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USING NATURAL ALTERNATIVE FERTILIZERS FOR POTATO PRODUCTION UNDER SANDY SOIL CONDITIONS IN EGYPT

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ABSTRACT

Two field experiments were carried out during the two successive seasons of 2010/2011 and 2011/2012 in the Farm of Agric. Res. Station, Wady El-Natrown Area, Fac. Agric. Cairo University, Egypt under saline water and sandy soil conditions. This investigation aimed to study the effect of compost, natural alternative fertilizers (rock phosphate and feldspar) combined with bacterial inoculation (*Azotobacter spp* and *Azospirillum perna* + *B. megaterium* + *B. circulans*) on yield, tubers quality and its component of (dry matter, NPK, carbohydrate and nitrate) of potato tubers Diamant cultivar. *Azotobacter spp* and *Azospirillum perna* were used as nitrogen fixing bacteria from compost, *B. megaterium* was used as phosphate dissolving bacteria from rock phosphate and *B. circulans* was used as potassium dissolving bacteria from feldspar. The experiment included 13 treatments as follows three compost levels source of (N) (5.9, 8.8, 11.8 ton/fed.), three rock phosphate levels source of (P) (204.4, 140.7, 77.04 kg/fed.) and five feldspar levels source of (K) (888.8, 592.6, 580.7, 333.3, 251.9 kg/fed.) compared with control (mineral NPK at rate of 120 N -75 P_2O_5 - 96 K_2O kg/fed.) were applied in a (RCBD) randomized complete blocks design with three replicates. Results at harvest showed that significant increases in yield characteristics as (yield/plant, total yield, number of tubers and weight of tubers/plant) and tubers quality (dry matter, carbohydrate, nitrate) were treated with high rate of compost (11.8 ton/fed.) combined with potassium at the highest rate in the presence of bacterial inoculation mixture and showed significantly increasing compared with control. Therefore, compost, rock phosphate, feldspar and biofertilizers could be an alternative to mineral fertilizer for potato production.

Keywords: Compost, rock phosphate, feldspar, bacterial inoculation, dry matter, N, P, K, carbohydrate, nitrate.

INTRODUCTION

Potato (*Solanum tuberasum L.*) is one of the most important vegetable crops cultivated in Egypt for local consumption and exportation. Increasing the quality of potato for exportation is the main aim of potato growers. It ranks after wheat, rice and maize as the fourth most important crop for human consumption (Ewing, 1997). In 2012, the total area cultivated with potato reached to approx. 208425 fedden with total production for winter season 2245431. Also, cv. Diamant is one of the important imported cultivars of winter potatoes, the total area cultivated reached to 53913 fed. with total production 599847 ton (Agriculture Directorates of Governorates, Publisher: Economic Affairs Sector).

The problems associated with the use of hazardous chemicals for crop protection, weed control and soil fertility are receiving increasing attention worldwide since pests, diseases and weeds become resistant to chemical

pesticides and environmental pollution and ecological imbalances may occur. Therefore, non-renewable petrochemical resources should be replaced by biologically based renewable inputs (Quimby *et al.*, 2002).

Sustainability in agro ecosystems involves environmentally-friendly techniques based on biological and non- chemical methods (Bonato and Ridray, 2007). Several investigators indicated that inoculation with *Azotobacter* and *Azospirillum* improved growth and yield of potato crop (Mahendran *et al.*, 1996; Mahendran and Kumar 1998) and (El-Ghinibihi and Fatouh 2001).

Sandy soil is generally characterized as a very poor soil in mineral nutrients and has low moisture holding capacity as well as scarcity of organic matter. Sandy soils have their own problems as single grain structure susceptibility to erosion, high salinity and low level of nutrients and microorganisms (Nour, 1999). Also, addition of chemical fertilizers has been criticized due to a suspicion of having an adverse effect of environment (Badr *et al*., 2006). Many studies showed that the adding organic fertilizers such as (compost, rock phosphate and feldspar) to sandy soil would improve its physical-chemical and biological properties which increase soil organic matter, cation exchange capacity, available mineral nutrients (Mervat *et al*., 1995) and this in turn stimulate quantitative as well as qualitative characteristics of vegetable crops (Abd-El-Aty, 1997 and Abdalla *et al*., 2001). Heeb *et al*., (2006) reported that the sheep manure treatment; yields of tomatoes from the organically fertilized plants were significantly lower than yields from plants that received mineral fertilizer. This might be due to the fact that organic fertilizers release nutrients more slowly than mineral fertilizers, resulting in decreased S and P concentrations in the leaves, which limited growth and yield in the organic fertilizers. Abou-Zaid and Bakry (2011) found, in sandy soil, that using the inoculation with *Bacillus megaterium var*. *phosphaticum* increased tubers number/plant and total yield as compared to untreated one. These results were true under 0 and 90 kg mineral as well as chicken manure at 7 ton/fed.

