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RETIONALIZATION OF MINERAL POTASSIUM FERTILIZER BY USING BIODESOLVING POTASSIUM AND ITS EFFECT ON YIELD AND QUALITY POTATOS.

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ABSTRACT

Potassium is one of the three essential elements *viz*., NPK needed in large quantities for the growth and reproduction of the plants and it plays many vital roles in plant nutrition. The crop production in Egypt relies completely on imports to meet its annual requirement of potash fertilizers besides; the high cost of conventional, water soluble K fertilizers constrain their use by most of the farmers in the country. In order to reduce the dependence on imported potash, feldspar a potash mineral, contains 10.5 % K_2O and therefore it could be a potential K-source for crop production. Novel approaches are needed to unlock K from the silicate structure of this mineral in order to render K more available for plant nutrition. A strain of silicate dissolving bacteria (*Bacillus circulans*) as well as fungus (*Penicillium* sp.) were used as bio-inoculants. These studies were undertaken to evaluate the effectiveness of bacterial and fungus inoculation in combination with two levels of feldspar and mineral potassium fertilizer (full recommended dose and half recommended dose) on K-releasing capacity as well as potato yield. To achieve this target, bio-inoculated potato tubers (*Solanum tuberosum,* L.) were sown on calcareous soil at Nubaria Agriculture Research Station. The obtained data showed that inoculation with silicate dissolving bacteria as biofertilizer in the presence of different potassium sources increased all examined potato tuber yield, tuber content of carbohydrate and protein, moreover soil available and plant (shoot and tubers) content of N, P , K ,Fe, Mn, Zn and Cu compared to the sole use of K sources. On the other hand, the highest tubers yield (15.62 and 15.33 ton fed^{-1}) were obtained when mineral fertilizer and feldspar were inoculated with bacteria. The apparent nutrient recovery and partial factor productivity were significantly enhanced by inoculated feldspar with Silicate Dissolving Bacteria (SDB) than other treatments. However, the use of feldspar in combination with biofertilizers may be more useful and economically.

Keywords: Potato, mineral fertilizer, feldspar, silicate dissolving bacteria, fungi.

INTRODUCTION

Potato (*Solanumtuber* sum L.) is considered one of the most important vegetable crop in Egypt. Increasing productivity of potato with good quality is an important target by the growers for local and foreign consumptions. Importance and significance of potassium in agriculture as well as for human and animal health is well established. Further more, potassium forms are the third most important plant nutrient limiting plant growth and consequently crop yield (*Marschner,1995*). Potassium is absorbed by plants in larger amounts than any other mineral elements *except* nitrogen and phosphorous. The main source of K for plants comes from K minerals and organic K-source, K-feldspar is one of the most important K minerals (*Straaten,2002*). Mineral potassium fertilizer is a high expensive fertilizer in Egypt, so most of farmers ignored using it. Thus, the use of alternative indigenous resources such as feldspar (orthoclase) is gaining importance to alleviate the dependence of imported or costly commercial fertilizers. According to *Buchholz and Brown (1993*), more than 98% of potassium in soil exists in the form of silicate minerals(microcline, muscovite, orthoclase,biotite,feldspars,.etc.).Making use of such minerals are meaningful in increasing crop production and quality, competing capacity of Egyptian agriculture production in international markets and protecting ecological environment. The potassium ion is not easily released and is therefore not suitable for direct supply to the plants. However, it is recognized that the weathering process can be further mediated by organisms and their metabolites. Bacteria, fungi and plants produce soluble compounds that are capable of interacting with mineral surfaces and altering mineral reaction rates.Complete microbial respiration and degradation of particulate and dissolved organic carbon can elevate carbonic acid concentration at mineral surfaces, in soil and ground water (*Barker et al., 1998*), which can lead to an increase in the rates of mineral weathering by a proton promoted dissolution mechanism. Some recent reports showed that silicate dissolving bacteria could activate soil P, K, Si reserves and promote plant growth (*Sheng et al., 2003*). *Styriakova et al. (2003*), reported that the activity of silicate dissolving bacteria played a pronounced role in the release of Si, Fe and K from feldspar. In addition *Kloepper et al.* (*1988*) concluded that, numerous microorganisms, especially those associated with roots, have the ability to increase plant growth and productivity by many beneficial strategies comprised the solubilization of unavailable mineral nutrients.

