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INFLUENCE OF DIFFERENT LEVELS OF PHOSPHORUS AND POTASSIUM ON GROWTH OF *Leucaena leucocephala* SEEDLINGS

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ABSTRACT

A pot experiment was conducted during the summer season 2011/2012 in the greenhouse of the Atomic Energy Authority, Nuclear research center, Soil and water Research Department. A complete randomized design with four replications was used in this study. A combination of four phosphorus levels (0; 50; 100; and 200 kg P_2O_5 fed^{-1} as superphosphate with four levels of potassium fertilizer levels (0; 25; 50 and 100 kg K_2O fed^{-1} on growth, nodules and nutrients of the *Leucaena leucocephala*. Shoots and roots dry weights were gradually increased with increasing potassium rate up to 100 kg K_2O fed^{-1}, where it accounts for 61.85,9.59,71.17 g pot^{-1} for shoot, root and whole plant, respectively, while addition of sole phosphorus induced an increase of the dry weight of roots and shoots up to the rate of 100 kg P_2O_5 fed^{-1}, (111.8, 15.61, 127.41 g pot^{-1} for shoot, roots and whole plant, respectively), and then tended to decrease for the same sequence. Maximum shoot dry weight (197.43 g pot^{-1}) was achieved by addition of 100 kg P_2O_5 fed^{-1} combined with 50 kg K_2O fed^{-1}.The maximum number and dry weight of nodules were detected with P-K(100-50) (3.13 g pot^{-1}), while the minimum detected with P-K (0-0) (1.14 g pot^{-1}). Moreover, all the nodules were distributed on secondary roots. Nitrogen uptake was enhanced by the addition of phosphorus and potassium and gradually increased by increasing rates of both of them.

Keywiords: growth; *Leucaena leucocephala*, nodule; phosphorus; potassium; sandy soil

INTRODUCTION

During the 1970s and early 1980s, *Leucaena leucocephala* (Lam.) de Wit (leucaena) was known as the 'miracle tree' because of its worldwide success as a long-lived and highly nutritious forage tree, and its great variety of other uses. As well as forage, leucaena can provide firewood, timber, human food, green manure, shade and erosion control. It is estimated to cover 2-5 million ha worldwide (Brewbaker and Sorensson 1990, Wall, 2000). Leucaena can fix 75-584 kg N ha^{-1}year^{-1}, can supply its own N requirements and has the ability to enhance soil fertility (Hussain *et al* 1991). In addition woody legume species are a source of nitrogen mulch, fodder, poles and fuel (Teel, 1988). *Leucaena leucocephala* is the most attractive agroforestry shrub due to its high N_2 fixation, fast growth and large biomass production (Kang and Duguma 1983). *Leucaena leucocephala* (Lam.) de Wit. has great potential for utilization in tropical agriculture, particularly in livestock production as a protein source and in enriching the soil, both of which uses rely on its capability for nitrogen fixation (Lucena and Paulino 1990). Its establishment and growth depend on an adequate supply of nutrients. Potassium fertilization often can dramatically increase yields of alfalfa and other forage legumes (Collins *et al.* 1986). A number of biochemical and physiological processes common to all plants require K (Collins andDuke 1981). Additionally, K can stimulate increases in legume N_2 fixation by increasing availability of photosynthate to the nodules (Duke *et al.* 1980). Phosphorus deficiency is reported to be the major limitation to the growth of legumes (Costa and Paulino 1993). Before developing nodules, legumes depend on soil nitrogen and also need a good supply of phosphorus and potassium, which not only help seedling growth but also aid early nodulation, leading to optimum growth and biomass production (Naugariya and Pathak 1993). Adequate nutrition also enhances seedling growth and survival after planting in the field. Adding fertilizers to ensure adequate nutrition may reduce overall production costs (Sonkar *et al.* 1993).This study was undertaken to determine the effects of phosphorus and potassium on the growth and nodulation of Leucaena seedlings.