The present study was investigated to study the effect of compost, natural alternative fertilizers (rock phosphate and feldspar) combined with bacterial inoculation (*Azotobacter spp. and Azospirillum perna* + *B. megaterium* + *B. circulans*) on vegetative growth, yield, tubers quality and its component of (NPK, carbohydrate and nitrate) of potato tubers Diamant cultivar.

MATERIALS AND METHODS

Two field experiments were carried out under sandy soil conditions during winter seasons of 2010 – 2011 and 2011 – 2012 in the Farm of Agric. Res. Station, Wadi El-Natrown Area, Fac. Agric. Cairo University, Egypt. Tubers of potato (*Solanum tuberasum L*.) cv. Diamant were sown in 28th and 25th of October in 2010 and 2011 season, respectively. The previous treatments were arranged in three replicates using randomized complete blocks design. The area of each experimental unit was 13.5 m^2 with 45 plants. Drip irrigation system was used.

Treatments

The experiment consisted of 13 treatments as follows:

1. 5926 kg compost + 204.4 kg rock phosphate + 592.6 kg feldspar/fed. (T_1)
2. 5926 kg compost + 204.4 kg rock phosphate + 592.6 kg feldspar + (*Azotobacter spp* and *Azospirillum perna* + *B. megaterium* + *B. circulans*)/fed. (T_2)
3. 5926 kg compost + 204.4 kg rock phosphate + 888.8 kg feldspar/fed. (T_3)
4. 5926 kg compost + 204.4 kg rock phosphate + 888.8 kg feldspar + (*Azotobacter spp* and *Azospirillum perna* + *B. megaterium* + *B. circulans*)/fed.(T_4)
5. 8888 kg compost + 140.7 kg rock phosphate + 333.3 kg feldspar/fed. (T_5)
6. 8888 kg compost + 140.7 kg rock phosphate + 333.3 kg feldspar (*Azotobacter spp* and *Azospirillum perna* + *B. megaterium* + *B. circulans*)/fed. (T_6)
7. 8888 kg compost + 140.7 kg rock phosphate + 592.6 kg feldspar/fed. (T_7)
8. 8888 kg compost + 140.7 kg rock phosphate + 592.6 kg feldspar + (*Azotobacter spp* and *Azospirillum perna* + *B. megaterium* + *B. circulans*)/fed. (T_8)
9. 11852 kg compost + 77.04 kg rock phosphate + 580.74 kg feldspar/fed. (T_9)
10. 11852 kg compost + 77.04 kg rock phosphate + 580.74 kg feldspar + (*Azotobacter spp* and *Azospirillum perna* + *B. megaterium* + *B. circulans*)/fed. (T_{10})
11. 11852 kg compost + 77.04 kg rock phosphate + 251.9 kg feldspar/fed. (T_{11})
12. 11852 kg compost + 77.04 kg rock phosphoate + 251.9 kg feldspar + (*Azotobacter spp* and *Azospirillum perna* + *B. megaterium* + *B. circulans*)/fed. (T_{12})
13. Control (mineral fertilizer NPK at rate of 120 N-75 P_2O_5-96 K_2O/ fed.). (T_{13})

Three compost levels were used at (80, 120 and 160 units N/fed. which were about (5.9, 8.8, 11.8 ton compost/fed.) while two potassium levels (120 and 140units K/fed.) which were about (888.8, 592.6, 580.7, 333.3, 251.9 kg/fed.) while one phosphoure level was used at (75 units P/fed.) which were about (204.4, 140.7, 77.04 kg/fed.). Rock phosphate (P_2O_5 22.8%) and feldspar (K_2O 10.6%) were used as a source of P and K, respectively and were added during soil preparation mixture with compost before agriculture. Biofertilizers treatments involved a mixture of beneficial microorganisms including *Azotobacter spp* and *Azospirillum perna* were used as nitrogen fixing bacteria from compost, *B. megaterium* was used as phosphate dissolving bacteria from rock phosphate and *B. circulans* was used as potassium dissolving bacteria from feldspar. Biofertilizers mixture was mixed and added with compost before agriculture.

Soil and water analysis

A soil sample was collected from the experimental field at the beginning of the experiment from a depth of 0-30 cm in both seasons, where some physical and chemical properties of the experimental soil are presented in Table(1) (Soils, Water and Environment Research Institute, Agriculture Research center, 2011) and water chemical analysis is presented in Table(2).

Compost analysis

A compost sample was analysed and some physical and chemical properties of the experimental compost are presented in Table (3) (Soils, Water and Environment Research Institute, Agriculture Research Center, 2011). Compost were obtained from (El-Beheira Company, 2011).

