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Effect of Different Sources of Potassium Fertilization on Wheat Production and Fertility of Calcareous Soil

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Abstract:

Calcareous soil is relatively poor in plant nutrients and organic contents. Such great problem may be solved by applying organic manure and inorganic minerals. Therefore, a field experiment was conducted during (2007/2008- 2008/2009) to study the effect of different sources of K on soil fertility, chemical properties, wheat yield and quality at Al-galaa location, west of Nubaria (calcareous soil). Potassium sources were (K_2SO_4) as a mineral source, Feldspar (F) as a natural source, K-humate (KH) as an organic source, Feldspar inoculated with potassium dissolving bacteria (FB) and Feldspar +K humate (FKH). The obtained results indicated that application of different source of potassium significantly decreased soil pH, EC and increased the organic matter content. Also, the role of potassium sources on K forms takes the following descending order: available > exchangeable > water soluble regardless of potassium treatments. Available Fe, Mn, Zn and Cu were increased significantly due to K sources compared the control treatment. The addition of feldspar enriched with potassium humate (FKH) increased both straw and grain yields and decreased the plant harvest index (HI). Protein (%) in wheat grains and protein yield (Kg fed^{-1}) were increased significantly as affected by sources in the descending order of: FKH > KH > FB > K > F. Also, there was positively clear superiority for all treatments over the control for K, Fe, Mn, Zn and Cu in both grains and straw yields. Relative agronomic efficiency (RAE) and apparent K recovery (AKR) were significantly enhanced by the application of FKH fertilizer treatments.

Key words: Potassium sulfate, Feldspar, K-humate, Wheat plants, Calcareous soil.

Introduction:

Potassium is one of the essential nutrients for plant growth. It plays a vital role in photosynthesis, carbohydrate transport, protein formation, ionic balance control, water use, activation of plant enzymes and many other processes (Munson et al., 1985).

Calcareous soils exist in large areas particularly in semi-arid regions. In Egypt, most of the newly reclaimed soils are calcareous. These soils are generally characterized by low

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fertility levels and easily ammonia volatilization due to their high content of calcium carbonate and alkaline pH. In addition, the availability of most nutrients is considerably low especially phosphorus and micronutrients (Peter et al., 2000). In general, majority of the calcareous soils show poor hydrophysical and fertility characteristics. So, additions of organic materials are of vital importance to improve physical and chemical characteristics as well as fertility status of these soils. Soil pH value was modified due to the addition of organic amendments. According to Buchholz and Brown (1993), more than 98% of potassium in soil exists in the form of silicate minerals (microcline, muscovite, orthoclase, biotite and feldspars, etc.). Potassium and other elements can be released when these minerals are slowly weathered. In spite of that, the most important sources of potassium in soil are the primary alumino-silicates, which include K-feldspar. Abdel-Aziz et al. (2000) and Basyouny (2002) reported that increasing the rates of applied organic manure to calcareous soil, in general, resulted in an increase in the soil organic matter content as well as a decreases in the soil pH. Micronutrient-deficient soils are widespread; millions hectares of arable land world-wide are deficient in one or more micronutrient (Ziaeian and Malakouti, 2001). Usually micronutrients deficiency problems are found in calcareous soils of arid and semi-arid regions.