MATERIALS AND METHODS

A pot experiment was conducted under green house of Soil and Water Department, Atomic Energy Authority, Egypt. Sand soil with pH: 7.10 , EC 2.3 dS m^{-1}, OM 0.45% was packed in pots at rate of 8 kg pot^{-1}. Each pot was planted with 8 leucaena seeds (*Leucaena leucocephala* (Lam) de wit, after prepared of seed (seeds of Leucaena were scarified with concentrated sulphoric acid for 20 minutes and rainsed several times in sterile water, (Winthington, 1986). Seeds were sown immediately after coating with peat carrier inoculants of Rhizobium strains DS158), then thinned to 5 seedlings after two weeks from germination. Pots were irrigated with fresh water and the moisture content was maintained at 80% of water holding capacity. A basal dose of nitrogen was applied at a rate of 20 mg N kg^{-1} soil as ordinary ammonium sulphate $(NH_4)_2SO_4$. Phosphorus fertilizer was applied as superphosphate at the rates of 50,100 and 200 kg P_2O_5 fed^{-1}, and potassium was applied as potassium sulfate at rates of 0, 25,50 and 100 kg K_2O fed^{-1}. Leucaena seedlings harvested 120 days after sowing. Separate shoot and root were oven dried at 70°C for 24 hours then dry weights of whole plants and plant part, were recorded. Total nitrogen, phosphorus and potassium content were determined. The N content was determined using kjeldahl method as described by Carter and Gerogerish (2008). Data were subjected to analysis of variance using the system ANOVA and the values LSD from the controls were calculated at 0.05 levels according to SAS SOFTWARE program, (2002).

RESULTS AND DISCUSSTION

Shoot and root dry weight:

In most cases, the dry weight yield of shoots and roots were gradually increased with increasing potassium rate up to 100 kg K_2O $fed.^{-1}$, (61.6, 9.6 g pot^{-1} shoot, root) respectively, while the addition of sole P had increased the dry weight of shoots and roots (111.8, 15.6 g pot^{-1}) respectively (Table 1). Increase of phosphorus levels up to 200 kg P_2O_5 fed^{-1} has a little bit adverse effect on dry weight (shoots and roots) as compared to 100 kg P_2O_5 fed^{-1} rate. Regarding the interaction between P and K, both dry weights of shoots and roots were significantly increased comparable to those of sole potassium. In this respect, the best values of shoot and root dry weights were detected with application of 50 kg K_2O fed^{-1} either interacted with 50,100 or 200 kg P_2O_5 fed^{-1} were induced by application of 100 kg P_2O_5 interacted with 50 kg K_2O fed^{-1}.

El-Sallami (2002,2003) studied the response of *Leucaena leucocephala* seedlings to soil (clay and sand) mixed with farmyard manure (FYM)) during 2000 and 2001 seasons at an experimental farm in Assiut, Egypt and observed that the soil mixture significantly increased all growth measurement i.e. number of branches, offsets and pods per plant, fresh weights of aerial parts and offsets, and fresh and dry weights of roots, shoot: root ratios and seed yield.

Similarly the response of potted seedlings of *Leucaena leucocephala* to phosphorus (P) was observed by Ezenwa (1994) that applying P at 7.5 mg kg^{-1} soil significantly increased shoot height by 14% over the control. Dixit *et al.* 1999 also expressed similar views regarding the effect of P application on the seedlings of 3 species of Acacia and observed that the growth parameters were improved with the phosphorus fertilization. The results of the study corroborate with the findings of Gupta *et al.* 1998 in glasshouse experiments on *Leucaena leucocephala* who investigated that application of P gave best height and diameter growth and biomass parameters seedlings.

Table 1: Effect of phosphorus and potassium fertilizers on dry weight yield (g pot^{-1}) of *Leucaena leucocephala* seedlings

		shoot				root			
		Potassium application							
		0	25	50	100	0	25	50	100
Phosphorus application	0	28 h	55 g	61.4 g	61.6 g	4.4 i	8.6 gh	9.3 egh	9.6 fgh
	50	57.6 g	82 f	97.3 e	88 ef	8.2 hi	12.6 efg	15 cde	14 def
	100	111.8 d	170.6 b	197.4 a	136 c	15.6 cde	23.8 ab	28.4 a	19.9 bc
	200	89.3 ef	95.6 ef	117.6 d	85.1 ef	13.4 defg	15.9 cde	18.9 bcd	11.7 efg
LSD		12.8				1.627			

Plant height:

From Table (2) the results showed that application of phosphorus and potassium at the rate of 100 - 50 kg fed^{-1} exhibited the highest values for maximum plant height (77.4 cm) and further increase in P_2O_5 and K_2O rates did not accounted a significant increase in plant height. The lowest values for all recorded parameters were achieved without phosphorus and potassium application. Also data showed that an increase in the height of the plants in all rates add potassium individually. While when adding different levels of phosphorus individually led to an increase in the height of the plants added to the level of 100 kg P_2O_5 fed^{-1}, but when added to increase the rate of phosphorus led to reduced plant height.