Hence, the aim of this study is to evaluate the efficiency of mineral and bio- potassium fertilizers on potato production.

MATERIALS AND METHODS

During two successive seasons (2011-2012), two field experiment was conducted on calcareous soil at Nubaria Agriculture Research Station Farm under surface irrigation to study the effect of inoculation with biofertilizer on the availability of potassium from either potassium sulphate or feldspar as a natural source of potassium to potato yield and its constituents. Also, soil available nutrients were determined after potato harvesting. some physical and chemical properties of the experimental soil are shown in Table (1).The experiment was in split plot design, which contained 12 treatments with three replicates, two levels of mineral potassium fertilizer (1/2 full dose of K from potassium sulphate (48%K_2O) =100 kg fed^{-1} & full dose of K (96%K_2O) = 200 kg fed^{-1}) and two levels of feldspar(half full dose of K from feldspar(10.5 % K_2O) = 457 kg fed^{-1} & full dose of K from feldspar = 914 kg fed^{-1})as a natural source of potassium. Two sources of biofertilizers were applied : the first one is silicate dissolving bacteria (*Bacillus circulans*)(SDB) and the second is fungus *(Penicillium* Sp*.).*Both are supplied from the Dept. Agric. Microbiol. Res., Soils, Water & Environ. Res. Inst., ARC, Giza, Egypt. Each plot received equivalent amount of 250 kg super phosphate as P_2O_5 fed^{-1} (15.5%)

before planting. Nitrogen was added at a rate of 120 kg fed^{-1} in the form of ammonium nitrate (33%N) in two equal doses. The plant spacing was 25 cm between plants in line of about 150 cm length.

At harvest time (in April), fresh tubers production (ton / fed), total carbohydrate% (*A. O. A. C., 1990*) and total protein was calculated by multiplying total nitrogen × 6.25 (*Ranganna,1977*). Available macro and micronutrient (N, P, K, Fe, Mn, Zn, and Cu) were determined according to *Chapman and Pratt (1978).*

Soil surface samples 0-30 cm depth were collected, air dried, passed through 2mm sieve and then subjected to determine available macro and micronutrients as described by *Page et al. (1982*). The obtained data were subjected to the analysis of variance procedure according to SAS 9.1programme (SAS, 1985).

Apparent Nutrient Recovery: (ANR) is calculated as follows :

ANR = Uptake in fertilized plot (kg ha^{-1})-Uptake in control plot (kg ha^{-1})-

Quantity of fertilizer nutrient applied (kg ha^{-1})

Partial factor productivity (Pfp): it is the ratio of yield to applied nutrients and stated as :

$$Pfp = Y / Nr$$

Where, Y is the yield of dry rhizome in kg ha^{-1} and Nr is the amount of fertilizer nutrients ($N+P_2O_5+K_2O$) in kg ha^{-1}.

Table (1): Some physical and chemical properties of the experimental soil

Particle size distribution (%)		**Soluble cations (meq/L)**	
Course sand	40.00	Ca^{2+}	5.30
Fine sand	16.00	Mg^{2+}	3.40
Silt	14.00	Na^{+}	7.60
Clay	30.00	K^{+}	0.80
Textural class	Sandy clay loam	**Availablenutrients(mgkg^{1}) soil**	
$CaCO_3$ (%)	32.00	N	30.20
Organic matter (%)	0.9	P	10.20
pH(1:2.5)	8.15	K	215.00
EC(dSm^{-1})	1.70	Fe	13.5
Soluble anions (meq/L)		Mn	7.50
CO_3^{2-}	0.00	Zn	0.73
HCO^{3-}	2.56	Cu	1.50
Cl^{-}	8.25		
SO_4^{2-}	6.29		

RESULTS AND DISCUSSION

(A) Soil fertility :

Available nutrients :

Potassium fertilizer response; natural mineral and inoculation with bacteria and fungus on macro and micro nutrients in the soil at harvest time for both studied seasons are shown in Table (2). Results indicate that application of bio fertilizer combined with both K sources led to increase soil NPK availability after harvest time. However, values of available (K) and nutrients in the soil, at both studied seasons, increased significantly as a consequence of inoculation with bacteria or fungus as compared to the control soil.