Table 1: Physical and chemical properties of the soil.

Soil Characteristics	Values
Particle size distribution (%)	
Corse sandy	50.1
Fine sandy	40.6
Silt	4.2
Clay	5.1
Texture	Sand
Physical analysis	
pH	8.35
Ec (ds/m)	1.23
$CaCO_3$ (%)	3.24
O.M (%)	0.1
C.E.C (mol.kg-1)	5.32

Table 2: Chemical analysis of irrigation water.

Characters	Values
pH	7.5
Ec (mmohs/cm)	3.9
Adsorb Na^+ meq/l	13.83
SO_4^{--} meq/l	12.71
CO_3^{--} meq/l	4.04
Cl^- meq/l	22.83
Mg^{++} meq/l	7.15
Na^+ meq/l	29.88
K^+ meq/l	0.39
Ca^{++} meq/l	2.16

Climatic conditions

The meteorological data were taken from (Central Laboratory Agriculture Climatic, Agriculture Research Center, 2011 and 2012) according to the formal data from the Egyptian Ministry of Agriculture. Some meteorological data during the growing seasons are presented in Table (4).

Soil preparation

Soil was washed before planting using drip irrigation system for several days to wash the soil from salinity. After partial drying of the soil, it was ploughed. Thereafter, the experimental field was divided into 13 lines. Each line contained one treatment. However, compost, feldspar and rock phosphate were applied in different amounts according to the treatments, compost combined with (feldspar and rock phosphate + biofertilizers) and broadcast in the lines with relieve to fill up. Organic and natural rocks were incorporated with the soil as using rotary tiller.

Cultivation

Potato tubers cv. Diamant were planted on 28th and 25th of October in 2010 and 2011 season, respectively, using lines-planter after adding compost combined with (feldspar and rock phosphate and (biofertilizers combined with little of sand and broadcast in lines) were treated

after adding compost. Potato tubers were planted with leaving 30 cm between plants and 90 cm between lines in all plots. All potato tuber seeds were planted completely tubers. However, each plot was 175.5 m^2 and included 13 lines (15 m length and 90 cm width).

Table 3: Chemical analysis of compost used in the field.

Characters	Values
C/N ratio	1:12.58
O.M (%)	29.51
O.C (%)	17.11
pH	7.21
E.c (ds/m)	7.53
Total Nitrogen (%)	1.36
Total phosphorus (%)	0.49
Total potassium (%)	0.97
Humidity (%)	25
Ash (%)	70.49
Weight of m^{τ} (kg)	615
Weeds seeds	Nil
Nematode	Nil

Table 4: Averages of air temperature during the growing seasons 2010 and 2011.

Date	Max. temp	Min. temp
	Growing season 2010	
Oct.	32.6	18.6
Nov.	28.1	15.3
Des.	24.5	9.3
Jan.	18.0	9.2
Feb.	19.1	9.2
	Growing season 2011	
Oct.	27.1	15.1
Nov.	21.7	11.1
Des.	19.6	7.8
Jan.	21.0	3.0
Feb.	20.9	2.6

Application of NPK

Regarding mineral fertilization application, all amounts of phosphorus and potassium were added during soil preparation in the form of superphosphate (P_2O_5 15%), and potassium sulphate (K_2O 48%), while nitrogen amount was divided into equal doses, during soil preparation and 6 weeks after planting in the form of ammonium sulphate (20.5%).

Data recorded

Plant productivity

Tubers yield of plants were harvested on 24th and 22th of February in 2011 and 2012 season, respectively. At harvest, the following yield data were recorded:

1. Number of tubers per plant.
2. Tubers weight per plant.
3. Total yield (ton/fed.).

Chemical composition

At harvest, a sample of 100 gram fresh weight of tubers was taken from each plot and was dried at 70°C for three days to determine the following:

N, P and K concentration in tubers.

Tubers quality traits (dry matter, carbohydrate and nitrate).

Chemical analysis

To analyse N, P and K in potato tubers, were determined according the methods of Cottenie *et al*., (1982). Total phosphorus was determined by a spectrophotometer according to Cottenie et al., (1982). Total carbohydrates and nitrate in tubers, were determined according the methods of Dubois *et al*., (1956) and Singh (1988), respectively.

Statistical analysis

Data of the present study were statistically analysed using Assistat and the differences between the means of the treatments were considered significantly, when they were more than least significant differences at the confidence level of 5% Silva and Azevedo, (2009).

RESULTS AND DISCUSSION

Effect of compost, rock phosphate, feldspar levels and biofertilizers on number of potato tubers /plant, tubers weight/plant and total yield ton/fed.