Table 2: Effect of phosphorus and potassium fertilizers on height (cm) of *Leucaena leucocephala* seedlings

		Height of plants			
		Potassium application kg fed^{-1}			
		0	**25**	**50**	**100**
Phosphorus application kg/fed	0	21.6 l	37.3 k	41.6 j	48.3 h
	50	43.5 i	52.3 g	61.8 d	58.5 e
	100	61.8 d	65.6 c	77.4 a	69.3 b
	200	57.5 f	61.8 d	65.6 c	60.7 d
LSD		0.7058			

The results are comparable to those of Anurag *et al.* (2002) and Reager *et al.* (2003) for both the plant height. Increase with phosphorus application has been reported by Ali *et al.* (2010).

Number and dry weight of nodules:

The nodule number, dry weights of *Leucaena leucoephala* in different treatments were shown in Table 3. The nodulation was found to greatly affect by the fertilizer combination of P and K. In all cases the nodule number was significantly increased at phosphorus and potassium (P-K) 100-50 (55) nodules and followed by P-K(50-50) 50 nodules and P-K (200-50) 46 nodules compared to P-K (0-0)20 nodules. The maximum nodules dry weight was found in P-K (100-50) 3.13g pot^{-1} while the minimum in P-K (0-0) 1.14 g pot^{-1}. Moreover, all the nodules were distributed on the secondary roots.

The findings of the present study indicate that nodulation status (number and dry weight of nodule) in *Leucaena leucocephala* resulted from different fertilizer treatments were varied significantly. The data are compatible with those of Datta and Das (1997) who reported a positive relationship between nodule dry weight and biomass. The findings also revealed that the use of inorganic fertilizers increased the nodule numbers and support the result of Razz et al. (1995) who examined the effect of inorganic fertilizers on nodulation status of plants. It was observed from the present study that increased fertilizer rates resulted in increase in growth and dry matter production of nodules, also supporting the result of nodulation characteristics of *Samanea saman* investigated by Rahman et al. (2004). Gentili and Huss-Danell (2002) explained that P stimulated both nodule biomass and nodule number, and revealed that the stimulation was specific for nodulation but not simply mediated via plant growth. It was found that the nodule shapes in *D. sissoo* were globose, elongated, coralloid, and oblate. Nodules were mostly brown in color and rough surfaced. Rests of the young nodules were smooth-surfaced while older nodules took on various shapes. These findings were consistent with the results of Anegbeh and Tchoundjeu (2002) who reported the characteristics of nodules of agroforestry tree species in Niger Delta, Nigeria.

Table 3: Effect of phosphorus and potassium fertilizers on nodules of *Leucaena leucocephala* seedlings

		Number of nodules				Weight of nodules (g pot^{-1})			
		Potassium application							
		0	**25**	**50**	**100**	**0**	**25**	**50**	**100**
Phosphorus application	0	20 j	32 ghi	41 cde	40 cdef	1.14 h	1.82 f	2.33 d	2.28 d
	50	26 ij	35 efgh	50 ab	42 cd	1.48 g	1.99 ef	2.85 b	2.39 cd
	100	32 ghi	40 cdef	55 a	42 cd	1.82 f	2.28 d	3.13 a	2.39 cd
	200	30 hi	38 defg	46 bc	34 fgh	1.71 fg	2.16 de	2.62 bc	1.93 ef
LSD		6.178				0.2612			

Nitrogen uptake:

As shown in Table (4), nitrogen uptake by plant had followed, to some extent, the same trend like dry matter accumulation. Nitrogen uptake was enhanced by the addition of phosphorus and potassium where it gradually increased by increasing rate. In the same time, increasing phosphorus with potassium rates (100-50) induced higher N uptake 678.78 mg pot^{-1} than control treatment 80.31 mg pot^{-1}.

