Zagazig J. Agric. Res., Vol. 41 No. (3) 2014 467-477

Zagazig Journal of Agricultural Research

http:/www.journals.zu.edu.eg/journalDisplay.aspx?JournalId=1&queryType=Master

EFFECT OF K-FELDSPAR, POTASSIUM SULPHATE AND SILICATE DISSOLVING BACTERIA ON GROWTH, YIELD AND QUALITY OF SWEET POTATO PLANTS

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ABSTRACT

A field experiment was carried out during two successive summer seasons of 2010 and 2011 at Moshtohor Experimental Farm, Faculty of Agriculture, Benha University, Qalubiya Governorate, to investigate the effect of applied different sources from potassium fertilizers(potassium sulphate as chemical fertilizer and feldspar as natural rock potassium) at the recommended rate (48 kg K_2O/fad.) either single or in combination with others and/or the biofertilizer silicate dissolving bacteria (SDB); *i.e. Bacillus circulans* on plant growth and chemical composition, yield and its components as well as tuber roots quality of sweet potato (*Ipomoea batatas* (L.) Lam.) cv. Minufia 6. Obtained results indicated that, using the treatment 50% potassium sulphate + 50% K- feldspare + SDB recorded maximum values of plant fresh and dry weight, chlorophyll a , total chlorophyll (a+b), percentage of N and K in vine, as well as roots tuber yield and its components; *i.e.* average of root tuber fresh weight, yield of tubers/ plant and total yield /fad. In addition, it improved the quality of tuber roots; *i.e.* P, K, reducing and non-reducing sugars, total sugars and carbohydrates percentage as well as dry matter content compared to the other tested treatments.

Key words: Sweet potato, K-feldspar, Potassium sulphate, *Bacillus circulans*.

INTRODUCTION

Sweet potato (*Ipomoea batatas* (L.) Lam) is a member of convolvulaceae family. It considered as tuberous root vegetable crop which grown in the tropical, sub-tropical and forst-free temperate climatic zones of the world for either domestic or industrial uses (Onwueme and Sinha, 1991). It ranks fifth as the most important food crop after rice, wheat, maize and cassava in developing countries (Som, 2007). Sweet potato production achieve about 95% of the world output and it is considered as a substitute food to overcome the food shortage and defeat hunger (Kassali, 2011). Sweet potato is valued for its vine and tubers which consumed by human and livestock. Tuber roots are rich in vitamins A (in the form of beta-carotene), B, C and minerals such as manganese, potassium and iron (Wallerstein, 2000). It plays an important role as a high value added food particularly for children and pregnant women who are often exposed to vitamin A deficiency (Degras, 2003). Sweet potato could have superior impact as industrial material for application in medicinal purposes and for processing other profit products like starch, alcohol as well as for table use (Yasmin *et al.*, 2007).

Recently, a great attention was paid for improving the production and quality of sweet potato to increase local and exported yield (Hassan *et al.*, 2005 a and b). Sweet potato like irish potato and cassava are crops that have high demands for K because leaves, vines, stems and tubers usually remove substantial quantity of K from the soil. Potassium is the most important

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nutrient in the production of sweet potato which affect the number, size, quality and unit weight of tuberous roots produced (Degras, 2003 ; Uwah *et al.*, 2013).

Potassium has s significant role in all processes needed to plant growth and reproduction such as photosynthesis, translocation of photosynthates, protein synthesis, control of ionic balance, stress tolerance and water use, activation of more than 60 enzymes and many other processes (Marschner, 1995).

In Egypt, farmers used large amounts of K-chemical fertilizers (such as potassium sulphate or chloride) to maximize crop yield per unit area and to compensate K-decreases in soils due to crop uptake, runoff, leaching and soil erosin (Sheng and Huang, 2002).

The high prices of these fertilizers is responsible for increasing production cost and environmental pollution. The use of natural potassium fertilizer and / or bio-fertilizer is low cost resources for providing plants with K which could alternate the expensive applied K-chemical fertilizers (Manning, 2010; Labib *et al.,* 2012).