The highest soil available K was due to the soil treated with (S2 + bacteria) with insignificant difference to(F2+bacteria).The increase of available K could be explained by the production of CO_2 and forming H_2CO_3, which enhancing potassium solubility. This result is in agreement with *Han and lee (2005)* who reported that the inoculation with potassium solubilizing bacteria synergistically solubilized the insoluble natural K.

Availability of potassium in the studied soil may be arranged as follows: S2+bacteria > F2+bacteria > F1+bacteria >S1+bacteria >F2+fungus > S2+fungus > F1+ fungus > S1+ fungus respectively compared to the control soil. The availability of investigated nutrients (Fe, Mn, Zn & Cu) was taken the same trend.

Carboxylic acid groups, which were shown to promote dissolution of silicate (*Cordt and Kussmau,1992),* are also common in extra cellular organic materials. Moreover, some microorganisms in soil environment contain enzymes that function in ways analogous to chitinase and celluloses, i.e., they specifically break down mineral structures and extract elements required for metabolism or structure purposes (e.g., mineralizes *(Barker,et al., 1997*).

Table(2): Available macro and micro nutrients in the investigated soil at harvesting time

Treatments	Concentration(mg kg^{-1})soil						
	N	P	K	Zn	Fe	Mn	Cu
Control	31.80e	9.10e	203.00g	0.64f	10.59f	7.32c	1.13e
S1 Without bio	35.30e	11.50cde	230.10efg	0.71ef	13.67de	7.88bc	1.57bcde
S1 With fungi	44.40d	14.70abcd	269.20def	0.84cdef	15.1cd	8.55bc	1.71abcd
S1With bacteria	48.0bcd	16.00abc	324.5bc	1.12abcd	15.23bcd	10.00abc	1.87abc
S2 Without bio	35.30e	14.2abcd	233.60efg	0.79def	14.88cd	8.66bc	1.69abcd
S2 With fungi	48.2bcd	14.9abc	313.6bcd	0.93bcdef	16.74ab	9.76abc	1.94ab
S2With bacteria	55.60a	19.00a	378.50a	1. 20ab	19.40a	11.67a	2.10a
F1 Without bio	10.20f	10.20de	219.00fg	0.62f	11.87ef	7.27c	1.27de
F1 With fungi	47.0cd	13.50abcd	281.6cde	0.88bcdef	13.47de	8.12bc	1.65bcd
F1 With bacteria	51.2ab	17.20ab	352.40ab	1.16abc	16.62abc	9.23abc	1.81abc
F2 Without bio	33.90e	11.30cde	224.60fg	0.65f	13.20def	8.05bc	1.43cde
F2 With fungi	46.90cd	15.1abc	315.00bcd	1.02abcd	15.75bcd	8.95abc	1.79abc
F2 With bacteria	53.43ab	18.30ab	365.8ab	1.35a	18.00ab	10.40ab	2.00a

Means with the same letters are not significantly different.
S1= ½ full dose of potassium sulphate (100 kg fed^{-1}), S2= full dose of potassium sulphate (200 kg fed^{-1}).
F1= 1/2full dose of feldspar(457 kg fed^{-1}) , F2= full dose of feldspar(914 kg fed^{-1}).