Abd-El- Hadi et al. (1990) found that the addition of potassium to the soils in Egypt increased the production of most of the main field crops. Amer (1995) concluded that the sand content was the main modifier for the exchangeable K critical level, which increased from 200 mg kg^{-1} for soils having more than 85% sand to 500 mg kg^{-1} for those containing 85 to 45% sand. Also, El-Kabbany (1999) reported that N, P, Fe, Mn, Zn and Cu uptake by plant were increased with the application of K fertilizers. This may be attributed to the vital role of potassium in physiological processes inside plants, enzyme activities, water absorption and transpiration. Total soil K reserves are generally large although the distribution of K forms differs from soil to another as a function of the dominant soil minerals (Mclean and Watson, 1985). For optimal nutrition of a crop, the replenishment of K-depleted soil solution is affected predominantly by the release of exchangeable K from clay minerals. Consequently, for maximal crop growth, soil solution and exchangeable K need to be replenished continually with K through the release of non-exchangeable K through the weathering of K reserves (i.e. micas and feldspars) (Sparks and Huang, 2002) or the addition of K fertilizers. Many microorganisms in the soil are able to solubilize the 'unavailable' forms of K-bearing minerals, such as micas, illite and orthoclases, by excreting organic acids which either directly dissolves rock K or chelate silicon ions to bring the K into solution (Bennett et al., 1998). Therefore, the application of K-solubilizing microorganisms (KSM) (Vandevivere et al., 1994) is a promising approach for increasing K availability of KSM amended soils. Production of carboxylic acids like citric, tartaric and oxalic acids was associated with feldspar solubilization by Bacillus mucilaginosus and Bacillus edaphicus (Sheng and Huang, 2002). Increased nutrient uptake by plants inoculated with plant-growth promoting bacteria has been attributed to the production of plant growth regulators at the root interface, which stimulated root development and resulted in better absorption of water and nutrients from the soil (Kloepper et al., 1991).

Crop productivity measured in terms of responses to fertilizers can only be sustained if soil fertility levels are maintained to match with crop need and in proper proportions (Anonymous, 1999). In order to sustain the production system, it is essential that the nutrient demand of a crop to produce a target yield and the amount removed from the soil should be perfectly matched. In this context the nutrient recovery from applied fertilizers is primarily important and varies according to crop species, management practices, soil properties and environmental conditions (Jagadeeswaran, 2005).

Thomas et al. (2009) demonstrated that fertilizer management of calcareous soils differs from that of non-calcareous soils due to the effect of soil pH on soil nutrient availability and chemical reactions that affect the loss or fixation of some nutrients. Presence of $CaCO_3$ directly or indirectly affects the chemistry and the availability of nitrogen (N), phosphorus (P), magnesium (Mg), potassium (K), manganese (Mn), zinc (Zn), iron (Fe), and copper (Cu). The availability of N, P, K, Mg, Mn, Zn, and Fe decreases when the soil $CaCO_3$ content increases to more than 3% by weight. These soils generally have a pH value in the range of 7.6 to 8.3.

The purposes of this investigation are to study the impact of different K fertilization sources on 1) the yield and grain quality of wheat, and 2) the soil pH and levels of Fe, Mn, Zn and Cu in the highly calcareous soils of west of Nubaria, Egypt.

Materials and Methods:

Two field experiments were conducted on a farm at Al-Galaa location, west of Nubaria Alexandria Governorate, during the winter season of (2007/2008 and 2008/2009) to investigate the effect of different sources of K fertilization on growth, yield, quality and micronutrients content of wheat plants (*Triticum aestivum*, Sakha 69). The effect of these K sources was studied on some properties as well as K forms and micronutrients of the soil. The chemical and physical properties of the studied soils are present in Table (1). The treatments consisted of three potassium fertilizer sources (potassium sulfate K_2SO_4 as a mineral source, feldspar (6.5 % K_2O) as a natural source and K humate as an organic source.

Table 1. Soil physical and chemical properties of the experiment site

Soil properties	Value
Sand (%)	66.93
Silt (%)	11.70
Clay (%)	21.37
Texture (%)	Sandy clay loam
Organic matter (%)	0.98
$CaCO_3$ (%)	18.39
PH (1:2.5 suspension)	8.09
EC (dS m^{-1})	2.82
Available nutrients (mg.kg^{-1})	
K	276.42
Fe	3.83
Mn	0.86
Zn	0.58
Cu	0.49

Each value represents the mean of 3 replicates.

Wheat plants received the recommended dose 48 kg K_2O fed^{-1}. Potassium feldspar (6.5 %K_2O) and potassium humate (12.5% K_2O) were added either individually or mixed together. Potassium humate was added at the rate of 20 L.fed^{-1} and dilute with tab water at a 1:20 v/v ratio to soil application. Feldspar was also applied after inoculation with potassium dissolving bacteria (*Bacillus circulans*), that were provided by the Biofertilizers Unit, Ain Shams Mircen, Microbiological resource Center. The experiment included the following treatments:

1. Untreated soil (control).
2. K_2SO_4 (K).
3. K feldspar (F).
4. K feldspar inoculated with potassium dissolving bacteria (*Bacillus circulans*) (FB).
5. K humate (KH).
6. K feldspar + K humate (FKH).