The main source of K for plant growing under natural conditions comes from the weathering of K minerals (K-feldspar, Leuctie, K-mica and illite) (Hellal *et al.*, 2009). Many investigators concluded that K-feldspar may be valuable as a slow releasing fertilizer and cheaper source of K (Shafeek *et al.*, 2005; Hellal *et al.*, 2009; Manning, 2010; Abou-el-Seoud, 2012; Labib *et al.*, 2012). The use of potassium solbilizing bacteria (KSB) as biofertilizer; *i.e.* silicate dissolving bacteria was suggested as a sustainable solution to improve plant growth, nutrition, root growth, plant competitiveness and responses to external stress factors (Vessey, 2003; Sheng, 2005; Dawwam *et al.,* 2013 ;Priyanka and Sindhu, 2013). Moreover, KSB play an important role in the formation of humus in soil, the cycling of other minerals tied up in organic matter (Zakaria, 2009). Also, it can be able to solubilize rock – K mineral powder, such as mica, illite and orthoclases (feldspar) through production and excretion of organic acids or chelate silicon ions to bring K into solution (Ullman *et al.*, 1996; Bennett *et al.*, 1998). On the other hand, inoculation with potassium solubilizing bacteria either potassium sulphate or feldspar was applied slowely or integrated might provide faster and continous supply of K for improving plant growth, yield and its quality (Badr *et al.*, 2006; Eweda *et al.*, 2007; Zakaria, 2009; Abdel-Salam and Shams, 2012; Abou-el-Seoud, 2012).

Therefore, the object of this work was to evaluate the possibility of partial or total substitution of the expensive potassium chemical fertilizers (such as potassium sulphate) by natural rock potassium fertilizer; *i.e.* feldspar with or without biofertilizer which solubilized potassium (such as silicate dissolving bacteria) and the effect of these treatments on the growth, root yield and quality of sweet potato.

MATERIALS AND METHODS

A field experiment was carried out at the Experimental Farm of the Faculty of Agriculture, Moshtohor, Benha University, Kalubia Governorate, Egypt during the two successive summer seasons of 2010 and 2011 to study and evaluate the application of natural rock potassium (K-feldspar) to be the source of potassium, partly or totally as substitute the potassium sulphate fertilizer with or without inoculation by the biofertilizer (SDB) (*Bacillus circulans*) on vegetative growth, tuber root yield and its components, as well as the chemical composition of both vine and tuber roots of sweet potato (*Ipomoea batatas* L. (Lam.)) cv. Minufia 6.

Mechanical and chemical analyses of the experimental soil field were determined according to the standard methods mentioned by Jackson (1973) and Black (1982). Data in this respect are shown in Table 1.

This experiment included 10 treatments which were as follows:

1. Potassium sulphate at 100% of the recommended rate (48 kg K_2O/fad.)
2. 75% potassium sulphate + 25% K-feldspare
3. 50% potassium sulphate + 50% K- fedlspare
4. 25% potassium sulphate + 75% K-feldspare
5. 100%potassium sulphate+ biofertilizer (SDB)
6. 75% potassium sulphate + 25% K-feldspare + biofertilizer (SDB)

Table 1. Mechanical and chemical properties of the experimental soil as average of two seasons (2010 and 2011)

Soil characteristics	Values
Mechanical analysis	
Coarse sand (%)	8.1
Fine sand (%)	17.0
Silt (%)	34.4
Clay (%)	40.5
Texture class	Clay- loom
Chemical analysis	
Soluble ions (meq/1)	
Na^+	2.30
K^+	0.70
Ca^{++}	1.28
Mg^{++}	0.89
Cl^-	0.90
HCO_3^-	2.00
SO_4^{--}	2.20
Available N (ppm)	
NH_4 -N	610
NO_3 – N	255

Schedule 1. The recommended rate of K_2O, quantity of potassium sulphate and feldspar (kg/fad.)

