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Growth, Yield and Nutritional Status of Egyptian Lupine in Sandy Soil in Relation to Bio and Non Conventional Potassium Fertilization

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TWO field experiments were conducted in the experimental farm of the Salah El-Din, El-Bostan, Nobaria, El-Behera Governorate, Egypt which belongs to NRC during 2007and 2008 to evaluate K fertilization using some non- conventional products, *i.e* , K feldspar, compost of plant residues rich in their K content and their mixture with or without inoculation with the K dissolving bacteria (Bacillus circulans) (K.D.B) on growth, yield and nutritional status of Egyptian lupinus termis L .c.v Giza 2.

Obtained results indicated the effective role of K.D.B. when combined with K-fertilization using feldspars, composts and their mixtures. Growth parameters, yield and nutritional status of the plants were significantly increased by applying such types of non-conventional K-fertilizers particularly in the case of seeds inoculation with K.D.B.

A conclusion was drawn that using such natural sources of K-fertilizers combined with K dissolving bacteria may become a suitable solution for reducing the heavy use of non- friendly chemical fertilizers .

Keywords: Sandy soil. Bio-fertilizers. K.D.B., Feldspars. Composts. Lupine.

Sound fertilization programs in Egypt should satisfy plant needs and minimize the harmful effects on the environment. Substitutes of the expensive mineral fertilizers for plant needs especially for potassium is a must. This can be argued through 1 . The reuse of plant residues, rich in K after composting as organic manure, as well as the use of K–bearing minerals (K-feldspars) can be positively contributed in covering a great portion of K- plant need after weathering of potassium through the release of their potassium contents as a part of K- cycle in soil. 2 . Applying bio- fertilizers (microbial inoculants) such as nitrogen fixers, micorrhiza, free living bacteria, phosphate dissolving bacteria, silicate dissolving bacteria and sulphur oxidation bacteria (Marschner, 1998; Khalil, 2005; Badr, 2006 and Seddik Wafaa, 2006).

Lupine is one of the important legumes in the world. It has been used as a green manure, forage and seeds for human usage because of it's high protein contents. Lupine can grow in poor soil, improving its fertility and considered drought tolerant (Gladstones, 1970 and Planchuelo, 1982).

Lupine is a suitable crop for the newly reclaimed soils in Egypt. Increasing the productivity of this crop can be achieved through planting highly productive cultivars as well as optimizing the agronomic practices. Concerning K-fertilization (Ordovas *et al.*, 1988) pointed out that seed yield of lupine was positively affected by K-fertilization. Fayed (1992) and Ismail & Hagag (2005) found that plant height, pods number / plant, pods length, seeds numbers, seeds weight / plant, 100-seed weight and seed yield /fed increased with increasing K-levels up to 100 kg K_2O / fed in sandy soils.

Therefore, this study aimed to investigate the effect of soil application of potassium fertilizer from natural sources with or without inoculation with K-dissolved bacteria, Bacillus circulans (KDB), on growth, yield and nutritional status of Egyptian Lupinus termis L C.V. Giza 2. grown on a sandy soil in Nobareia Region.

Material and Methods

Two field experiments were conducted in the experimental farm of the Salah El-Din, El-Bostan, Nobaria, El-Behera Governorate, Egypt which belongs to NRC during winter seasons of 2007and 2008. Some properties of the soil in the experimental sites were noted in Table 1 (Cottenie *et al.*, 1982 and Page *et al.*, 1982).

Examined fertilizers

1. Potassium Feldspar (F)

K-bearing mineral (k-feldspar)($KAlSi_3O_8$), which was taken from the mines of western desert, ground and chemically analyzed for total and available K (Table 1).

2. Compost enriched with K (C)

Natural organic compost rich in K- content, which prepared by composting the residues of plants rich in potassium (*i.e.*, the wastes of leaves, stem and corms as will as addle and broken fruits of banana trees) for six months under proper conditions of moisture and temperature until reaching mature stage. Then air- dried, finely crushed and chemically analyzed (Table 1).

TABLE 1. Some analytical data of sandy soil, natural K-fertilizers and irrigation water used.