Potassium fertilizer treatments were applied in one dose and mixed with the surface soil layer (0-15cm) of the plots, expect of K humate that was added to the soil 15 days before planting. The experimental design was a randomized complete block with three replications. Nitrogen was added at the level of 100 kg N fed^{-1} as ammonium sulfate (20.5 %N) and phosphorus was applied at the level of 22.5 kg P_2O_5 fed^{-1} as superphosphate (15 % P_2O_5) according to the fertilization recommendations of wheat. superphosphate was added before planting, while ammonium sulfate was added in two equal doses at tillering and booting stages.

Potassium humate was prepared by the extraction from rice straw compost with the method modified by using $K_4P_2O_7$ and KOH to avoid the presence of sodium (Kononova, 1961). At harvest, surface soil samples (0-15 cm) were collected. Soil pH, electrical conductivity (EC) and organic matter content (OM %) were determined according to Black (1982). Available soil potassium was extracted using 1.0 N ammonium acetate at pH 7.0; water soluble potassium was extracted using a 1:5 extract of soil to water potassium in the extracts was determined using flame photometer. The exchangeable K was calculated by the difference between available potassium and water soluble potassium (Hesee, 1971). Available soil Fe, Mn, Zn and Cu were extracted using the ammonium acetate EDTA mixture at PH 4.65 to extract the available elements according to (Cottenie et al., 1982) and determined using Atomic Absorption Spectrophotometer.

Wheat plant samples were taken at harvest (after 150 days from planting) from each plot to calculate straw and grain yields. Plant samples were oven dried at 70°C for 48 h up to obtain a constant dry weight, then ground and wet-digested using H_2SO_4:H_2O_2 method (Page et al., 1982). The digests were then subjected to the determination of K, Fe, Mn, Zn and Cu (Cottenie et al., 1982). Protein percent in the grain was calculated by multiplying N% b y 5.75, according by A.O.A .C. (1980).

Harvest index (HI) was determined using the formula:

$$\mathrm{HI} = \frac{\text{Grain yield}\left(\text{kg fed}^{-1}\right)}{\left[\text{Grain yield}\left(\text{kg fed}^{-1}\right) + \text{straw yield}\left(\text{kg fed}^{-1}\right)\right]} \times 100$$

Nutrient use efficiency: The relative agronomic efficiency (RAE) and apparent nutrient recovery (ANR) were calculated according to Jagadeeswaran et al. (2005) and Franzini et al. (2009) as follows:

Relative agronomic Efficiency (RAE):

$$RAE = \frac{\left[\text{Yield in fertilized plot}\left(\text{kg fed}^{-1}\right) - \text{Yield in control plot}\left(\text{kg fed}^{-1}\right)\right]}{\text{Quantity of fertilizer nutrient applied}\left(\text{kg fed}^{-1}\right)} \times 100$$

Apparent Nutrient Recovery (ANR):

$$ANR = \frac{\left[\text{Uptake in fertilized plot}\left(\text{kg fed}^{-1}\right) - \text{Uptake in control plot}\left(\text{kg fed}^{-1}\right)\right]}{\text{Quantity of fertilizer nutrient applied}\left(\text{kg fed}^{-1}\right)} \times 100$$

The obtained results were subjected to statistical analysis and the treatments were compared using the least significant difference test (L.S.D) at 0.05 level of probability, according to Snedecor and Cochran (1980).

Results and Discussion :

Effect of different K sources on some soil characteristics:

Data in Table (2) indicated that the addition of different K sources slightly reduced soil pH and soil salinity from 7.84 to 7.22 and from 3.15 to 2.01 dS/m respectively. The corresponding relative decreases were 12.76 and 31.7% as compared to the control, respectively. Khademi et al. (2009) concluded that when organic acids are added to solution they bind cations (e.g Ca) causing the release of H^+ from organic acids, which consequently lowers solution pH.

The addition of such treatments relatively increased the organic matter content after wheat harvest. The increase was from 0.98 to 1.12 times of the control. Organic matter in the soil plays an important role through building up soil aggregates and enhancing proper soil physical and physiochemical properties.