Recommended rate		Potassium sulphate 48%	Feldspar 10.6 %
K_2O (kg/fad.)	(%)	K_2O (Kg/fad.)	K_2O (kg/fad.)
48	100	100	452
36	75	75	339
24	50	50	226
12	25	25	113

7. 50% potassium sulphate + 50% K-feldspare + biofertilizer (SDB)
8. 25% potassium sulphate + 75% K-feldspare + biofertilizer (SDB)
9. K-.feldspare at 100% of the recommended rate(48 kg K_2O/fed)
10. 100% K-fedlspare + biofertilizer (SDB)

These treatments were arranged in a randomized complete block design with four replicates. Each replicate included 10 treatments.

Sweet potato vine cuttings were planted on May 28th in 2010 and 2011. Plot area was 10.5m^2, which included four ridges (75cm width and 3.5m long). Vine cuttings of 20-25 cm in length with 4or 5 nodes were inserted to half their length slanting at an angle of 45° on one side of the ridge at 25 cm apart.

K-feldspare is a low grade rock potassium samples from a sedimentary rock materials deposit, supplied as raw mining after grinding to a fine powder by Al-Ahram mining and natural fertilizer company in Egypt. Rock potassium as feldspare and illite powder contains 10.6% K_2O. K-feldspare was added to the soil before planting,at the time of soil preparation.

The biofertilizer, silicate dissolving bacteria (*Bacillus circulans*) was supplied by the Botany Dept. (Microbiology Branch), Fac. Agric., Moshtohor, Benha Univ., Egypt. Vine cuttings were dipped for 10 minutes in a suspension of silicate dissdving bacteria to inoculate before planting.

Potassium sulphate (48% K_2O) treatments were split and applied to the soil at 30 and 60 days after planting. All the experimental plots were received 180 kg/fad., ammonium nitrate (33.5%N) as nitrogen fertilizer and 300 kg/fad., calcium superphosphate as phosphorus fertilizer at two equal portions after one and two months from transplanting. Other agricultural practices of growing sweet potato plants were carried out as commonly followed in the district.

Data Recorded

Plant growth measurements

A random sample of three plants was taken from each experimental unit at 120 days after transplanting in both seasons of study to determine fresh and dry weight of vine (branches as well as leaves)/ plant (g).

Chemical Constituents

Chlorophyll content in leaves

Chlorophyll a and b were colorimetrically determined as described in the AOAC (2005).

N, P and K percentage in vine

Nitrogen, phosphrous and potassium were determined in the digested dry matter of vine according to the methods described by Cottenie *et al.* (1982).

Tuber roots yield and its components

At harvest time (150 days after planting) tuber roots of each experimental unit were harvested and the following measurements were recorded: average tuber fresh weight (g) and total tuber roots yield per plant (g) as well as per faddan (ton).

Tuber roots quality

At harvest time, a sample valued 100 g of tubers from each treatment were oven dried at 70°C till constant weight, ground and wet digested to determine: 1- Total nitrogen, phosphorus and potassium contents according to the same methods described previously in vine chemical constituents. 2- Total carbohydrates percentage were determined according to Dubois *et al.* (1956). 3- Reducing, non-reducing and total soluble sugars were determined according to Nelson (1974).4- Root content of carotene pigments was determind .according to AOAC (2005). 5-Dry matter percentage.

Statistical Analysis

All collected data were subjected to statistical analysis of variance by using a computer program (Co-stat software, 2004). Means separation was done by using Duncan's multiple range test (Duncan, 1958).

