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Influence of Phosphorus Application on the Initial Growth and Leaf Nutrient Contents of Some Leguminous Tree Species

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Abstract

Phosphorus applications (0.6, 1.2 and 1.8 gm/kg soil) were applied to six leguminous tree species; *Acacia laeta, Acacia abida*, *Acacia nilotica, Acacia farnesiana*, *Tamarindus indica* and *Haematoxylum campechianum* to define the suitable P rate for favorable growth. The heaviest roots in average of both seasons; fresh and dry were obtained from *T. indica*. The thickest and heaviest shoot were resulted from *A. laeta*. The longest roots recorded by *A. nilotica* and *A. farnesiana*. The maximum N and P contents were obtained by *T. indica*. The other species achieved intermediate levels of N and P. In relation to P application, a rate of 1.2 gm/kg of phosphorus was the best for shoot diameter and root length, meanwhile, 1.8 gm/kg increased fresh and dry weight of both shoots and roots. Leaf content of N was increased with increasing P from 0.6 to 1.8 gm/kg. Phosphorus addition at 1.2 gm/kg was more effective in accumulation of P concentration.

Keywords: *phosphorus fertilization, leguminous trees, tree growth, seedlings.*

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Introduction:

Phosphorus plays an essential role in all physiological and biochemical processes in plants (Lott *et al*., 2000). Moreover, phosphorous is essential to many plant functions and structures. It plays a role in photosynthesis, respiration, energy production, and cell division and enlargement. An adequate supply of P promotes early root formation and growth, better growth in cold temperatures and better water use efficiency. Therefore, to achieve more rational use of phosphorus fertilization, specifically phosphorus-treated seeds are used (Stramkale *et al*., 2004). Usage of phosphorus-treated seeds improves utilization of mineral nutrients and avoids contamination of the environment. In this respect, Shah *et al*. (2011) pointed out that treating okra seeds with different sources of phosphorus and soaking durations significantly affected germination percentage, survival percentage, number of days to emergence and plant height. On the other hand, because phosphorous is essentially immobile in most soils, any factor that reduces normal root growth and function, for example soil compaction, will likely result in a P deficiency in those plants. This occurs even in soils with adequate to high P level. Generally, in soils developed in temperate climates, the contribution of P by organic matter is relatively small and the main source of P for plants is the inorganic forms. The low availability of P causes a reduction in leaf area and the CO_2 assimilation rate, consequently resulting in a reduced availability of photo assimilates for whole-plant growth (Thomas *et al*., 2006); therefore, a drop in the accumulation of total dry matter is a major feature of plants cultivated under conditions of P deficiency. Phosphorus deficiency can be also a limiting factor in nodulation by legumes which results in an inadequate growth and N fixation. This could be overcome by P fertilizer application (Giller and Cadisch, 1995).

In some situations, the response to P application is found to be more effective in promoting plant growth than the application of N (Graciano *et al.,* 2006). Moreover, the increase in N levels in the soil may even decrease the plant growth if there is no corresponding increase in the availability of P. These results highlight the strong relationship between the availability of both N and P and plant growth.

In Egypt, plantations of leguminous tree species have recently expanded. These include fast-growing species used mainly to supply wood and N fixation. *Acacia farnesiana* L. (Willd.) is a deciduous shrub growing to 9 m. suitable for light (sandy), medium (loamy) and heavy (clay) soils, prefers well-drained soil and can grow in nutritionally poor soil. A gum exuding from trunk is considered to be superior to Arabic gum in arts. The woody branches are used in India as tooth brushes. In suitable climates the plant is grown as a hedge. Its wood is heavy, hard, durable in the soil, close-grained used for fencing posts, agricultural implements, pegs, woodenware etc. (Clarke *et al*., 1989). *Acacia nilotica* L. Delile is known for its foliage and seeds which are eaten by a wide range of herbivores as well as highly valued as fodder and fuel- wood in regions of semi-arid Africa and India. It is used as a pioneer species in land rehabilitation and as a barrier to desertification. The timber has been used to produce railway sleepers, fence-posts and fuel-wood. Non-forage/timber uses include gum/resin, tannin /dyestuff; traditional medicine and vertebrate poisons (Fagg, 2001). *Acacia laeta* Benth. is native to Africa, including the Sahara, the Middle East, and Western part. The tree is used for fodder; the foliage and seed pods make good forage for livestock and the tree stands up well to this use. It produces an edible gum. Water and heat are used to extract tannin from the tree's bark for use in tanning hides. The wood is used for fuel, charcoal and domestic construction. It is used to make wooden posts for fences (Burkill, 2000). *Acacia albida* Delileis one of the largest thorn trees, reaching 30 m in height, with spreading branches and a rounded crown. The leaves and pods are palatable to domestic animals and an important source of protein for livestock in the dry season. The wood is susceptible to staining fungi and pinhole borer when green; therefore, it is left to soak for several months to remove sap and minimize attack by fungi, borers and termites. The wood works fairly easily by hand, but a smooth finish is difficult to obtain (Booth an Wickens, 1988). *Tamarindus indica* L. is indigenous to tropical Africa, particularly in Sudan, where it continues to grow wild. The tree grows well in full sun in clayey, loamy, sandy, and acidic soil types, with a high drought and aerosol salt (wind-borne salt as found in coastal areas) resistance. The tamarind is best described as sweet and sour in taste, and is high in acid, sugar, B vitamins and, oddly for a fruit, calcium. Due to its density and durability, tamarind heartwood can be used in making furniture and wood flooring. *Haematoxylum campechianum* L. is native to southern Mexico and northern Central America. It prefers light soils with some humus. Logwood has been used for a long time as a natural source of dye, and still remains an important source of haematoxylin, which is used in histology for staining. The wood is strong but brittle; it is durable for use outdoors and in contact with the ground. It is sometimes used for furniture and fancy articles because it may be finished to a very smooth surface and takes a high polish (Rico-Gray *et al*., 1991).