Effect of different K sources on soil K forms after wheat harvest:

Concerning, potassium forms in the soil after wheat harvest, Table (3) shows that regardless of the treatments, K forms take the descending order of available K> exchangeable> water soluble, which is taken directly by plants but is usually found in low quantities in soils. Gomaa (2007) found that the available potassium was increased by increasing K fertilizer rate at calcareous soil. While exchangeable potassium is held by negative charges of organic matter and clay particles and is readily available to plants Oelslighe et al. (1975). The amount of K in each fraction varies and depends on past cropping history, past fertilizer and manure use (Golakia et al., 2001). Potassium content of the soil was also affected by the investigated treatments regardless of K forms. The highest K values recorded with potassium sulphate followed by FKH , KH , FB and F treatments, respectively.

Table 2. Effect of different K fertilization sources on some soil characteristics.

Treatment	pH (1:2.5)	EC(dS/m)	O.M (%)
*Control	7.84	3.15	0.98
K	7.45	2.15	1.01
F	7.65	2.75	0.98
FB	7.23	2.45	1.04
KH	7.75	2.01	1.12
FKH	7.22	2.13	1.09
L.S.D. 0.05	0.02	0.14	0.04

*Control= untreated soil, K= K_2SO_4, F= feldspar, FB= Feldspar inoculated with potassium dissolving bacteria *(Bacillus circulans)*, KH= K-HUMATE AND FKH= Feldspar + K-huma

Table 3. Effect of different K fertilization sources on K forms of the studied soils.

Treatment	Available K (ppm)	Exchangeable K (ppm)	Water soluble K (mg/l)
*Control	280.5	251.25	29.25
K	490.2	453.62	36.58
F	327.2	306.78	20.42
FB	374.2	344.74	29.46
KH	439.4	406.92	32.48
FKH	475.8	452.66	23.14
L.S.D. 0.05	1.02	23.01	3.02

*Control= untreated soil, K= K_2SO_4, F= feldspar, FB= Feldspar inoculated with potassium dissolving bacteria *(Bacillus circulans*), KH= K-HUMATE AND FKH= Feldspar + K-huma

Soil micronutrients after wheat harvesting:

The results in Table (4) show that available Fe, Mn, Zn and Cu were increased significantly by the application of different K sources. The increase in available nutrients in soil was due to the nutrient complexing agents such as humate, which augmented solubility, mobility, and availability of insoluble micronutrients in calcareous soil which considerably showed a positive reflection on wheat yield. Generally, application of different sources of K especially, K-humate individually or incorporated with feldspar changes the biochemical and physical composition of soil organic matter, and gradually increases soil maco- and micronutrients compared to feldspar only. Among three different forms of potassium in soils, the concentrations of soluble K in soils are usually very low but the highest proportion of potassium in soils are the insoluble K (Goldstein, 1994). A significant share of soil potassium occurs in unavailable form in soil minerals such as orthoclase and microcline (K-feldspars). The production of organic acids such as acetate, citrate and oxalate by microorganisms can increase mineral dissolution rate (Barker et al., 1998). Moreover results also suggest that the role of weathering ability of the bacteria which involves the production of protons, organic acids, siderophores and organic ligands (Rogers et al., 2004).

These results are in agreement with Van Hees et al. (2005) who found that organic acids could potentially lower the pH of the rhizosphere and therefore increase the dissolution of metals and improve their availability for plant uptake. This is particularly apparent for metals that become more soluble with decreasing pH (e.g. Fe, Zn, Mn etc.).

Table 4. Fe, Mn, Zn and Cu concentrations in soil as affected by different K-fertilizer sources.

Treatments	Available micronutrients mg.kg^{-1}			
	Fe	Mn	Zn	Cu
*Control	4.92	1.86	0.50	0.79
K	15.38	8.11	0.63	1.17
F	13.3	8.43	0.52	1.26
FB	14.62	9.02	0.83	1.25
KH	13.96	9.38	0.68	1.34
FKH	15.03	9.92	0.78	1.32
L.S.D. 0.05	1.21	0.23	0.15	0.06

*Control= untreated soil, K= K_2SO_4, F= feldspar, FB= Feldspar inoculated with potassium dissolving bacteria *(Bacillus circulans)*, KH= K-HUMATE AND FKH= Feldspar + K-huma

Wheat yield and harvest index:

Wheat (straw and grains) production as affected by such treatments is shown in Table (5). The lower mean values were noticed for the control, while, the highest mean values were obtained for FKH treatment. The results also indicated that the addition of feldspar enriched with potassium humate (FKH) increased both straw and grain yield with relative increases of 83 and 43%, respectively compared to the control.