RESULTS AND DISCUSSION

Plant Growth Measurements

Data presented in Tables 2 and 3 indicate that there were significant differences among the different tested treatments on fresh and dry weight of vine (branches and leaves)/plant. In this respect, such data reveal that application of 50% potassium sulphate + 50% K-feldspar + biofertilizer (SDB) recorded the highest values and followed by the treatment 100% potassium sulphate + biofertilizer (SDB). On the other hand, the treatment 100% K-feldspar alone achieved the lowest values of both growing parameters. It was also obvious that, applying K-feldspar with potassium sulphate or biofertilizer (SDB) each alone or together was more effective than K-feldspar alone on vegetative growth characterizes; *i.e.* fresh and dry weight of vine. Obtained results were true in both growing seasons.

In this respect, the superiority of plant growth expressed as fresh and dry weight of plant might be attributed to the availability and speed solubility of chemical potassium form and this reflect on its role in cell multiplication and photosynthesis in conjunction with N, which gave rise to increase in length of vine, number of both leaves and branches, this consequent heavier dry weight of vine (Trehan *et al.*, 2009; Shafeek *et al.*, 2005). Moreover, the recorded data pointed that feldspar wasn't enough source of K to supply plants by their requirements due to the fact that potassium ion is tightly bound within its minerals structure and little release appeared to have occurred with its application (Bakken *et al.*, 2005; Hellal *et al.*, 2009). In this regard such increments in growth parameters due to inoculation with SDB either with potassium sulphate alone and/or feldspar might

Table 2. Effect of feldspar, potassium sulphate and silicate dissolving bacteria on fresh and dry weight of vine, photosynthetic pigments and N, P and K contents of sweet potato during 2010 season

Characters / Treatments	Vine weight / plant (g)		Cholorophyll content (mg/g FW)			Minerals content (%)		
	Fresh	Dry	a	b	Total (a+b)	N	P	K
100% K-sulphate	753.2c	110.1b	1.68b	1.19ab	2.87a	1.31b	0.19a	3.05a
75% K-sulphate+ 25% K-feldspar	715.6d	107.5b	1.61c	1.10cde	2.71b	1.22b	0.21a	3.15a
50% K-sulphate + 50% K-feldspar	616.4f	92.8c	1.72a	1.16abcd	2.88a	1.62a	0.22a	3.12a
25% K-sulphate + 75% K-feldspar	593.2g	86.6d	1.61c	1.11cde	2.72b	0.96c	0.22a	2.76b
100% K-sulphate + SDB	839.0b	126.9a	1.67b	1.19a	2.87a	1.33b	0.20a	3.07a
75% K-sulphate+ 25% K-feldspar + SDB	667.4e	96.4c	1.60c	1.10de	2.70b	1.23b	0.22a	3.16a
50% K-sulphate+ 50% K-feldspar + SDB	869.4a	129.9a	1.72a	1.17abc	2.89a	1.63a	0.23a	3.12a
25% K-sulphate+ 75% K-feldspar + SDB	721.2d	108.9b	1.60c	1.11bcde	2.71b	0.97c	0.23a	2.78b
100% K-feldspar	525.3i	71.2f	1.53d	1.05e	2.58c	1.30b	0.22a	3.03a
100% K-feldspar + SDB	547.3h	81.7e	1.52d	1.05e	2.57c	1.30b	0.23a	3.05a

K-sulphate: potassium sulphate. SDB: silicate dissolving bacteria

Values with the same letter (s) in the same column in each season did not differ significantly by using Dunncan's multiple range at 0.05 probability level.

Table 3. Effect of feldspar, potassium sulphate and silicate dissolving bacteria on fresh and dry weight of vine, photosynthetic pigments and N,P and K contents of sweet potato during 2011 season