Similar studies are rather scarce for the legume trees despite its importance and potential for planting in afforestation programs in Egypt. Therefore, the aim of this work was to evaluate the influence of phosphorus applications on plant growth and leaf nutrient contents of phosphorus and nitrogen in the studied tree species.

Materials and Methods:

Seed collection:

Ripe pods were collected from the mature phase of *Acacia laeta* Benth, *Acacia albida* Delile, *Acacia nilotica L., Acacia farnesiana* L., *Tamarindus indica* L. and *Haematoxylum campechianum* L. grown in Kom-Ombo, Aswan Governorate in Upper Egypt during 2012 and 2013 seasons. Pods were ruptured to remove seeds. To break dormancy, the requirements of seeds for mechanical scarification which makes them germinate in soil was undertaken. Scarification was done by rubbing the seeds against coarse sand then they were surface sterilized by stirring in 0.1% Mercuric Chloride for 1 min. and rinsed thoroughly thereafter in distilled water.

Treatments:

This experiment was carried out in Kom-Ombo Tropical Farm, Aswan Botanical Garden in June 2012 and 2013. Granulated triple superphosphate fertilizer (15% P_2O_5) was added as phosphorus source to the sowing soil. Treatments included 4 levels: 0, 0.6, 1.2 and 1.8 gm P_2O_5/Kg soil which were mixed with the soil before sowing. The soil was loamy sand and the chemical properties are shown in Table 1.

Table (1): Chemical properties of the sowing soil in average of 2012 and 2013 seasons.

Property	Value	Property	Value
EC.ms/s	0.24	HCO_3^- Meq/L	1.36
pH	8.50	Cl^- Meq/L	0.26
CaCO3%	4.79	SO_4^{2-} Meq/L	0.34
Ca^{++} Meq/L	1.26	N%	0.17
Mg^{++} Meq/L	0.43	P mg/kg	0.70
Na^+ Meq/L	0.36	K mg/kg	76.13
K^+ Meq/L	0.11	O.M.%	0.33

Procedures and experimental design:

Five seeds of each species were sown in perforated polyethylene bag filled with 5 kg treated soil. The experiment consisted of 24 treatments were arranged in randomized complete blocks in a split-plot design, six tree species as main plots and four P treatments as sub-plots. Each treatment contained nine bags and replicated three times. Plants were irrigated daily to reach soil moisture 80-85% F.C. All horticultural practices were similarly done whenever needed.

Growth parameters and chemical analysis:

Three months of after sowing, samples were collected to measure biomass production in terms of, shoot and root length (cm), shoot diameter (cm) and root and shoot fresh and dry weights (dried in oven at 68°C for 48h). Nitrogen and Phosphorus contents in leaves of the tested tree species were estimated. The nitrogen content was determined in dried samples (0.2 gm) by using the modified micro Kjeldahal method (Black *et al.,* 1965). Phosphorus content was determined spectrometrically using the chlorostannus-phosphomolybdic acid method in a sulphoric acid system (Jackson, 1985).

Data were subjected to statistical analysis using F test according to Snedecor and Cochran (1973) and L.S.D value for comparisons according to Weller and Duncan (1969).

