilizers by adopting organic and bio fertilizers, but to obtain the maximum production requires the addition of the three fertilizers and the management of good fertilizers. So, from the results of the current study, it is possible to conclude that it can obtain good crop quality and a good productivity of the potato crop by adopting an integrated joint fertilization between organic, biological and mineral substances, while minimizing mineral fertilization relatively.The best treatment under experiment conditions was adding organic and bio-fertilizer with 75% of the recommended dose which led to increasing potato yield.

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تأثير الاستخدام المتكامل للتسميد العضوى والحيوي والمعدني على إنتاجية وجودة البطاطس

طارق محمد أحمد رجب الزهيرى

قسم الأراضى - كلية الزراعة - جامعة المنصورة

تم تنفيذ تجربة حقلية فى الموسم الشتوى لعام 2016/2015 في المزرعة البحثية بكلية الزراعة جامعة المنصورة- المنصورة. مصر, وذلك لدراسة تأثير ألأسمدة العضوية والحيوية والمعدنية على إنتاجية وجودة نبات البطاطس. وقد تم تصميم التجربة فى قطع منشقة مرة واحدة فى أربع مكررات حيث كانت المعاملة الرئيسية (كنترول=بدون عضوى وحيوىO_0B_0-عضوى فقطO_1B_0 -حيوى فقط O_0B_1 - عضوى+حيوى O_1B_1) بينما المعاملة الشقية هى التسميد المعدنى بمعدلات (100%, 75%, 50% من التوصية السمادية لنبات البطاطس). وكانت النتائج المتحصل عليها : أدى التسميد العضوي والحيوي (B_1O_1) مع 75% من التسميد المعدني إلى زيادة معنوية في محصول الدرنات الطازج والجاف وكان قيم المحصول المتحصل عليها هى 17100 كجم.فدان$^{-1}$ و 3099.38 كجم.فدان$^{-1}$ على الترتيب. كما أدى التسميد العضوي والحيوي (B_1O_1)الى زيادة معنوية فى محتوى (%) درنات البطاطس من النيتروجين والفسفور والبوتاسيوم حيث كانت القيم المتحصل عليها هى 1.03 و 0.4788و 2.3% لعناصر الدراسة على الترتيب. بينما مع التسميد المعدنى 100% من التوصية السمادية ادت الى زيادة معنوية فى المحتوى من (%) النيتروجين والفسفور والبوتاسيوم فى درنات البطاطس حيث كانت أعلى القيم المتحصل عليها هى 0.92 و0.3667و 1.97% على الترتيب للمغذيات تحت الدراسة. وقد وجد كذلك أنه لا توجد فروق معنوية بين متوسطات التسميد المتكامل لكل من الأسمدة العضوية والحيوية (B_1O_1) مجتمعة مع 75% و100% من التوصية السمادية وعليه فان التسميد العضوى والحيوى مع 75% من التوصية السمادية يمكنة أن يضارع التسميد العضوى والحيوى مع 100% من التوصية السمادية مما يعنى وفر فى التسميد المعدنى بما يعادل 25% . فيما يتعلق بمعايير الجودة لدرنات البطاطس فقد وجد أنه بالنسبة للمواد الصلبة الذائبة الكلية (TSS) و%للبروتين و%للنشا و%للمادة الجافة لم توجد فروق معنوية للمعاملات المشتركة للأسمدة. بينما تأثير معاملة التسميد العضوى+الحيوىB_1O_1 كانت هي الأفضل بالنسبة لصفات الجودة وكذلك معاملة 100% من التوصية السمادية المعدنية.