(B) Potato yield and its components:

Data presented in Table (3) indicate that the heaviest tonnage of tubers was recorded with potato plants, which received its required potassium in the form of potassium sulphate, followed by K- natural form (Feldspar). However, feldspar alone was not suitable for direct application due to the fact that potassium ion is tightly bound within its mineral structure and little release appeared to have occurred with its application. Regardless of biofertilizer treatments, using recommended dose of potassium in the chemical form increased tuber yield of potato by 15.8% over using the natural source(feldspar).This simulative effect may be due to the role of potassium on production of enzymes activity, which enhance the translocation of assimilation and protein synthesis (*El-Desuki et al. 2006).*

On the other hand, the conjoint use of potassium sulphate (full dose) plus silicate dissolving bacteria enhanced productivity of potato and scored more tuber yield (15.62 Ton fed^{-1}) comparing to the control treatment (7.2 Ton fed^{-1}). The positive effect of bio-k fertilizer on yield is an expected result for its effect on improving plant growth and dry matter production. These results are in accordance with those reported by *Abdel- Mouty et al. (2001)* who reported that biofertilizer application improved plant growth and dry matter production, which in turn reflected on increasing total yield of potato plants. Although, using half dose of feldspar inoculated with bacteria caused reduction of potato yield by about 7% in relative to the full dose of K_2SO_4 inoculated with silicate dissolving bacteria, Moreover, tubers quality which expressed as carbohydrate %, protein% and dry matter% in tubers was affected by conjunctive use of K sources plus silicate dissolving bacteria. Total tuber yield was taken the same trend. With respect to carbohydrate percentage, potassium is an essential element for adequate rate not only increases the yield, but also tends to stimulate its quality characters. The highest potato carbohydrate content (54.25%) was recorded with full dose of potassium sulfate plus silicate dissolving bacteria, while the lowest K- content was recorded with the control treatment. The full dose of feldspar inoculated with bacteria was on a par with half dose of feldspar or K inoculated with bacteria.

Table (3): Potato production and its components

Treatments	production, Ton fed^{-1}	Carbohydrate,	Protein,	Dry matter,
		%		
Control	7.2g	34.067g	9.88d	17.73a
S1 Without bio	11.03def	40.22defg	14.81bc	18.60a
S1 With fungi	12.20cde	41.50cdef	15.31abc	19.30a
S1 With bacteria	14.03abc	48.30abc	16.19abc	19.80a
S2 Without bio	12.12cde	43.500bcdef	16.25abc	19.00a
S2 With fungi	13.49abcd	44.60bcde	16.25abc	20.00a
S2 With bacteria	15.62a	54.25a	18.00a	21.20a
F1 Without bio	8.67fg	36.50fg	13.75c	18.06a
F1 With fungi	12.53bcde	43.15bcdef	14.38bc	18.40a
F1 With bacteria	14.5abc	50.13ab	15.63abc	18.70a
F2 Without bio	10.21ef	39.40efg	15.0bc	18.50a
F2 With fungi	13.92abcd	46.80bcd	15.63abc	19.13a
F2 With bacteria	15.33ab	50.04ab	16.75ab	19.40

Means with the same letters are not significantly different.

S1= ½ full dose of potassium sulphate (100 kg fed^{-1}), S2= full dose of potassium sulphate (200 kg fed^{-1}).

F1= 1/2full dose of feldspar(457 kg fed^{-1}) , F2= full dose of feldspar(914 kg fed^{-1}).

Concerning protein percentage, data in Table (3) reveal that application different K-levels to soil increased significantly protein percentage from 9.88% for control treatment to 18.0% for full dose of K inoculated with bacteria.There were no significant differences between the feldspar treatment, either inoculated with fungi or bacteria and potassium sulphate (half dose or full dose) inoculated with fungi. The positive effect of K fertilization on protein percentage could be related to the main role of K in plant that associated directly and indirectly with protein synthesis. Similar results were obtained by *Gomaa ,Nadia (2007).*

The application did not significantly affect on dry matter %. However, the effect of such treatment led to increase in Dry matter percentage as compared with the control. Similar observations were mentioned by *Allison et al. (2001).*

(C) Nutrients content in potato plants:

Tables (4&5) show the effect of the tested treatments on macro and micronutrients content of potato shoot and tubers. Results indicate that application of biofertilizers combined with both K sources at both tested levels led to increase the content of N, P , K, Fe, Mn, Zn and Cu in both potato shoot and tubers compared to either the control or the other treatments received no inoculation. However, inoculcation with *Bacillus circulans* was superior in increasing the contents of the investigated macro & micro nutrients in both shoots and tubers rather than *Penicillium sp*. This may be due to *Bacillus sp.* seemed to be a good candidate for biofertilizers application in agriculture. Inoculation with bacteria can improve P and K and micro nutrients availability in soils by producing organic acids and other chemicals, which stimulate growth and mineral uptake of plants .

Macro and micro nutrients Content in both shoot and tubers can be arranged as follows: S2+bacteria > F1+bacteria > S1+bacteria >F2+bacteria >F1+fungus > F2+fungus > S2+ fungus > S2+ fungus, respectively compared to the control. In general, applying half recommended dose from Feldspar in combination with bacterial inoculation is satisfactory for supplying nutrients. As for, the previous study found that inoculation of K solubilizer (B. mucilaginosus) along with P soluiblizer (*B. megaterium*) and N-fixer (*Azotobacter chroococcum*) increased the growth, nutrients uptake significantly in maize crop and also improved soil properties, organic matter contents and total N in soil (*Wu et al. 2005*). Also *Sheng and He (2006)* recorded an increase in roots and shoots growth as well as significantly high N, P and K contents of wheat plants components due to inoculation of *B. edaphicus* growth in a yellow brown soil that had low available K. As for, an increase in the yield of tomato crop due to inoculation of silicate dissolving bacteria *B. circulars* as bioinoculant along with feldspar and rice straw on K releasing capacity was found by (*Badr, et al. 2006*).

Table (4): Macro nutrients content of potato plants

Treatment	Concentration(%)					
	N		P		K	
	Shoot	Tubers	Shoot	Tubers	Shoot	Tubers
Control	1.95e	1.58d	0.80d	0.16e	2.39f	2.40f
S1 Without bio	2.55cde	2.37bc	1.00cd	0.28bcde	3.2abcdef	2.87def
S1 With fungi	2.81cd	2.45abc	1.20bcd	0.30abcde	2.80cdef	3.35abcd
S1 With bacteria	3.14bc	2.59abc	1.30abcd	0.34abcd	3.42abcd	3.61ab
S2 Without bio	2.75cd	2.60abc	1.03cd	0.23de	2.80cdef	3.00cde
S2 With fungi	3.0bcd	2.60abc	1.25bcd	0.23bcde	3.35abcde	3.43abc
S2 With bacteria	4.05a	2.88a	1.76a	0.44a	3.91a	3.80a
F1 Without bio	2.4de	2.20c	0.85d	0.20de	2.55ef	2.76ef
F1 With fungi	2.7dc	2.30bc	0.98cd	0.22de	2.61def	3.20bcde
F1 With bacteria	3.5ab	2.50abc	1.45abc	0.40abc	3.51abc	3.62ab
F2 Without bio	2.45de	2.40bc	0.90d	0.25cde	2.60ef	3.10bcde
F2 With fungi	3.85a	2.50abc	1.29abcd	0.26cde	3.00bcdef	3.53ab
F2 With bacteria	3.68ab	2.68ab	1.55ab	0.42ab	3.80ab	3.74a

Means with the same letters are not significantly different.
S1= ½ full dose of potassium sulphate (100 kg fed^{-1}), S2= full dose of potassium sulphate (200 kg fed^{-1}).
F1= 1/2full dose of feldspar(457 kg fed^{-1}) , F2= full dose of feldspar(914 kg fed^{-1}).