Particle size distribution (%)											
Sand 63.18			Silt 19.51		Clay 17.31			Texture sandy loam			
Chemical properties											
pH $CaCO_3$ 1:2.5	EC ds/m 1:5		O.M %	Soluble cations meq/100gsoil				Soluble cations meq/100gsoil			
				Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO^{--}_3	HCO^{-}_3	Cl^{-}	SO^{--}_4
8.15	0.53	0.26	22.3	0.37	0.16	0.08	0.58	00	0.30	0.59	0.29
Irrigation water											
7.45	0.40	---	---	7.50	2.35	1.88	0.20	00	2.60	0.60	8.73

Nutritional status											
	Total %					Available(mg/kg)					
	OC	C/N	N	P	K	N	P	K	Zn	Fe	Mn
Soil	0.15	3.75	0.04	0.019	0.21	11.7	1.32	40.0	0.52	2.61	0.44
K-feldspar	-	-	-	-	8.52	-	-	820	-	-	-
Compost	23.4	16.7	1.4	0.65	4.80	23.9	5.11	510	140	2400	342

Plant

Seeds of Egyptian Lupinus termis L c.v Giza 2 were mixed with Rizobia-sugar solution directly before planting. Half amounts of lupine seeds were inoculated with potassium dissolving bacteria "Bacillus circulans" (KDB), While the other half did not inoculated.

After one month from planting, all plots that inoculated with (KDB) received activation dose from (KDB) added as aqua-solution on the surface of the soil adjacent to the growing plants.

All plots received the basal doses of N and P mineral fertilizers equals to 200kg super-phosphates / fed. (15.5% P_2O_5) added during soil preparation and 20kg ammonium sulfate (20.5% N) / fed. that added as activation dose at the beginning of plant growth in two equal doses, the first during planting and the other after ten days from planting.

Treatments of K- fertilization were as follows:

1- 0 kg/ fed Control.
2- 500 kg/ fed K-Compost, C (4.80%K_2O).
3- 300 kg/ fed K- Feldspars, F (8.52%K_2O).
4- 250+150kg/fed K-Compost,C(4.80%K_2O)+ K- Feldspars, F(8.52%K_2O).

Taking into consideration that K- fertilizers were added during seed bed preparation. Irrigation was carried out, using drip irrigation system. Water analysis is also shown in Table 1.

At harvest yield attributes were recorded, *i.e.*, plant height, number of pods/plant, number of seeds/plant and seed yield g/plant. Plants were separated to straw and seeds, oven dried at 70°C and analyzed for macronutrients (NPK) and micronutrients (Fe, Zn and Mn) after (Cottenie *et al.*, 1982).

The obtained data were statistically analyzed using the analysis of variance (ANOVA) as a complete randomized factorial design in three factors with three replicates using Minitab Program . Then, the least significant differences (LSD) were calculated at 0.5% level as outlined by Gomez & Gomez (1984).

Results and Discussion

1. Growth parameters and yield components of lupine plants

Growth parameters and yield components of lupinus termis L. plants expressed as plant height (cm), number of pods/plant, dry weight of pods (g), number of seeds/plant, yield of seeds/plant (g) and in Mg/fed. as affected by different sources of K-fertilization and K.D.B. inoculation are presented in Table 2.

Data show that plants of inoculated seeds with K.D.B. archived significant increments than those of non- inoculated ones. Increments due to inoculation of seeds with K.D.B. are 12.4, 10.9, 13.8, 11.5, 12.7 and 15.5% for plant height, number of pods/plant, dry weight of pods/plant, number of seeds / plant, and seed yield /plant and / fed, respectively .

Regarding the effect of different sources of K-fertilization on yield parameters of lupinus termis L. plants grown in sandy soil, data show also that all sources of K-fertilization, in general, significantly increased plant growth comparing with the control treatment, with this respect, the afore mentioned growth parameters were 1.1, 1.48, 1.46, 1.48, 1.46 and 1.42 folds that of the non fertilized ones for plants fertilized with compost having high content of K (treatment C) and 1.04, 1.36, 1.41, 1.41, 1.32, and 1.33 folds for those fertilized with K- feldspars (treatment F) and 1.2, 1.54, 1.54, 1.56,1.59 and 1.49 folds for plants fertilized with mixtures of both (treatment C+F), in sequence.