Data presented in Table (5) in both seasons, showed that application of the highest rate of compost combined with potassium at the highest rate in the presence of bacterial inoculation mixture (11852 kg compost + 77.04 kg rock phosphate + 251.9 kg feldspar + (*Azotobacter spp* and *Azospirillum perna* + *B. megaterium* + *B. circulans*)/fed. had the highest significant value among treatments in tubers weight per plant (g) and total yield (ton/fed.) and no significant differences between treatments from (T_9 to T_{12}) in number of tubers in both seasons compared with control treatment (mineral NPK at rate of 120 N-75 P_2O_5-96 K_2O/ fed.). The lowest value was recorded in (5926 kg compost + 204.4 kg rock phosphate + 592.6 kg feldspar/fed. with significant reduction in number of tubers per plant, tubers weight per plant (g) and total yield (ton/fed.) at harvest in both seasons compared with control treatment.

The obtained results were in accordance with those obtained by Hammad and Abdel-Ati, (1998) and Abou-Zaid and Bakry (2011) who estimated significant higher values of number of tubers per plant, total weight of tubers per plant, total and marketable yield of potato/fed. with saving 25% in the nitrogen fertilization owing to using *Azospirillum* + *arbuscular mycorhizae* fungi as compared to plots received the recommended N-dose (80 kg N/fed.) such increase in number of tubers/plant, total weight of tubers /plant and total yield. Biofertilizer proved to be very effective in increasing potato quality by reducing nitrate content indicated that the use of dual inoculation (*Azospirillum* and *Mycorhizae*) as a biofertilizer for potato plants reduced the nitrate and nitrite contents of potato tubers as compared with untreated plants.

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These results were agreement with Arafa and El-Maghraby, (2004) who found that under sandy soil conditions, using a mixture of biofertilizers (consisting of nitrogen fixation bacteria, a mixture of phosphate dissolving bacteria, and spray liquid fertilizer containing 24% K and 5% N in plots received 100 + 14 + 80 kg/fed. of NPK, respectively, gave significantly higher values of number of tubers /plant, total weight of tubers /plant and marketable and total yield as compared to plots received the recommended NPK rate (125, 21 and 100 kg N,P and K, respectively/fed.) but without biofertilization inoculation.

Effect of compost, rock phosphate, feldspar levels and biofertilizers on macro nutrients in potato tubers at harvest.

As shown in Table (6), the highest value of nitrogen, phosphorus and potassium concentration in tubers at harvest were obtained from the application of the highest rate of compost in both seasons compared with mineral fertilization (control treatment). Application of high rate of compost combined with potassium at the highest rate in the presence of bacterial inoculation mixture (11852 kg compost + 77.04 kg rock phosphate + 251.9 kg feldspar + (*Azotobacter spp* and *Azospirillum perna* + *B. megaterium* + *B. circulans*)/fed. had the highest significant differences between treatments in P contents in potato tubers, for nitrogen in tubers, no significant differences between treatments from (T_{11} to T_{12}). Also no significant differences between treatments from (T_6 to T_{12}) in K contents in potato tubers in both seasons compared with control treatment (mineral NPK at rate of 120 N-75 P_2O_5-96 K_2O/ fed.). The lowest value was recorded in (5926 kg compost + 204.4 kg rock phosphate + 592.6 kg feldspar/fed. with significant reduction in nitrogen, phosphorus and potassium concentration in tubers compared with control treatment.

The obtained results were in accordance with those obtained by Abdel-Salam and Shams (2012) who reported that adding a biofertilizer consisting of a combined mixture of N-free fixing bacteria (*Aztobacter* and *Azospirillum*) + P-dissolving bacteria (*Bacillus megatrium*) + silicate dissolving bacteria (*Bacillus circulans*) to feldspar increased shoot uptake of N and K, as compared to using feldspar alone with inoculation. Also, Khalil (2009) who found that nitrogen and phosphorus uptake by potato plants were increased as a result of inoculation with *arbuscular Azospirillum* as compared with uninoculated plants. The mechanisms by which *Azospirillum spp*. can exert a positive effect on plant growth is probably composed of multiple effects including synthesis of phytohormones, N_2-fixation, nitrate reduce activity and enhancing minerals uptake according to El-Komy (2004).

Effect of compost, rock phosphate, feldspar and biofertilizers on quality of potato tubers

Data presented in Table (7) showed that the highest value of dry matter and carbohydrate concentration in tubers at harvest were obtained from the application of the highest rate of compost in both seasons compared with mineral fertilization (control treatment).

Application of the highest rate of compost combined with potassium at the highest rate in the presence of bacterial inoculation mixture (11852 kg compost + 77.04 kg rock phosphate + 251.9 kg feldspar + (*Azotobacter spp* and *Azospirillum perna* + *B. megaterium* + *B. circulans*)/fed. had the highest significant among treatments in dry matter and no significant differences between treatments in dry matter from T_9 to T_{12} in both seasons.