With regard to the weight of 1000 grains, the obtained results showed that the combined treatment (FKH) exhibited a significant superiorly over the other studied ones. The increase was 74.6 % over control. However, the combined treatment exhibited a significant superiorly over the other studied ones. Park et al. (2003) reported that bacterial inoculation could improve potassium availability in the soils by producing organic acid and other chemicals trough stimulating growth and mineral uptake of plant. On the other hand, numerous microorganisms particularly those associated with roots have the ability to increase plant growth and productivity (Cheng et al., 1986). However, certain groups of microorganisms can directly or indirectly transform rocks and minerals in quantities large enough to influence the geological distribution. These transformations include enzymatic oxidation, reduction reactions, formation of chelates and complexes with protein, amino-acids ‹organic acids etc. (Henderson and Duff, 1963). Also, the responsibility of growth and yield increases should be improved as a result of the interaction between bio and natural fertilizers (rock phosphate and feldspar), (Massoud et al., 2009). The plant harvest index (HI), the ratio of grain weight to the total plant weight, is an weight, is an important trait associated with the dramatic increases in crop yields. it reflects the partitioning of photosynthate between the grain and the vegetative growth. Accumulation of high levels of nitrogen is essential for high grain yields, and thus, high levels of nitrogen are commonly associated with crops having high harvest index (HI). One factor that may influence the changes of the harvest index was the relative value of grain yield compared to straw yield. Data in Table (5) indicated that the highest HI (46.3) was for the control treatment, and the minimum one (40.3) for the FKH treatment. The application of such treatments actually decreased HI but this marginal reduction was compensated by a greater biomass increase (Khan et al., 2008).

Table 5. Dry matter, straw and grain wheat yields and weight of 1000 grains as affected by different K-fertilizer sources

Treatment	Wheat yield(t.fad^{-1})		Weight of 1000 grain(g)	Harvest index(%)
	straw	grain		
*Control	2.53	2.18	24.0	46.30
K	4.01	2.42	34.5	36.65
F	3.64	2.30	31.2	38.72
FB	4.10	2.52	35.7	36.23
KH	4.36	3.01	37.5	35.41
FKH	4.62	3.12	41.9	40.3
L.S.D. 0.05	0.25	0.21	2.45	-

*Control= untreated soil, K= K_2SO_4, F= feldspar, FB= Feldspar inoculated with potassium dissolving bacteria *(Bacillus circulans*), KH= K-HUMATE AND FKH= Feldspar + K-huma

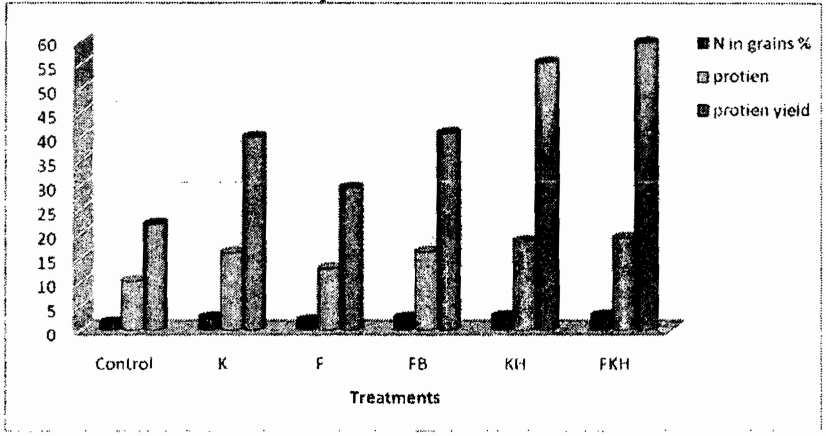

Fig. (1): Effect of different sources of potassium on protein and protein yield in wheat plants.