2. Nutritional status of lupine plants

The content of macro (N, P and K) and micro (Fe, Zn and Mn) nutrients (mg/plant) in seeds and of straw lupinus termis plants grown in sandy soil as affected by inoculation with K.D.B., fertilization with different sources of K- and the interaction between them are shown in Tables 3 and 4, respectively .

Data show that nutrients content (mg/plant) in seeds and straw of the plants recorded high significant values due to inoculation with K.D.B. compared to the non – inoculated ones.

TABLE 2. Some growth parameters and yield components of lupine plants as affected by different sources of K-fertilization and inoculation with K.D.B.*

Treatments		Plant height (cm)	Number of pods/ plant	Pods dry weight/ plant (g)	Number of seeds/ plant	Seeds yield/ plant (g)	Seeds yield (ton/ fed)
non inoculated with K.D.B.	Control	61.60	15.63	19.56	42.36	19.37	0.84
	K-feldspar	63.03	20.80	27.33	60.23	24.73	1.14
	Compost	65.10	22.06	28.76	63.23	26.26	1.22
	F x Com.	75.63	23.56	30.40	64.83	29.74	1.29
inoculated with K.D.B.	Control	69.06	17.33	22.26	47.23	21.83	0.97
	K-feldspar	73.40	24.03	31.73	66.03	29.73	1.26
	Compost	79.27	26.06	32.53	69.23	33.73	1.35
	F x Com.	81.33	27.16	34.06	75.06	35.80	1.41
LSD at 0.05%							
-With and without inoculation		5.45	0.21	0.25	0.42	0.31	0.001
-K-sources		7.71	0.29	0.35	0.60	0.44	0.013
-interaction		NS	0.19	0.20	0.23	0.25	NS

*Average of two growing seasons.

TABLE 3. Macro and micronutrients content (mg/plant) in lupine seeds as affected by different sources of K- fertilization and inoculation with K.D.B.*

Treatments		Macronutrients			Micronutrients		
		N	P	K	Fe	Zn	Mn
non inoculated with K.D.B.	Control	105.2	14.1	13.83	0.08	0.07	0.02
	K-feldspar	188.4	24.06	44.73	0.56	0.25	0.09
	Compost	218.8	24.17	48.73	1.00	0.31	0.15
	F x Com.	266.8	32.43	53.80	1.61	0.45	0.31
inoculated with K.D.B.	Control	190.5	22.50	28.53	0.49	0.16	0.12
	K-feldspar	289.1	40.36	119.6	3.13	0.47	0.22
	Compost	346.3	47.47	120.9	3.46	0.64	0.26
	F x Com.	455.7	51.23	135.4	4.01	0.69	0.72
LSD at 0.05%							
-With or without inoculation		38.17	3.22	7.71	0.90	0.06	0.05
-K-sources		53.98	4.56	10.91	1.20	0.08	0.07
-interaction		NS	11.18	26.73	NS	NS	0.19

*Average of two growing seasons.

TABLE 4. Macro and micro nutrients contents (mg/plant) in lupine straw as affected by different sources of K- fertilization and inoculation with K.D.B.*

Treatments		Macronutrients			Micronutrients		
		N	P	K	Fe	Zn	Mn
non inoculated with K.D.B.	Control	41.66	1.66	3.53	1.23	0.07	0.07
	K-feldspar	142.7	4.10	85.57	18.25	3.44	0.38
	Compost	151.8	4.33	95.73	34.35	3.67	1.16
	F x Com.	213.9	4.53	116.7	40.04	6.62	2.75
inoculated with K.D.B.	Control	115.1	2.93	9.63	4.36	0.24	0.19
	K-feldspar	209.5	7.40	143.6	25.55	5.48	1.63
	Compost	320.5	7.60	234.1	68.65	6.91	2.71
	F x Com.	327.4	13.50	251.9	79.10	11.26	4.20
LSD at 0.05%							
-With or without inoculation		17.18	0.54	19.18	4.19	0.74	0.33
-K-sources		24.30	0.38	27.13	5.93	1.04	0.47
-interaction		59.55	1.87	66.46	14.53	2.56	1.16

*Average of two growing seasons.