Also (T_{12}) had the highest significant among treatments in carbohydrate concentration in tubers and no significant differences between treatments from T_8 toT_{12} in carbohydrate concentration in potato tubers compared with control treatment (mineral NPK at rate of 120 N-75 P_2O_5-96 K_2O/ fed.). The lowest value was recorded in (5926 kg compost + 204.4 kg rock phosphate + 592.6 kg feldspar/fed. with significant reduction in carbohydrate concentration in tubers compared with control treatment.

The obtained results were in accordance with those obtained by Mahendran and Kumar (1998) who found that dual inoculation of potato with the asymbiotic N_2-fixers i.e. *Azotobacter* or *Azospirillum* and phosphate dissolving bacteria improved growth performance, dry matter and carbohydrate content and tuber yield of potato. Also, data in Table (7) showed that the highest value of nitrate concentration in tubers at harvest was obtained from the mineral fertilizer (mineral NPK at rate of 120 N-75 P_2O_5-96 K_2O/ fed.) had the highest significant differences between treatments in nitrate concentration in tubers compared with application of compost.

The lowest value was recorded in (T_1) to (T_{12}) with significant reduction in nitrate concentration in tubers and no differences between them compared with control treatment. These results were agreement with those obtained by Hammad and Abdel-Ati, (1998) who found that biofertilizers proved to be very effective in increasing potato quality by reducing nitrate content indicated that the use of dual inoculation (*Azospirillum* and *Mycorhizae*) as a biofertilizer for potato plants reduced the nitrate and nitrite contents of potato tubers as compared with untreated plants.

Also, El-Banna and Tolba (2000) found that saving 25% in the mineral NP using nitrobien (a biofertilizer contains *Aztobacter sp*., *Azospirillum sp*., and phosphate dissolving bacteria, namely, *Bacillus sp*.) as compared plots received the recommended N and P-dose (180 N and 75 kg P, respectively/fed.). using nitrobien (a biofertilizer contains (*Azospirillum sp*., *Aztotobacter sp*., and phosphate dissolving bacteria, namely, *Bacillus sp*.) in plots received 75% of recommended N and P (135 and 56.25 kg N and P respectively/fed.) significantly reduced the concentration of nitrate and nitrite in potato tubers as compared to plots received the recommended N and P-dose (180 and 75 kg of N and P, respectively/fed.) but without nitrobien inoculation.

REFFRENCES

Abdalla, A.M.; Rizk, F.A. and Adam, S.M. (2001). The productivity of pepper plants as influenced by some biofertilizer treatments under plastic house conditions.Bull.Fac.Agric.Cairo Univ.,52:625-640.

Abd-El-Aty, S.A. (1997). Influence of some organic fertilizers on growth and yield of pepper plants(Capsicum annuum L.) cultivated under plastic houses. M.Sc. Thesis Fac. Agric. Ain Shams Univ., Cairo,Egypt.

Abd-El-Salam , M.A. and Shams, A.S. (2012). Feldspar-K fertilization of potato (*Solanum tuberosum L*.) augmented by biofertilizer. American-Eurasian J. Agric.&Environ. Sci.,12(6):694-699.

Abou-Zeid, Y.M.; and Bakry, M.A.A. (2011). Integrated effect of bio-organic manures and mineral fertilizers on potato productivity and the fertility status of a calcareous soil. Australian Journal of Basic and Applied Science,5(8):1385-1399.

Arafa, M.M. and El-Maghraby, T.A. (2004). Effect of bio and chemical fertilizers on growth, yield and chemical composition of potato (Solanum tuberosum L.) under sand soil condition. Annals Agric. Sci., Moshtohor, 42(4):2017-2032.

Badr, M.A.; Shafei, A.M. and Sharaf El-Deen, S.H., (2006).The dissolution of K and P-bearing minerals by silicate dissolving bacteria and their effect on sorghum growth. J. Agric. Biol. Sci., 2(1):5-11.

Bonato, O. and Ridray, G. (2007). Effect of tomato deleafing on mirids, the natural predators of whiteflies, Agron. Sustain. Dev.,27:167-170.

Cottenie, A.; Verloo, M.; Kiekens, L.; Velghe, G. and Camerlynck, R. (1982). Chemical analysis of plants and soils. Laboratory of Analytical and Agrochemistry State University Ghent-Belgium.

Dubois, M.; Gilles, K.A.; Hamition, J.K. and Rebers, P.A.(1956). Colorimetric method for determination of sugars and related substances. Anal. Chem., 28:350-356.

El-Banna, E.N. and Tolba, A.F. (2000). Effect of microbien (biofertilizer) and different levels of nitrogen and phosphorus in growth and yield of potato plant (Solanum tuberosum L.). J. Agric. Sci. Mansoura Univ., 25(8):5343-5352.