Table 4: Effect of phosphorus and potassium fertilizers on N % and N uptake of *Leucaena leucocephala* seedlings

		N%				N uptake mg pot^{-1}			
		Potassium application							
		0	**25**	**50**	**100**	**0**	**25**	**50**	**100**
Phosphorus application	0	2.49 d	2.52 cd	2.61 bcd	2.67 bcd	80.3 k	160.2 j	184.7 i	190.5 i
	50	2.59 cd	2.65 bcd	2.68 bcd	2.75 bc	170.8 j	251.4 h	301.5 f	280.9 g
	100	2.61 bcd	2.67 bcd	3.0 a	2.71 bcd	333.2 e	519.6 b	678.8 a	424.1 c
	200	2.66 bcd	2.76 b	2.78 b	2.67 bcd	273.7 g	308.7 f	378.3 d	259.2 h
LSD		0.209				53.015			

Phosphorus uptake:

Effect on total P uptake is given in Table (5). The results indicated that phosphorus uptake and utilization were significantly affected by phosphorus and potassium fertilization. In general, phosphorus uptake was high at phosphorus and potassium treatments (100 - 50) 91.4 mg pot^{-1} compared to the control 13.3 mg pot^{-1}. The results are nearly closed to those of Aslam et al.(2004); Mian *et al.* (2001); Ilyas *et al.* (2001). Navale and Gaikwad (1998) also reported that application of FYM combined with inorganic fertilizer, increased phosphorus uptake of soybean. Aulakh et al. (2003) studied the effect of phosphorus on soybean-wheat production and found that 60 kg P_2O_5 ha^{-1} enhanced P uptake and, total biomass of both crops.

Potassium uptake:

The results in Table (5) showed that the addition of potassium alone led to a gradual increase in the uptake of potassium, while increasing the phosphorus rate led to high significant increase of K when interacted with the high rate of potassium until phosphorus 100 kg P_2O_5 ha^{-1}. Also, led the overlap between phosphorus and potassium to the increase in potassium uptake when adding treatment of 100-50, which recorded 703.12 mg pot^{-1} as compared to control treatment.

Table 5: Effect of phosphorus and potassium fertilizers on P and K uptake of *Leucaena leucocephala* seedlings (mg pot^{-1})

		P				K			
		Potassium application							
		0	25	50	100	0	25	50	100
Phosphorus application	0	13.3 j	21.6 ij	28.4 hi	28.8 hi	100.3 i	196.9 k	218.8 j	221.9 j
	50	26.4 hi	38.2 fg	45.5 ef	41 fg	203.2 k	293.8 h	350 f	315.6 g
	100	51.59 de	78.8 b	91.4 a	62.9 c	396.9 e	606.6 b	703.1 a	484.4 c
	200	41.4 fg	43.1 cfg	55.3 cd	34.9 gh	318.8 g	346.9 f	425.2 d	268.8 i
LSD		8.82				48.478			

REFERENCES

Ali, M.A., G. Abbas, Q. Mohy-ud-Din, K. Ullah, G. Abbas and M. Aslam (2010) Response of (*Vigna radiate*) to phosphatic fertilizer under arid climate. J. Anim. Plant Sci. 20:83- 6.

Anegbeh, P.O., Tchoundjeu, Z. (2002) Nodulation in some agroforestry tree and shrub legumes grown on acid soils in southeast Nigeria. NFT News, 5: 2–3.

Anurag, S., Singh Y.V., Singh D.V. and Patidar M. (2002) Effect of nitrogen, phosphorus and sulphur on growth and yield of cluster bean. In proceedings of national symposium on arid legumes for food nutrition security and promotion of trade, Hisar, India. May, 15-16, 2002.

Aslam SM, Shah SA, and Sikandar A. (2004) Differential response of wheat cultivars to phosphorus application to potato through irrigation water. Pak. J. Soil Sci. 2004; 23:34-39.

Aulakh MS, Pasricha NS, and Bahl GS. (2003) Phosphorus fertilizer response in an irrigated soybean-wheat production system on a subtropical, semiarid soil. Field-Crops Research; 80(2):99-109.