Increments due to inoculation of seeds with K.D.B. were calculated to be 81.1, 59.6 and 106.3% and 512.5, 128.6 and 900% for N, P and K and Fe, Zn and Mn in lupine seeds, respectively. Relevant values for lupine straw are 176.3, 76.5, 172.8 % and 254.5, 242.9 and 171.4 % in sequences.

Moreover, K- fertilization treatments, *i.e.*, applying composts having high content of K (treatment C), K-feldspars (treatment F) or mixtures of both (treatments C+F) significantly increased nutrients content in both straw and seeds. With this respect, nutrients content due to applying such treatments in seeds were 1.9, 1.6, 2.5 folds for N , 2.0, 1.8 and 2.3 folds for P, 4.0, 3.9 and 4.5 folds for K, 7.8, 6.5 and 9.9 folds for Fe, 4.1, 3.1 and 5.0 folds for Zn and 1.9, 1.4 and 4.7 folds for Mn for the treatments C,F and C+F, respectively. The same was true in the nutrients content in straw, nutrients content of straw in plant, fertilized by the treatment C were 3.0, 2.6, 24.5, 18.4, 34.1 and 14.9 folds that of the non fertilized plants for N.P.K and Fe, Zn and Mn, respectively. Corresponding values for the treatment F were 2.2, 2.5, 17.0, 7.8, 28.8 and 7.7 and folds and for the treatment C+F were 3.5, 3.9, 27.4, 21.3, 57.7 and 26.7 folds in sequence.

Data indicate the effective role of K.D.B. when combined with K-fertilization using the examined non-conventional materials, *i.e.*, feldspars, composts rich in their K-content and their mixtures on increasing growth, yield and nutritional status of the plants.

Obtained results are in agreement with those of Fayed (1992); Abd El-Naby (2000); Abo El-Soud *et al.* (2004); Khalil (2005); El-Shikha *et al.* (2005); Ismail & Hagag (2005) and Badr (2006) on different crops, *i.e.,* Egyptian lupine, faba been, tomato and banana.

On conclusion, using such natural sources of K- besides inoculation of seeds with K- dissolving bacteria may become a suitable solution for reducing the heavy use of non friendly chemical fertilizers.

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أثر التسميد الحيوي واضافات بعض الاسمدة البوتاسية الغير تقليدية للاراضي الرملية علي النمو والمحصول والحالة الغذائية للترمس المصري

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و ** قسم الاراضي واستغلال المياه – المركز القومي للبحوث – الجيزة – مصر .

أجريت تجربة حقلية لمدة موسيمين متتاليين (٢٠٠٧، ٢٠٠٨) بمحطة التجارب الزراعية التابعة للمركز القومي للبحوث بمنطقة البستان محافظة البحيرة لتقييم أثر التسميد البوتاسي بأستخدام بعض الاسمدة الغير تقليدية (الفلوسبار والكمبوست الغني في محتواة من البوتاسيوم) وخليط منهما مع تلقيح البذور بالبكتريا المذيبة للبوتاسيوم (Bacullus circulas) علي النمو والمحصول والحالة الغذائية لنبات الترمس المصري صنف جيزة ٢.

تؤكد النتائج المتحصل عليها علي الدور المؤثر لتلقيح البذور بالبكتريا المذيبة خاصة في وجود الاسمدة البوتاسية الغير تقليدية تحت الدراسة حيث زادت دلائل النمو والمحصول وايضا الحالة الغذائية للنبات تحت الدراسة زيادة معنوية .

من النتائج ايضا امكن استنتاج ان اضافة مثل هذة المصادر الطبيعية للاسمدة البوتاسية بالاضافة الي تلقيح البذور بالبكتريا المذيبة للبوتاسيوم يمكن ان يكون احد الحلول المناسبة للاقلال من الاستخدام المكثف للاسمدة الكيماوية والملوثة للبيئة .