Grain protein content:

The obtained results in Figure (1) indicate that the prevailing favourable conditions are positively reflected on protein (%) and protein yield in wheat grains plants in Kg/Fed. The individual effect of the previous treatments showed an descending increase in the order of (FKH > KH > FB > K > F). Bidari and Hebsur (2010) demonstrated the role of potassium in plant nutrition. Unlike N, P, Ca and Mg, the potassium ion does not enter into permanent organic combinations in plants, but apparently exists as soluble inorganic and organic salts. Evidence available shows that, potassium influences the following processes. (1) synthesis of simple sugars , starch and protein (2) translocation of carbohydrates (3) reduction of nitrates (4) cell division (5) synthesis of pigments or carotenoids (6) balancing acid sugar ratio in fruits (7) imparting disease and insect resistance in plants and (8) maintenance of cell turgor of plants.

Potassium and micronutrient concentration in wheat grains and straw:

Potassium content of wheat as affected by the abovementioned treatments is present in Table (6). There was significant increase in the K content of wheat by using such treatments, but the obtained values in wheat straw were relatively higher than that of grains. The relative increases in grains with respect to FKH, KH and FB were 3, 2.8 and 2.3 folds over the control treatment, respectively. However, for straw, the results demonstrate that the K content increased by 2.7, 2.4 and 2 folds over the control for the same treatments. Singh et al. (2002) found that the application of organic manure increased the crop uptake of potassium. Indeed, microorganisms catalyze oxidation of organic matter in calcareous soil and, if representing organic matter by carbohydrate (CH_2O), the reaction is: $CH_2O + O_2 \rightarrow CO_2 + H_2O$.

The carbon dioxide and water can then combine and form carbonic acid which again with calcium carbonate leads to the production of more carbon dioxide. Such CO_2 can break down many common minerals to release elements.

$$2KAlSi_3O_8 + 2H + 2HCO_2^- + H_2O \rightarrow Al_2Si_2O_5(OH)_4 + 2K^+ + 2HCO_3^- + 4SiO_2$$

Concerning, the concentration of Fe, Mn, Zn and Cu in wheat plants (grains and straw), the results indicated that the highest Fe content was noticed in case of applying feldspar +K-humate to the soil with relative increase of 4.25 and 6.7 folds over the control for (grains and straw) respectively. The highest values of Mn, Zn and Cu were achieved by FB treatment with 4.0, 4.1 and 2.0 folds for grains and 2.4, 5.2 and 2.7 folds of the control for straw, respectively.

Table 6. Effect of different K- sources on of K and micronutrients of wheat

Treatment	K content in grains Kg.fed^{-1}	Micronutrients content in grain wheat mg.k^{-1} plant				K contentin straw mg.k^{-1} plant	Micronutrients content in straw wheat mg.kg^{-1} plant			
		Fe	Mn	Zn	Cu		Fe	Mn	Zn	Cu
*Control	10.43	24.15	6.44	4.78	1.81	13.59	24.85	8.30	8.11	1.40
K	14.94	22.50	13.6	11.11	2.98	17.18	54.06	16.2	21.9	2.09
F	12.29	19.66	10.9	8.89	2.59	14.23	35.02	17.2	10.6	1.98
FB	24.29	42.26	25.9	19.62	3.67	27.61	62.92	19.9	41.9	3.80
KH	29.18	78.64	14.9	11.23	2.87	32.87	113.27	11.5	17.8	2.63
FKH	31.74	102.6	20.0	15.41	3.14	36.45	165.26	19.2	14.5	3.56
L.S.D.0.05	6.33	1. 25	0.35	75.2	12.5	5.24	1.75	0.28	1.23	8.45

*Control= untreated soil, K= K_2SO_4, F= feldspar, FB= Feldspar inoculated with potassium dissolving bacteria *(Bacillus circulans)*, KH= K-HUMATE AND FKH= Feldspar + K-huma

Potassium use efficiency:

As for the relative agronomic efficiency (RAE), the results present in Table (7) show that it varied with the application of different treatments. It varied from 2.56 for feldspar application to 6.31 for feldspar + K humate. The treatments effects can be ranked as follows: FKH > KH > FB > F. The relative agronomic efficiency was superior (6.31%) for FKH source. Apparent K recovery due to potassium sources varied from 3.88% with feldspare treatment to 44.4% with feldspar + K humate treatment.