Results:

Vegetative characteristics:

Data of vegetative characteristics are shown in Table 2. The data show that there was a significant effect of phosphorus fertilization on shoots length, and a significant difference among tree species as well as phosphorus levels. Shoot length of the tested tree species was increased significantly with increasing phosphorus levels in both seasons and the highest shoot length was obtained with 1.8 gm P_2O_5/kg and 1.2 gm P_2O_5/kg soil in both seasons, respectively. The maximum shoot length was recorded with *A. nilotica*, followed by *A. laeta* for 1st and 2nd seasons. These results showed that *A. nilotica* seeds treated with 1.8 gm P_2O_5/kg soil followed by seeds treated with 1.2 gm/kg soil produced the highest values of shoot length compared to the other treatments. Root length of legume seedlings at various phosphorus levels was increased significantly compared to the control and the significant higher length was recorded with P fertilizer at 1.2 gm/kg soil for both seasons. However, the root length of the tested trees improved with phosphorus levels and the maximum root length was recorded with *A. farnesiana* followed by *T. indica* seedlings, while the minimum root length was recorded with *H. campechianum*. The interaction effect between phosphorus levels and tree species was found to be significant. Phosphorus application with all the tested seeds significantly increased root length compared to the control. These results showed that treated *A. farnesiana* seeds with 1.2 gm P_2O_5/kg soil followed by seeds treated with 1.8 gm/kg soil produced the highest values of root length compared to the other treatments. Data presented in Table 2 also showed that various phosphorus levels and tree species had significant effects on shoot diameter of the tested trees while their interaction in the second season had no significant effect. Maximum diameter was recorded in trees fertilized with phosphorus at 1.2 gm P_2O_5/kg soil followed by 1.8 gm P_2O_5/kg soil compared to the control. Results of various legume tree species indicate that maximum shoot diameter was recorded in *A. laeta* followed by *A. farnesiana* seedlings in both seasons. However, in their interaction, the highest shoot diameter was detected in *A. laeta* treated with 1.2 gm P_2O_5/kg soil, followed by *A. nilotica* treated with 1.8 gm P_2O_5/kg soil.

Table (2): Effect of phosphorus application on growth of different leguminous trees during 2012 and 2013 seasons.

Tree species/ P level (g/ kg soil)	First season (2012)					Second season (2013)				
	0	0.6	1.2	1.8	Mean	0	0.6	1.2	1.8	Mean
	Shoot length (cm)									
A. laeta	42.8	51.5	57.0	60.8	53.0	37.9	40.5	47.4	50.9	44.2
A. albida	14.5	19.1	20.2	21.1	18.8	20.9	23.2	24.4	27.5	24.0
A. nilotica	45.1	66.0	71.6	73.2	64.0	26.8	51.8	59.5	63.9	50.5
A. farnesiana	26.1	29.6	38.5	26.6	30.2	29.4	28.1	44.4	29.3	32.8
T. indica	16.6	21.9	25.4	38.3	25.6	27.2	30.1	34.2	37.3	32.2
H. campechianum	52.8	67.9	44.3	41.1	51.5	46.9	51.4	38.8	33.6	42.7
Mean	33.0	42.7	42.8	43.5		31.5	37.5	41.4	40.4	
L.S.D. 5%	Trees: 1.3 P level : 1.6 Interaction: 4.0					Trees: 4.2 P level: 2.9 Interaction: 7.1				
	Root length (cm)									
A. laeta	13.7	13.6	14.9	16.2	14.6	12.3	12.3	13.4	14.6	13.2
A. albida	12.7	13.9	14.9	19.2	15.2	11.3	12.4	13.3	17.1	13.6
A. nilotica	13.6	16.8	18.4	20.6	17.3	12.2	15.0	16.4	18.4	15.5
A. farnesiana	15.5	18.1	27.5	23.3	21.1	13.5	15.7	23.9	20.3	18.4
T. indica	22.0	20.6	20.4	18.3	20.4	19.4	18.3	18.0	16.2	18.0
H. campechianum	13.7	17.3	12.6	10.3	13.5	12.6	15.9	11.7	9.5	12.4
Mean	15.2	16.7	18.1	18.0		13.5	14.9	16.1	16.0	
L.S.D. 5%	Trees: 1.4 P level: 0.8 Interaction: 2.1					Trees: 1.2 P level: 0.7 Interaction: 1.8				
	Shoot diameter (cm)									
A. laeta	0.33	0.39	0.41	0.35	0.37	0.30	0.35	0.37	0.31	0.33
A. albida	0.26	0.26	0.27	0.28	0.27	0.23	0.23	0.24	0.25	0.24
A. nilotica	0.23	0.31	0.33	0.41	0.32	0.20	0.28	0.29	0.36	0.28
A. farnesiana	0.31	0.32	0.32	0.34	0.32	0.28	0.29	0.29	0.31	0.29
T. indica	0.25	0.27	0.33	0.34	0.30	0.23	0.25	0.30	0.31	0.27
H. campechianum	0.17	0.22	0.37	0.29	0.27	0.15	0.22	0.34	0.26	0.24
Mean	0.26	0.30	0.34	0.34		0.23	0.27	0.31	0.30	
L.S.D. 5%	Trees: 0.03 P level: 0.02 Interaction: 0.05					Trees: 0.04 P level: 0.03 Interaction: N.S.				