Characters / Treatments	Vine weight / plant (g)		Cholorophyll content (mg/g FW)			Minerals content (%)		
	Fresh	Dry	a	B	Total (a+b)	N	P	K
100% K-sulphate	741.7b	115.1b	1.05b	0.67f	1.72bc	1.34d	0.17a	2.86b
75% K-sulphate + 25% K-feldspar	699.4c	103.9c	0.84d	0.71e	1.55f	1.70a	0.18a	2.86b
50% K-sulphate + 50% K-feldspar	671.7de	101.6c	1.23a	1.05a	2.28a	1.13e	0.17a	2.86b
25% K-sulphate + 75% K-feldspar	666.3de	98.6cd	0.93c	0.86c	1.79b	1.51b	0.20a	2.89b
100% K-sulphate + SDB	776.7a	116.9b	1.05b	0.73de	1.78bc	1.36d	0.18a	2.98a
75% K-sulphate+25% K-feldspar + SDB	689.8cd	101.9c	0.86d	0.74d	1.60def	1.71a	0.19a	2.97a
50% K-sulphate+50% K-feldspar + SDB	795.8a	129.3a	1.24a	0.98b	2.22a	1.14e	0.18a	2.98a
25% K-sulphate+75% K-feldspar + SDB	735.6b	113.7b	0.95c	0.76d	1.71bc	1.53b	0.21a	2.99a
100% K-feldspar	594.7f	84.3e	0.85d	0.83c	1.68cde	1.41c	0.18a	2.88b
100% K-feldspar + SDB	652.9e	93.3d	0.89cd	0.70e	1.59ef	1.43c	0.20a	2.98a

K-sulphate: potassium sulphate. SDB: silicate dissolving bacteria

Values with the same letter (s) in the same column in each season did not differ significantly by using Dunncan's multiple range at 0.05 probability level.

be attributed to bacteria can solubilize them provide faster and continuous supply of K for optimal plant growth (Eweda *et al.*, 2007; Abou-el-Seoud, 2012; Priyanka and Sindhu, 2013).

Obtained results are in harmony with those reported by Abd El-Baky *et al.* (2010) and Uwah *et al.* (2013) on sweet potato and Han *et al.* (2006); Abdel-Salam and Shams, 2012 and labib *et al.* (2012); on different vegetable crops.

Chemical Constituents

Chlorophyll content

It is evident from data in Tables 2 and 3 that chlorophyll a, b and total chlorophyll in vine of sweet potato plant were significantly affected by different potassium applications. In this concern, such data reveal that application of potassium sulphate at 50% plus 50% K- feldspar and inoculation with SDB during the two growing seasons reflected the highest values of chlorophyll a, b and total chlorophyll (a+b). In addition, application of potassium sulphate 100% of the recommended rate with or without existing SDB had significant effect in this respect. On the other hand, adding K-feldspar at 100% of the recommended dose with or without SDB gave the lowest values of chlorophyll content. These results reflected the same trend in the two investigated seasons. The superiority of chlorophyll content as a result of applied chemical potassium fertilizer; *i.e.* potassium sulphate alone or with K-feldspare and/or potassium dissolving bacteria; *i.e.* SDB might be refer to the availability and speed solubility of chemical potassium form compared to the rock one, hence the rooting system of plants absorbed it in a short time. Potassium plays many important regulatory roles in biochemical and physiological functions of plant growth, although it does not become a part of the chemical structure of plants (Marschner, 1995).

Moreover, the unknown minerals in rock potassium may be inhibit plant growth and caused an inhibition in the absorption of other minerals and low water solubility of rock potassium maintain higher potassium concentration in soil solution due to its lower solubility. Obtained results are in accordance with those reported by Shafeek *et al.* (2005) and Abdel-Salam and Shams (2012).

N, P and K percentage

It was evident from presented data in Tables 2 and 3 that all treatments increased significantly N and K percentages in sweet potato vine. In addition, application of 50% potassium sulphate plus 50% K-feldspar with or without SDB achieved the maximum values of N and K percentage in the first season. Furthermore, the treatment 75% potassium sulphate +25% K-fledspar with or without SDB recorded the highest value of N% in the second season. On the other hand, all treatments had no significant effect on P% of vine during the two seasons. In this regard, Han *et al.* (2006) reported that inoculation with KSB increased significantly N and K uptake in pepper and cucumber plants especially when the respective rock K was added. Moreover, Ullman *et al.* (1996) mentioned that this increasing was due to fact that KDB release organic acids which solubilize the insoluble rock K materials. These results are in agreement with those found by Abou-el-Seoud (2012) and Labib *et al.* (2012).