El-Ghinibihi, Fatma, H. and Fatouh, A.A. (2001). Response of some potato cultivars to biofertilizers and different mineral nitrogen levels. Zagazig J. Agric. Res.,28(1):133-162.

El-Komy, M.A.H. (2004). Coimmobilization of Azospirillum lipoferum and Bacillus megaterium for successful phosphorus and nitrogen nutrition of wheat plants. Food technol. Biotechnol.,43(1):19-27.

Ewing, E.E. (1997). Potato. " The physiology of Vegetable crops". H.C. Wien (Ed).,pp: 293-344.CAP International.U.S.A. New York.

Hammad, A.M.M. and Abdel-Ati, Y.Y. (1998). Reducing of nitrate content of potato tuber via biofertilization with *Azospirillum* and via-Mycorrhizal fungi. J. Agric. Sci. Mansoura Univ., 23:2597-2610.

Heeb, A.; Lundegaardh, B.; Savage, G. and Ericsson, T. (2006). Impact of organic and inorganic fertilizers on yield, taste, and nutritional quality of tomatoes, J. Plant Nutr. Soil Sc., 169:535–541.

Khalil, H.M.A.(2009). Assessment of organic nitrogen availability to potato plant under affecting promoting rhizobacterium and mycorrhizal inoculation. Res. J. Agric. and Bio., 5(4):583-587.

Mahendran, P.P. and Kumar, N. (1998). Effect of biofertilizers on tuber yield and certain quality parameters of potato cv. Kufri Jyoti. South India Horticulture, 46(1-2):47-48.

Mahendran, P.P.; Kumar, N. and Sarawathy, S. (1996). Studies on the effect of biofertilizers on potato. SouthIndian Horticulture, 44(3-4):79-82.

Mervat, A.T.; Amara, T. and Dandoh, M.S.A. (1995). Effect of inoculation with plant growth promoting Rhizobacteria (PGPR) on yield and uptake of nutrients by wheat grown on sandy soil. Fifth National Congrees on Bio Agriculture in relation to Environment.Nov.,20-21,Cairo Egypt,pp:327-331.

Nour, E.M.E. (1999).Effect of some agricultural treatments on pea under sandy soil condition. M.Sc. Thesis, Zagazig Univ., Egypt, pp:67-71.

Quimby, P.C.; King, L.R. and Grey, W.E. (2002). Biological control as a means of enhancing the sustainability of crop/land management systems, Agric. Ecosyst. Environ.,88:147-152.

Silva, F. A. S. e. and Azevedo, C. A.V. (2009). Principal components analysis in the software Assistat-Statistical Attendance. In: World Congress on Computers in Agric.,7, Reno-NV-USA: Amer. Society of Agricultural and Biological Engineers.

Singh, J.P.(1988). A rapid method for determination of nitrate in soil and plant extracts. J. Plant and Soil., 110:137-139.

إستخدام الأسمدة الطبيعية البديلة لإنتاج البطاطس تحت ظروف التربة الرملية في مصر

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بكالوريوس في العلوم الزراعية (خضر)- كلية الزراعة – جامعة القاهرة[٢]

أجريت التجربة على نبات البطاطس صنف دايمونت تحت ظروف التربة الرملية خلال موسمى ٢٠١٠/٢٠١١ و٢٠١١/٢٠١٢ وذلك في مزرعة كلية الزراعة جامعة القاهرة بوادي النطرون ، لدراسة تأثير إستخدام معدلات مختلفة من الكمبوست والصخور الطبيعية (صخر الفوسفات والفلسبارات) وخلطها مع الملقحات البكتيرية، و أثر ذلك على كل من النمو الخضرى والمحصول و مكوناته و صفات الجودة والقدرة التخزينية لدرنات البطاطس. إستخدم *Azotobacter spp and Azospirillum perna)* بكتيريا مثبتة للنيتروجين من الكمبوست وإستخدمت *B. megaterium* بكتيريا مثبتة للفوسفورمن صخر الفوسفات كما إستخدمت *B. circulans* بكتريا مثبتة للبوتاسيوم من الفلسبار.تم إستخدام ٣ تركيزات من الكمبوست هم (٩,٥,٨,٨,٨,١١) طن/فدان وإستخدم ٣ تركيزات من صخر الفوسفات (٠٤,٧٧,٧,١٤٠,٤,٢٠٤كجم/فدان) كما إستخدم ٥ تركيزات من الفلسبار (٩,٢٥١,٣,٣٣٣,٧,٥٨٠,٨,٥٩٢,٨,٨٨٨كجم/فدان) مقارنة بالكنترول (التسميد المعدني بمعدل ١٢٠النيتروجين – ٧٥ الفوسفور- ٩٦البوتاسيوم كجم/فدان) حيث تم تصميم التجربة في قطاعات كاملة العشوائية في ثلاث مكررات. أخذت بيانات على المحصول عند الحصاد وأوضحت البيانات زيادة معنوية في عدد الدرنات/نبات ووزن الدرنات/نبات والمحصول الكلي ومحتوى الدرنات من (النيتروجين – الفوسفور - البوتاسيوم - المادة الجافة- الكربوهيدرات – النترات) وذلك مع إستخدام أعلى معدل من الكمبوست (١١,٨كجم/فدان) مخلوطا مع أعلى معدل من البوتاسيوم بالإضافة إلى الملقحات البكتيرية الثلاثية مقارنة بمعاملة الكنترول. لذلك إستخدام الكمبوست, الفلسبار وصخر الفوسفات مخلوطا مع الملقحات البكتيرية مناسبة كأسمدة طبيعية بديلة عن السماد المعدني لإنتاج البطاطس.