Table (5): Micro nutrients content of potato plants

Treatments	Concentration(mg kg^{-1})							
	Zn		Fe		Mn		Cu	
	Shoot	Tubers	Shoot	Tubers	Shoot	Tubers	Shoot	Tubers
Control	19.65g	4.13g	193.95i	44.58a	18.05g	3.59f	16.15h	2.90e
S1 Without bio	31.45bcdef	4.87cde	295.74def	54.87a	28.45cdef	3.70def	22.90fg	3.23de
S1 With fungi	28.03def	4.82cde	301.60def	55.10a	30.40bcde	3.80cdef	26.60def	3.63cd
S1 With bacteria	34.11abcd	5.29b	314.30bcd	55.20a	30.79abcde	4.01bcd	34.78c	3.92bc
S2 Without bio	35.00abc	4.36fg	284.70gf	55.00a	26.61def	3.75def	24.35ef	4.15bc
S2 With fungi	32.95bcde	5.0bcde	309.05cde	55.30a	32.80abcd	3.80cdef	28.35de	4.36b
S2 With bacteria	39.55a	6.29a	345.33a	55.45a	36.99a	4.40a	47.07a	5.70a
F1 Without bio	25.85fg	4.60ef	210.45i	54.60a	22.80fg	3.62ef	17.60h	3.00de
F1 With fungi	27.01ef	4.93bcde	267.54gh	55.70a	26.18ef	3.94cde	27.20def	3.60cd
F1 With bacteria	36.61ab	5.12bc	322.46bc	54.75a	33.48abc	4.1abc	41.15b	4.40b
F2 Without bio	27.52ef	4.70def	253.60h	54.65a	26.55edf	3.65ef	19.40gh	4.09bc
F2 With fungi	30.02cdef	5.32b	291.89ef	54.80a	29.92bcde	4.00bcd	30.12d	4.41b
F2 With bacteria	39.55a	5.10bcd	329.86ab	54.90a	35.95ab	4.30ab	43.98ab	5.60a

Means with the same letters are not significantly different.
S1= ½ full dose of potassium sulphate (100 kg fed^{-1}), S2= full dose of potassium sulphate (200 kg fed^{-1}).
F1= 1/2full dose of feldspar(457 kg fed^{-1}) , F2= full dose of feldspar(914 kg fed^{-1}).

(D) Apparent nutrient recovery:

Apparent N recovery by potato varied from 6.42% with half dose of feldspar without inoculation to 24.76% with full dose of feldspar inoculated with bacteria (Table 6). The recovery percentage was maximum with full dose of sulphate or feldspar at all inoculation sources and significantly superior to other treatments. However, full dose of K sulphate inoculated with fungi was on a par with full dose of feldspar inoculated with fungi and significantly superior to the control or the non inoculated ones.

With respect to the apparent phosphorous recovery, it was the highest (2.29%) with full dose of K sulphate plus silicate dissolving bacteria and the lowest recovery (0.23%) was found with half dose of feldspar without inoculation. However, full dose of K sulphate inoculated with bacteria and full dose of feldspar plus bacteria were as half dose of feldspar with bacteria and half potassium sulphate with bacteria were equally effective in influencing P recovery in potato.

In case of potassium recovery, The highest value was established with half dose of K sulphate plus bacteria which reached 33.37 % and the lowest recovery was found with half dose of feldspar without inoculation reaching 0.23 %. K recovery with half dose of K plus fungi and full dose of k sulphate with bacteria were on apar and the results were significantly superior to other treatments. However, recovery of K decreased more when the rate of the application of the chemical or natural fertilizers (K sulphate or feldspar) increased, possible because of the ready available K from this sources and the great susceptibility of K to loss by leaching.

(E) Partial factor productivity:

Data on partial factor productivity in potato as calculated by Kg dry tuber per Kg of $N+P_2O_5+K_2O$ applied are presented in Table (6). The partial productivity declines with increasing levels of NPK. The highest value was observed with half dose of K sulphate plus silicate dissolving bacteria which reached 29.85 kg, it was followed by full dose of K sulphate inoculated with bacteria and with fungi plus half dose of K with fungi inoculation. Other K sulphate treatments recorded more or less similar values as that of straight fertilizer.