Brewbaker, J.L. and Sorensson, C.T. (1990) New tree crops from interspecific Leucaena hybrids. In: Janick, J. and Simon, J.E. (eds), Advances in New Crops. Timber Press, Portland,pp. 283-289.

Carter M.R. and Gregorich E.G. (2008) Soil sampling and methods of analysis. (2nd ed.), CRC Press Taylor & Francis Group, 6000 Broken Sound Parkway NW, Suite 300 Boca Raton, FL, p. 1224.

Collins, M., and Duke S.H. (1981) Influence of potassium fertilization rate and form onphotosynthesis and N_2 fixation of alfalfa. Crop Sci. 21:481-485.

Collins, M., Lang D.J., and Kelling K.A. (1986) Effects of phosphorus, potassium, andsulfur on alfalfa nitrogen fixation under field conditions. Agron. J. 78:959-963.

Costa, N. de L., and Paulino V.T. (1993) Phosphorus levels and sources affect growth, nodulation and chemical composition of pigeonpea. Nitrogen Fixing Tree Res. Reports 11:68-69.

Datta, A., and Das, P.K. (1997) Evaluation of nodulation and its impact on biomass in some agroforestry tree species. Range-Management-and-Agroforestry, 18(1): 91–97.

Dixit RK, Thomas MB, Farooqui UM, Patra AK, and Spurway MI. (1999) Phosphorus response and toxicity in Acacia spp. Forest Research Institute, Kanpur (U.P.), India.

Duke, S.H., Collins M., and Soberalske R.M. (1980) Effects of potassium fertilization on nitrogen fixation and nodule enzymes of nitrogen metabolism in alfalfa. Crop Sci. 20:213-219.

Ezenwa I. (1994) Early growth of *L. leucocephala* at different levels of sulphur and phosphorus application. Communications in Soil Sci. and Plant Analysis.;25(15/16):2639-2648.

El-Sallami IH.(2002) Seedling responses of some ornamental trees to soil type and NPK fertilization. Assiut J. of Agri. Sci.; 33(3):49-83.

El-Sallami, IH. (2003) Growth response of *L. Leucocephala* Lam. Seedlings to soil type, organic manure and yeast. Assiut J. of Agri. Sci.; 34(1):67-98.

Gentili, F., and Huss-Danell, K. (2002) Phosphorus modifies the effects of nitrogen on nodulation in split-root systems of *Hippophaë rhamnoides*. New Phytologist, 153: 53–61.

Gupta BN, Jha MN, Gupta MK.(1998) Optimum nutrient requirement of *L. Leucocephala*. Annals of Forestry; 6(1):116-118

Hussain, A., Jabar, A., Chughtaj, F. A. and Rasul, (1991) Effect of phosphorus fertilizer on growth of *Leucaena lecocephala* (Lam.) De Wit. Leucaena Research Reports, 12, 86-88.

Ilyas M, Ibrahim M, Siddique T, and Ishtiaq M. (2001) Effect of soil water potential on yield and nutrients uptake by wheat at different fertilizer role. Pak J. Soil Sci.; 20:19-24.

Kang,B.T. and Duguma, B. (1983) Nitrogen management in alley cropping systems. In: Kang B.T. and van der Heide j.(eds). Nitrogen Management in farming systems in Humid and Subhumid Tropics Inst. Soil Fert., Haren, Netherlands. Pp. 269-284.

Lucena, N.C., and Paulino V.T. (1990) Response of Leucaena to single and combined inoculation with Rhizobium and mycorrhiza. Leucaena Res. Reports 11:45-46.

Mian SM, Akram M, Gill KH, and Ahmad Z. (2001) Phosphorus and zinc fertilization on wheat and rice. Pak. J. Soil Sci.; 20:86-91.

Navale KB, and Gaikwad CB.(1998) Growth behavior of soybean as influenced by integrated nutrient management under irrigated condition. J. Maharashtra Agric.Univ.; 23(1):94-95.

Naugariya, M.N., and Pathak P.S. (1993) Effect of nitrogen, phosphorus and potassium on forage production of *Atylosia scarabaeoides* Benth. Range Mgmt. and Agroforestry 14(2): 131-134.