Tuber Roots Yield and its Components

Data in Table 4 indicated that application of potassium sulphate, K-feldspar and/or SDB and their combinations exerted a marked significant effect on average tuber root fresh weight, yield per plant as well as total root yield /fad. Moreover, the treatment of 50% potassium sulphate plus 50% K-feldspar in the presence of SDB was the most effective and favorable treatment for these parameters. The increase of total yield (average two seasons) for 50% potassium sulphate + 50%K-feldspar + SDB were about 8.98%, 49.00%, 1.30% and 41.56% over the 100%potassium sulphate, 100% K - feldspar, 100% potassium sulphate + SDB and 100% K- feldspar + SDB, respectively. These results were the same in the two seasons. The positive effect shown by yield characters may be attributed to the availability and speed solubility of K through chemical potassium form and SDB and this perement the rooting system absorbed it in short time. Moreover, potassium could be directly linked to the well-developed photosynthetic surfaces (Tables 2 and 3) and increased physiological activities leading to more assimilates being produced and subsequently

Table 4. Effect of feldspar, potassium sulphate and silicate dissolving bacteria on the yield and its components of sweet potato plants during 2010 and 2011 seasons

Seasons	2010				2011			
Characters / Treatments	Average tuber root fresh weight (g)	Total yield of tuber roots		Relative yield (%)	Average tuber root fresh weight (g)	Total yield of tuber roots		Relative yield (%)
		Plant (g)	Fad. (t)			Plant(g)	Fad.(t)	
100% K-sulphate	199.90c	715.14c	16.46b	88.54	212.85d	755.65b	17.38b	93.49
75% K-sulphate + 25% K-feldspar	150.94e	572.06d	12.76c	68.63	195.35e	658.32c	16.46c	88.54
50% K-sulphate + 50% K-feldspar	135.28f	476.18e	11.60d	62.39	178.00f	539.34d	16.14c	86.82
25% K-sulphate + 75% K-feldspar	125.12g	409.14f	10.99d	59.11	163.33g	489.99e	16.01c	86.12
100% K-sulphate + SDB	225.58ab	751.18b	18.35a	98.70	223.81c	787.81b	18.35a	98.70
75% K-sulphate+25% K-feldspar + SDB	219.41b	754.78b	11.85cd	63.74	233.61b	763.90b	16.42c	88.83
50% K-sulphate+50% K-feldspar + SDB	230.10a	874.00a	18.59a	100	246.50a	887.40a	18.59a	100
25% K-sulphate+75% K-feldspar + SDB	222.77ab	701.73c	16.14b	86.82	217.64cd	748.68b	17.22b	92.63
100% K-feldspar	124.90g	343.48g	10.10e	54.33	160.81g	366.64g	10.47d	56.32
100% K-feldspar + SDB	169.23d	472.17e	10.86d	58.41	183.72f	488.69e	10.86d	58.47

K-sulphate: potassium sulphate. SDB: silicate dissolving bacteria
Values with the same letter (s) in the same column in each season did not differ significantly by using Dunncan's multiple range at 0.05 probability level.

translocated and utilized in rapid tuber development and production. Potassium is known to activate a number of enzymes involved in photosynthesis, carbohydrate and protein metabolism and assists in the translocation of carbohydrates from leaves to tubers and tuberous roots of crops where carbohydrates are the main storage material (Mengel and Kirkby, 1987; Trehan *et al*., 2009). These findings are in harmony with those mentioned by Abd El-Baky *et al.* (2010); Uwah *et al.* (2013) on sweet potato and Alexander (1997); Abdel-Salam and Shams (2012); Labib *et al.* (2012) on different crops.