Table (6): Apparent nutrient recovery and Partial factor productivity

Treatments	Apparent recovery %			*Pfp Index
	N	P	K	
S1 Without bio	12.3	0.77	14.38	23.47
S1 With fungi	15.43	1.00	23.59	25.96
S1 With bacteria	20.8	1.45	33.37	29.85
S2 Without bio	16.78	0.65	9.54	21.26
S2 With fungi	19.75	0.78	14.50	26.98
S2 With bacteria	16.81	2.29	21.04	27.40
F1 Without bio	6.42	0.23	0.13	9.97
F1 With fungi	14.54	0.64	4.56	14.40
F1 With bacteria	20.73	1.86	7.04	16.67
F2 Without bio	10.94	0.56	1.44	7.45
F2 With fungi	19.52	0.99	3.19	10.16
F2 With bacteria	24.76	2.11	4.01	11.19

*** Partial factor productivity.**

S1= ½ full dose of potassium sulphate (100 kg fed^{-1}), S2= full dose of potassium sulphate (200 kg fed^{-1}).

F1= 1/2full dose of feldspar(457 kg fed^{-1}) , F2= full dose of feldspar(914 kg fed^{-1}).

Finally, potassium from feldspar mineral was solubilized and transformed into available form as evident from its higher available K when inoculated with silicate dissolving bacteria. Thus, this biofertilizer is highly efficient to achieve the economy of potash fertilizer and reduce the cost of cultivation through the use of cheap and locally potash source. However, this work should be repeated in several field trials to confirm the recommendation.

REFERENCES

Abdel-Mouty, M.M.; A.H. Ali and F.A. Rizk (2001). Potato yield as affected by the interaction between bio- and organic fertilizers. Egypt. J. Appl. Sci., 16: 267 – 286.

Allison, M.F., J.H. Fowler and E.J. Allen (2001). Response of potato (*Solanum tubersum* L.) to potassium fertilizers. J. Agric. Sci., 136: 407-426.

A. O. A. C. (1990). Association of Official Analytical Chemists, Official Methods of Analysis, 15th (Ed.) , (Horwitz, W., ed.), Washington, DC., USA.

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

Barker, W.W., S.A. Welch and J.F. Banfield (1997). Geomicrobiology of silicate minerals weathering. Rev. Mineral., 35: 391- 428.

Barker, W.W., S.A. Welch, S. Chu and F. Banfield (1998). Experimental observations of the effects of bacteria on alominosilicate weathering. Amr. Mineral., 83: 1551-1563.

Buchholz, D.D. and J. R. Brown (1993). Potassium in Missouri Soils. Agric. Publication, pp: 9-185.

Chapman, H.D. and P. F. Pratt (1978).“Methods of Analysis for Soils, Plants and Water.” Univ. California, Div. Agric. Sci. Priced Pub., 4034.

Cordt, T. and H. Kussmaul (1992). Characterization of some organic acids in the subsurface of the Sandhausen Ecosystem. Springer Verlag, Berlin, pp Germany : 93-100.

El-Desuki, M., M.M. Abdel-Mouty and H. A. Aisha (2006). Response of onion plants to additional dose of potassium application. J. Appl. Sci. Res., 2: 592-597.

Gomaa Nadia, M.H. (2007). Response of tuber crops (potato) to potassium fertilization in some soils in Egypt. Ph. D. Thesis, Fac. Agric. Zagazig University, Zagazig, Egypt.

Han, H.S. and K.D. Lee (2005). Phosphate and potassium soluiblizing bacteria effect on mineral uptake, soil availability and growth of eggplant. Res. J. Agric. Biol. Sci., 1: 176-180.

Kloepper, J. W.; D.J. Hume; F.M. Scherl C. Singieton; B. Tipping; M. Laliberte; K. Frauley; T. Kutchaw; C. Simonson; R. Lifshitz, I. Zateska and L. Lee (1988). Growth-promoting rizobacteria on canola(rape seed). Plant Dis., 72: 42- 46.