Rahman, M.S., Mridha, M.A.U., and Huda, S.M.S. (2004) Effect of fertilizers on nodulation and growth of *Samanea saman* Merr. in presence of arbuscular mycorrhizal fungi at nursery. In: Serraj, R. (ed.), Symbiotic Nitrogen Fixation–Prospects for Enhanced Application in Tropical Agriculture, New Delhi, India: Oxford and IBH Publishing Co. Pvt. Ltd., pp 327–333.

Razz, R., Clavero, T., and Perez, J.J. (1995) Effect of N and P fertilizer on nodulation in black locust (*Robinia pseudoacacia* L.) Seedlings. Pakistan Journal of Forestry, 44(2): 65–72.

Reager, M. L., Choudhary G. R. and Dahama A. K. (2003) Effect of weed control and phosphorus on growth and quality of cluster bean. Ann. Agric. Res. 24: 563-566.

SAS (2002) The SAS System for Windows. Release 9. 0. SAS Inst. Inc., Cary, NC.

Sonkar, S.D., Kumbhare V., and Totey N.G. (1993) Growth of *Tectona grandis* (Linn) F seedlings in Nursery. Indian J. Trop. Biod. 1:140-145.

Teel, W. (1988) A pocket dictionary of trees and shrubs in Kengo, Nairobi, Kenya.

Wall, L.G. (2000) The Actinorrhizal Symbiosis. J. Plant Growth Regul., 19: 167-182.

Winthington, D. (1986) A request for information about pre germination treatments for important NFT species. Nitrogen fixing tree research reports, 4, 70-71.

تأثير مستويات مختلفة من الفوسفور والبوتاسيوم على نمو بادرات الليوسينا

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أقيمت تجربة اصص فى الصوبة الزراعية التابعة لقسم بحوث الاراضى والمياه- مركز البحوث النووية-هيئة الطاقة الذرية. فى خلال الموسم الصيفى 2011/2010 وذلك بهدف تقييم تاثير مستويات مختلفة من الفوسفور والبوتاسيوم على النمو ومحتوى الليوسينا من العناصر الغذائية وكذلك تثبيت النيتروجين وتكوين العقد البكتيرية. وكان تصميم التجربة التام العشوائى، مع اربعة مكررات من خلال التداخل بين الفوسفور والبوتاسيوم فى وجود التلقيح والتسميدى النيتروجينى بمعدل 20 كجم ن /فدان, اما بالنسبة للفوسفور حيث استخدم 4 مستويات من السماد الفوسفاتى (سوبر فوسفات الاحادى) صفر ، 50، 100 ، 200 كجم /فدان. مع استخدام التسميد البوتاسى بمعدلات صفر، 25 ، 50، 100 كجم بو$_2$أ/فدان وتم جمع النباتات بعد 120 يوما وفصل المجموع الخضرى عن الجذور وتم فصل العقد الجذرية ووزنها ووضعها فى الفرن على درجة 70 م° ثم الوزن الجاف وتقدير العناصر المختلفة. وتمثلت اهم النتائج فى زيادة الوزن الجاف فى السيقان والجذور تدريجيا بزيادة معدلات البوتاسيوم منفردا حتى 100كجم K_2O/فدان. بينما عند اضافة الفوسفور بمفرده ادى الى زيادة الوزن الجاف فى كل من السيقان والاوراق حتى معدل اضافة 100كجمP_2O_5/فدان. وكانت افضل معاملة عند اضافة الفوسفور بمعدل 100كجم P_2O_5 /فدان مع اضافة البوتاسيوم بمعدل 50 كجم K_2O /فدان حيث كانت 197.43,28.38,225.81 (محصول المادة الجافة-الاوراق-السيقان على الترتيب). ولقد أظهرت النتائج زيادة فى عدد واوزان العقد الجذرية عند نفس المعاملة السابقة , حيث اعطت 3.13جم/أصيص مقارنة بالكنترول. بالاضافة الى ان اضافة الفوسفور مع البوتاسيوم بمعدل (100-50) أدى الى زيادة الاستفادة من النتروجين الممتص . وينصح بأضافة الفوسفور والبوتاسيوم بهذا المعدل السابق لأعطاء افضل نمو لشجرة الليوسينا مع التلقيح وأضافة النتروجين بمعدل 20كجم ن/فدان.

قام بتحكيم البحث

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