الكلمات الدالة : الكمبوست, صخر الفوسفات, الفلسبار, التلقيح البكتيري, المادة الجافة , النيتروجين, الفوسفور, البوتاسيوم, الكربوهيدرات, النترات.

Table 5: Effect of different fertilization treatments on number of potato tubers /plant, tubers weight/plant (g) and total

Treatments	2010			2011		
	No. tubers	Tubers weight	Total yield	No. tubers	Tubers weight	Total yield
T_1	10.3 f	373.7 h	4.3 h	10.5 f	401.4 f	4.6 f
$T_2 = T_1$ + bacterial inoculation	11.2 ef	444. 8 gh	5.1gh	11.3 ef	446.2 f	5.2 f
T_3	12.2 de	481.4 gh	5.6 gh	12.3 de	479.1 f	5.5 f
$T_4 = T_3$ + bacterial inoculation	13.6 bc	511.7 g	5.9 g	13.7 bc	515.6 f	6.0 f
T_5	13.2 cd	662.7 f	7.7 f	13.3 cd	670.5 e	7.8 e
$T_6 = T_5$ + bacterial inoculation	14.0 bc	711.4 ef	8.2 ef	14.2 bc	723.6 e	8.4 e
T_7	12.9 cd	750.4 ef	8.7 ef	13.1 cd	761.1 e	8.8 e
$T_8 = T_7$ + bacterial inoculation	13.6 bc	807.7 de	9.3 de	13.7 bc	818.5 de	9.5 de
T_9	14.9 ab	907.3 cd	10.5 cd	15.1 ab	913.8 cd	10.6 cd
$T_{10} = T_9$ + bacterial inoculation	15.5 ab	968.2 c	11.2 c	15.7 ab	954.3 cd	11.0 cd
T_{11}	15.6 ab	1001.8 bc	11.6 bc	15.7 ab	1016.8 bc	11.8 bc
$T_{12} = T_{11}$+ bacterial inoculation	16.8 a	1355.2 a	15.7 a	16.9 a	1369.2 a	15.8 a
T_{13} (mineral fertilizer)	13.4 bc	1108.2 b	12.8 b	13.6 bc	1114.1 b	12.9 b

T_1=5926 kg compost + 204.4 kg rock phosphate + 592.6 kg feldspar/fed. T_3=5926 kg compost + 204.4 kg rock phosphate + 888.8 kg feldspar/fed. T_5=8888 kg compost + 140.7 kg rock phosphate + 333.3 kg feldspar/fed. T_7=8888 kg compost + 140.7 kg rock phosphate + 592.6 kg feldspar/fed. T_9=11852 kg compost + 77.04 kg rock phosphate + 580.74 kg feldspar/fed. T_{11}=11852 kg compost + 77.04 kg rock phosphate + 251.9 kg feldspar/fed. Bacterial inoculation (*Azotobacter spp* and *Azospirillum perna* + *B. megaterium* + *B. circulans*)/fed. (mineral fertilizer) 120 N-75P_2O_5-96 K_2O kg/ fed.).

Table 6: Effect of different fertilization treatments on nitrogen (%), phosphorus (%) and potassium (%) concentration in potato tubers in 2010&2011 seasons.