The organic acids produced by microbial colonization on the mineral surfaces greatly accelerated the release of mineral elements to solution from feldspar particles. Microbes can enhance mineral dissolution rate by producing and excreting metabolic by-products that interact with the mineral surface. Complete microbial respiration and degradation of particulate and dissolved organic carbon can elevate carbonic acid concentration at mineral surfaces, in soils and in ground water. Micro-organisms can secrete growth promoting substances, e.g., indole acetic acid, gibberellins, cytokinins like substances and auxins. Biofertilization technology has taken a part to minimize production costs and at the same time, avoid the environmental hazards (El-Sirafy et al., 2010).

Table 7. Effect of different K- sources on the relative agronomic efficiency (RAE) and apparent potassium recovery (AKR)

Treatment	Relative agronomic efficiency (RAE)	Apparent potassium recovery (AKR).
*Control	-	-
K	3.58	9.40
F	2.56	3.88
FB	3.98	28.9
KH	5.54	39.1
FKH	6.31	44.4
L.S.D. 0.05	-	-

*Control= untreated soil, K= K_2SO_4, F= feldspar, FB= Feldspar inoculated with potassium dissolving bacteria *(Bacillus circulans)*, KH= K-HUMATE AND FKH= Feldspar + K-huma

Conclosion

The present study led to conclude that better management of using natural and organic sources rich in potassium in the presence of potassium dissolving bacteria is favorable. It has a positive effect on some soil properties, yield and soil fertility as compared to the mineral treatment (control). On the other hand, such management will decrease the enormous consumption of chemical fertilizer and will decrease environmental risks.

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تأثير مصادر مختلفة من الأسمدة البوتاسية على إنتاجيه القمح وتحسين خصوبة التربة الجيرية

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أجريت تجربه حقليه لدراسة تأثير مصادر مختلفة من التسميد البوتاسي على خصوبة التربه والخواص الكيميائية وإنتاجيه ونوعيه محصول القمح خلال الموسمين 2007/2008-2008/2009 في منطقه الجلاء غرب النوباريه (أرض جيريه). وكانت الأسمدة البوتاسيه المستخدمة هي: مصدر معدنى (سلفات بوتاسيوم 48٪ بو$_2$أ) ومصدر طبيعي (فلسبار) ومصدر عضوي (هيومات البوتاسيوم) واستخدم مخلوط من الفلسبارو هيومات البوتاسيوم بعد تلقيحه بالبكتريا المذيبه للبوتاسيوم (*Bacillus circulans*). وأوضحت النتائج أن اضافه المصادر المختلفة للتسميد البوتاسى لها تأثير معنوى على خفض كل من pH و EC وزياده محتوى التربه من المادة العضوية. وقد أخذت صور البوتاسيوم الترتيب التالى: الميسر> المتبادل> الذائب بغض النظر عن المعاملات وازداد تيسر كل من الحديد والمنجنيز والزنك والنحاس زيادة معنوية مقارنه بالكنترول باستخدام معاملات البوتاسيوم تحت الدراسة.

أشارت النتائج أيضا الى ان أضافه الفلسبار مع هيومات البوتاسيوم (FKH) أدى إلى زيادة محصول الحبوب والقش وانخفاض دليل الحصاد (HI) وازداد كل من النسبة المئوية للبروتين وأيضا محصول البروتين (كجم/فدان) زيادة معنوية تنازلية كالأتى: الفلسبار+هيومات البوتاسيوم > هيومات البوتاسيوم > الفلسبار الملقح بالبكتريا >البوتاسيوم المعدنى > الفلسبار. وقد لوحظ أيضا تفوق ايجابى لكل المعاملات مقارنه بالكنترول فى تركيز كل من البوتاسيوم والعناصر الصغرى فى كل من محصولى الحبوب والقش. بالنسبة للكفاءة النسبية للعنصر السمادى (RAE) وكذلك تعظيم الاستفادة منه (AKR) فقد ازدادت زيادة معنوية بإضافة FKH.