Marschner, H. (1995). “Mineral Nutrition of Higher Plants”. Academic Pess, Londen, pp: 889.

Page, A.L., R. H. Miller and D. R. Keeney (1982). " Methods of Chemical Analysis". Part 2: Chemical and microbiological properties (Second Edition). American Soc. Of Agron., Inc. and Sci. Soc. Of America Inc. Publishers, Madison, Wisconsin, USA.

Ranganna, S. (1977). "Manual of Analysis of Fruit and Vegetable Products". Central Food Technological Research Institute Mysore.USA.

Sanz- Scovino, J.I. and D. L. Rowell (1988). The use of feldspar as potassium fertilizers an the savannah of Columbia. Fert. Res.,. 17: 71-83.

SAS Institute (1985). SAS user's guide : Statistics, Version 5 ed. SAS Inst., Cry, NC.

Sheng, X.F. and L.Y. He (2006). Solubilization of potassium bearing minerals by a wild-type strain of Bacillus edaphicus and its mutants and increased potassium uptake by wheat. Can. J. Microbiol., 52: 66-72.

Sheng, X.F., L. Y. He and W.Y. Huang (2003). Conditions of releasing potassium by a silicate dissolving bacteria strain NBT. Agric. Sci., 1: 662-666.

Straaten, P.V.(2002). Rocks for crops, ICRAF. Nairobi, Kenya, pp:338.

strain of *Bacillus edaphicus* and its mutants and increased potassium uptake by wheat. Can. J. Microbiol., 52 : 66-72.,

Styriakova, I., I. Styriak, I. Galko, D. Hardi land P. Bezdicka (2003). The release of iron- bearing minerals and dissolution of feldspar by heterotrophic bacteria of bacillus species. Cermics Silicaty. 47: 20-26.

Wu, S.C., Z.H. Cao, Z.G. Li, K.C. Cheung and M.H. Wong (2005). Effect of biofertilizer containing N-fixer, P and K soluiblizers and AM-fungi on maize growth. Geoderma. 125: 155-166.

ترشيد إستخدام الأسمده البوتاسيه المعدنية باستخدام المذيبات الحيوية للبوتاسيوم واثر ذلك على جودة وانتاجية البطاطس

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أجريت تجربة حقلية بمحطة بحوث النوبارية – مركز البحوث الزراعية فى موسمين متتالين 2011 و 2012 لدراسة أثر التلقيح بالبكتريا المذيبة للبوتاسيوم (Bacillus circulans) فطر البنيسليوم (Penicillium sp.) فى وجود (مصدرين من البوتاسيوم هما كبريتات البوتاسيوم والفلسبار (المعدل الموصى به ونصف الموصى به من كلا المصدرين) وتاثير ذلك على إنتاجية وجودة محصول البطاطس وكذا (الكربوهيدرات والبروتين وأيضاً العناصر الكبرى والصغرى). وكذا محتوى التربة من العناصر الكبرى والصغرى. ولتحقيق الهدف من هذه الدراسه ، تم زراعه تقاوى درنات البطاطس الملقحه حيويا ((*Solanum tuberosum,*L تحت ظروف تربة التجربة

وكانت أهم النتائج المتحصل عليها مايلى:

أدى التلقيح بالبكتريا المذيبة للبوتاسيوم فى وجود مصدرى البوتاسيوم تحت الدراسة الى زيادة تيسر العناصرالكبرى والصغرى مقارنة بمعاملة الكنترول.وتم الحصول على أعلى قيم لانتاجية محصول البطاطس وكذا محتواه من الكربوهيدرات والبروتين من العناصر الكبرى والصغرى مقارنة بباقى المعاملات تحت الدراسة.

ومن ثم فإن استخدام المصادر الطبيعية مثل الفلسبار مع التلقيح الحيوى يزيد من إنتاجية وجودة محصول البطاطس بالإضافة إلى أنه أكثر أماناً للبيئة ولذلك يوصى بإجراء العديد من التجارب للوصول إلى أفضل توصية للإضافة.

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