Treatments	2010			2011		
	N	P	K	N	P	K
T_1	0.62 g	0.63 j	2.62 e	0.65 h	0.65 i	2.66 d
$T_2 = T_1$ + bacterial inoculation	0.74 fg	0.65 ij	2.76 e	0.80 gh	0.65 i	2.82 d
T_3	0.90 ef	0.67 ij	2.95 de	0.91 fg	0.68 hi	2.98 cd
$T_4 = T_3$ + bacterial inoculation	1.02 ef	0.71 hi	3.10 cd	1.05 fg	0.71 hi	3.16 cd
T_5	1.07 ef	0.74 gh	3.44 bc	1.14 fg	0.74 gh	3.65 bc
$T_6 = T_5$ + bacterial inoculation	1.14 de	0.80 fg	3.85 ab	1.15 fg	0.80 fg	3.99 ab
T_7	1.27 de	0.81 ef	3.91 ab	1.33 ef	0.85 ef	4.09 ab
$T_8 = T_7$ + bacterial inoculation	1.59 cd	0.86 e	4.07 ab	1.59 de	0.89 e	4.10 ab
T_9	1.81 bc	0.96 d	4.11 ab	1.96 cd	0.97 d	4.18 ab
$T_{10} = T_9$ + bacterial inoculation	2.09 ab	1.21 c	4.32 ab	2.09 bc	1.22 c	4.45 a
T_{11}	2.39 a	1.33 b	4.42 ab	2.49 ab	1.34 b	4.51 a
$T_{12} = T_{11}$ + bacterial inoculation	2.54 a	1.55 a	4.56 a	2.58 a	1.55 a	4.61 a
T_{13} (mineral fertilizer)	1.78 bc	1.29 b	3.55 bc	1.82 cd	1.29 b	3.58 bc

T_1=5926 kg compost + 204.4 kg rock phosphate + 592.6 kg feldspar/fed. T_3=5926 kg compost + 204.4 kg rock phosphate + 888.8 kg feldspar/fed. T_5=8888 kg compost + 140.7 kg rock phosphate + 333.3 kg feldspar/fed. T_7=8888 kg compost + 140.7 kg rock phosphate + 592.6 kg feldspar/fed. T_9=11852 kg compost + 77.04 kg rock phosphate + 580.74 kg feldspar/fed. T_{11}=11852 kg compost + 77.04 kg rock phosphate + 251.9 kg feldspar/fed. Bacterial inoculation (*Azotobacter spp* and *Azospirillum perna* + *B. megaterium* + *B. circulans*)/fed. (mineral fertilizer) 120 N-75P_2O_5-96 K_2O kg/ fed.).

Table 7: Effect of different fertilization treatments on dry matter (%), carbohydrate (%) and nitrate (ppm) concentration in potato tubers in 2010&2011 seasons.

Treatments	2010			2011		
	Dry matter	Carbohydrate	Nitrate	Dry matter	Carbohydrate	Nitrate
T_1	19.7 e	78.3 f	0.00 b	19.8 e	78.4 f	0.00 b
T_2 = T_1 + bacterial inoculation	19.8 e	79.0 ef	0.00 b	19.9 e	79.2 ef	0.00 b
T_3	19.9 e	80.4 ef	0.00 b	20.0 e	80.7 ef	0.00 b
T_4 = T_3 + bacterial inoculation	20.3 e	82.2 e	0.00 b	20.5 e	82.4 e	0.00 b
T_5	21.7 d	87.3 d	0.00 b	22.0 d	87.5 d	0.00 b
T_6 = T_5 + bacterial inoculation	22.4 cd	90.0 cd	0.00 b	22.5 cd	90.2 cd	0.00 b
T_7	22.7 cd	90.9 bc	0.00 b	22.8 cd	91.1 bc	0.00 b
T_8 = T_7 + bacterial inoculation	23.1 bc	91.9 ab	0.00 b	23.3 bc	92.0 ab	0.00 b
T_9	24.0 ab	92.1 ab	0.00 b	23.9 ab	92.3 ab	0.00 b
T_{10} = T_9 + bacterial inoculation	24.2 ab	93.0 ab	0.00 b	24.3 ab	93.2 ab	0.00 b
T_{11}	24.6 a	94.3 ab	0.00 b	24.6 a	94.6 ab	0.00 b
T_{12} = T_{11} +bacterial inoculation	24.9 a	95.0 a	0.00 b	24.9 a	95.2 a	0.00 b
T_{13} (mineral fertilizer)	22.1 cd	91.0 ab	0.49 a	22.3 cd	91.2 bc	0.51 a

T_1=5926 kg compost + 204.4 kg rock phosphate + 592.6 kg feldspar/fed. T_3=5926 kg compost + 204.4 kg rock phosphate + 888.8 kg feldspar/fed. T_5=8888 kg compost + 140.7 kg rock phosphate + 333.3 kg feldspar/fed. T_7=8888 kg compost + 140.7 kg rock phosphate + 592.6 kg feldspar/fed. T_9=11852 kg compost + 77.04 kg rock phosphate + 580.74 kg feldspar/fed. T_{11}=11852 kg compost + 77.04 kg rock phosphate + 251.9 kg feldspar/fed. Bacterial inoculation (*Azotobacter spp* and *Azospirillum perna* + *B. megaterium* + *B. circulans*)/fed. (mineral fertilizer) 120 N-75P_2O_5-96 K_2O kg/ fed.).