Tuber Roots Quality

Data in Tables 5 and 6 indicate that the addition of potassium sulphate as chemical fertilizer and feldspar as natural and their mixtures with or without SDB had significant effect on N, P and K concentrations, total carbohydrates, reducing , non –reducing and total sugars, as well as dry matter percentage in sweet potato tubers. The highest values of these constituents were obtained from the treatment received 50% potassium sulphate + 50% K-feldspar + SDB except N percentage. As for nitrogen content, the treatment of 100% K-feldspar with or without SDB in the first season and 25% potassium sulphate + 75% K-feldspar + SDB in the second season were the most effective treatments in this respect.

Moreover, caroten content had no significant difference among all the used treatments except two applications when K-feldspar was used only or with SDB which gave the lowest values than the other treatments of this study. Generally, the superiority of the above mentioned treatments on the nutritional status of root tubers of sweet potato might be due to their stimulating effect on plant growth, dry matter accumulation and its chemical composition (as shown in Tables 2and3) which are previously discussed. Such results coincided with those obtained by Pornthip (1986) and Abd El-Baky *et al.* (2010) on sweet potato as well as Sugiyama and Ae (2006) and Labib *et al.* (2012) on potato.

From the formentioned results, it could be concluded that, using 50% potassium sulphate (as chemical fertilizer) + 50% K-feldspar (as natural rock K) + SDB; *i.e. Bacillus circulans* (as

Table 5. Effect of feldspar, potassium sulphate and silicate dissolving bacteria on tuber roots quality of sweet potato during 2010 season

Characters	Minerals content (%)			Sugars (%)			Total carobhdrates (%)	Carotene mg/100g F.W.	DM (%)
Treatments	N	P	K	Reducing	Non-reducing	Total			
100% K-sulphate	0.72c	0.20bc	1.69b	5.53cd	4.24b	9.77bc	67.93a	4.63a	27.32b
75% K-sulphate + 25% K-feldspar	0.77b	0.19c	1.49cd	5.21cde	3.79c	9.00d	66.41b	4.62a	26.71cd
50% K-sulphate+ 50% K-feldspar	0.71c	0.23a	1.79a	6.75a	5.16a	11.91a	65.33c	4.77a	26.41cd
25% K-sulphate+ 75% K-feldspar	0.72c	0.21b	1.46cd	5.12de	4.20b	9.32cd	65.29c	4.61a	26.34cd
100% K-sulphate + SDB	0.72c	0.21b	1.69b	5.99b	3.90bc	9.89b	68.11a	4.65a	27.91a
75% K-sulphate + 25% K-feldspar + SDB	0.78b	0.19bc	1.52c	5.41cde	3.77c	9.18cd	66.37b	4.60a	26.64cd
50% K-sulphate + 50% K-feldspar + SDB	0.72c	0.23a	1.87a	6.84a	5.21a	12.05a	68.32a	4.72a	28.29a
25% K-sulphate + 75% K-feldspar + SDB	0.72c	0.21b	1.52cd	5.55c	4.24b	9.79bc	67.88a	4.65a	26.77c
100% K-feldspar	0.79ab	0.20bc	1.42d	5.02e	3.21d	8.23e	65.21c	4.22b	25.72e
100% K-feldspar + SDB	0.80a	0.21b	1.48cd	5.23cde	3.21d	8.44e	65.26c	4.25b	25.95de

K-sulphate: potassium sulphate. SDB: silicate dissolving bacteria

Values with the same letter (s) in the same column in each season did not differ significantly by using Dunncan's multiple range at 0.05 probability level.

Table 6. Effect of feldspar, potassium sulphate and silicate dissolving bacteria on tuber roots quality of sweet potato during 2011 season

Characters	Minerals content (%)			Sugars (%)			Total carobhdrates (%)	Carotene mg/100g F.W.	DM (%)
Treatments	N	P	K	Reducing	Non-reducing	Total			
100% K-sulphate	0.87e	0.17bc	1.30cd	5.24b	3.79cd	9.03cd	70.76bc	4.72a	26.22abc
75% K-sulphate + 25% K-feldspar	0.98c	0.18b	1.20d	6.04a	2.85f	8.89de	69.80c	4.71a	25.86bcd
50% K-sulphate + 50% K-feldspar	0.93d	0.19ab	1.49ab	6.00a	3.14ef	9.14cd	66.88d	4.70a	25.26def
25% K-sulphate + 75% K-feldspar	1.07b	0.15c	1.36c	5.51b	3.58de	9.09cd	66.50d	4.75a	25.06efg
100% K-sulphate + SDB	0.94d	0.19ab	1.31c	5.26b	5.02a	10.28a	72.56ab	4.75a	26.33ab
75% K-sulphate+25% K-feldspar + SDB	1.04b	0.20ab	1.21d	6.07a	3.34de	9.41bc	69.13c	4.73a	25.58cde
50% K-sulphate +50% K-feldspar+ SDB	0.99c	0.21a	1.52a	6.14a	4.30b	10.44a	74.23a	4.82a	26.79a
25% K-sulphate+75% K-feldspar + SDB	1.13a	0.17bc	1.38bc	5.56b	4.17bc	9.73b	70.38c	4.78a	25.89bcd
100% K-feldspar	1.00c	0.17bc	1.40abc	5.22b	3.30ef	8.52e	65.02d	4.22b	24.67g
100% K-feldspar + SDB	1.07b	0.19ab	1.42abc	5.43b	3.45de	8.88de	65.33d	4.25b	24.77efg

K-sulphate: potassium sulphate. SDB: silicate dissolving bacteria

Values with the same letter (s) in the same column in each season did not differ significantly by using Dunncan's multiple range at 0.05 probability level.

biofertilizer) proved to be the most effective treatment to obtain vigor plant growth, highest total yield per faddan and the best quality of sweet potato tuber roots. From economic point of view, it may be a way to reduce the cost of production by replacing partly the expensive potassium chemical fertilizer by the chipper locelly available feldspar mineral in combination with silicate dissolving bacteria.

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تأثير استخدام الفلسبار وكبريتات البوتاسيوم والبكتريا المذيبة للسليكات على النمو والمحصول وجودة نباتات البطاطا

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أجريت هذه التجربة الحقلية خلال موسمين صيفيين متتاليين لعامي ٢٠١٠، ٢٠١١ بمزرعة كلية الزراعة بمشتهر، جامعة بنها، محافظة القليوبية لدراسة تأثير استخدام عدة مصادر من الأسمدة البوتاسية، كبريتات البوتاسيوم كسماد كيماوي والفلسبار كصخر طبيعي للبوتاسيوم بالمعدل الموصي به (٤٨ كجم بو$_{٢}$أ/ فدان) سواء كلا بمفرده أو بعدة توليفات بينهما مع أو بدون السماد الحيوي (البكتريا المذيبة للسليكات) علي نمو النبات والتركيب الكيماوي له، المحصول ومكوناته وكذلك جودة الجذور الدرنية لصنف البطاطا" منوفية ٦"، وقد أشارت النتائج المتحصل عليها إلي أن استخدام المعاملة ٥٠% كبريتات بوتاسيوم + ٥٠% فلسبار + البكتيريا المذيبة للسليكات قد سجل أعلي القيم للوزن الغض والجاف للنبات ، كلوروفيل(أ) والكلورفيل الكلي (أ + ب) والنسبة المئوية لكل من النتروجين والبوتاسيوم بالساق والأوراق وكذلك المحصول ومكوناته كمتوسط الوزن الغض للدرنة الجذرية و المحصول الكلي من الدرنات للنبات والفدان، بالإضافة إلي ذلك فقد أدت نفس المعاملة إلي تحسين جودة جذور البطاطا كالنسبة المئوية للفوسفور، السكريات المختزلة والغير مختزلة والكلية والكربوهيدرات والمادة الجافة مقارنة بالمعاملات المختبرة الأخرى.

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