Biomass characteristics:

Shoot fresh weights for the tested tree species fertilized with P at 1.8 gm P_2O_5/kg soil were high when compared with the other treatments during both seasons. The maximum weight of fresh shoots was produced from *A. laeta*, while the lowest one was obtained from *H. campechianum* in both seasons. However, in their interaction, the highest shoot fresh weight was recorded with 1.8 gm P_2O_5/kg soil applied for *A. laeta*, followed by the same species treated with 1.2 gm/kg soil in the studied seasons (Table 3). Data also indicate that the separate effect of phosphorus levels and tree species affected root fresh weight significantly and their interaction was significant. Data showed that among various phosphorus levels, maximum root fresh weights were noticed from seeds treated with 1.8 gm P_2O_5/kg soil. Regarding results of various tree species, the maximum root fresh weight was recorded in *T. indica*, while the minimum weight was recorded with *A. albida* in both seasons. Data presented in Table 3. showed that maximum dry weights of shoots were noted in *A. laeta*, followed by *T. indica* compared to the other tree species in both seasons. Minimum weights were recorded by *H. campechianum*. Results of various P levels showed that the highest shoot dry weights were obtained with 1.8 gm P_2O_5/kg soil compared to the other treatments in both seasons. In their interaction maximum shoot dry weight was recorded in *A. laeta* fertilized by phosphorus at 1.8 and 1.2 gm P_2O_5/kg soil, respectively. Maximum root dry weight was observed by using 1.8 gm P_2O_5/kg soil treatment compared to the other treatments for both seasons. Results of various tree species indicated that the heaviest dry roots were recorded in *T. indica*, followed by *A. laeta* for both seasons, while the lightest values were recorded in *A. albida* and *H. campechianum*. The interaction effect showed that un- treated seeds of *T. indica* gave the heaviest dry roots, followed by the same species with 0.6 gm P_2O_5/ kg soil in the two studied seasons.

Table (3): Effect of phosphorus application on biomass characteristics of different leguminous trees during 2012 and 2013 seasons.

Tree species/ P level (g/ kg soil)	First season (2012)					Second season (2013)				
	0	0.6	1.2	1.8	Mean	0	0.6	1.2	1.8	Mean
	Shoot fresh weight (gm/plant)									
A. laeta	2.54	2.95	4.08	6.84	4.10	2.15	2.49	3.46	5.80	3.47
A. albida	0.30	0.38	0.55	0.70	0.48	0.27	0.34	0.49	0.51	0.40
A. nilotica	1.77	2.08	2.47	3.68	2.50	1.52	1.79	2.13	3.17	2.15
A. farnesiana	1.96	2.19	2.78	2.03	2.24	1.75	1.96	2.48	1.81	2.00
T. indica	1.80	2.21	2.37	3.44	2.45	1.56	1.92	2.05	2.99	2.13
H. campechianum	0.30	0.46	0.29	0.22	0.32	0.27	0.42	0.24	0.20	0.28
Mean	1.44	1.71	2.09	2.82		1.25	1.49	1.81	2.41	
L.S.D. 5%	Trees: 0.11 P level: 0.13 Interaction: 0.31					Trees: 0.21 P level: 0.17 Interaction: 0.42				
	Root fresh weight (gm/plant)									
A. laeta	0.60	0.82	1.02	1.51	0.99	0.55	0.75	0.94	1.42	0.92
A. albida	0.13	0.18	0.23	0.23	0.19	0.12	0.17	0.22	0.22	0.18
A. nilotica	0.24	0.25	0.38	0.65	0.38	0.22	0.23	0.35	0.60	0.35
A. farnesiana	0.24	0.27	0.37	0.54	0.36	0.22	0.25	0.34	0.50	0.33
T. indica	2.22	1.47	1.27	1.11	1.52	2.02	1.34	1.15	1.01	1.38
H. campechianum	0.19	0.30	0.21	0.15	0.21	0.18	0.28	0.20	0.14	0.20
Mean	0.60	0.55	0.58	0.70		0.55	0.50	0.53	0.65	
L.S.D. 5%	Trees: 0.08 P level: 0.06 Interaction: 0.14					Trees: 0.08 P level: 0.06 Interaction: 0.14				
	Shoot dry weight (gm/plant)									
A. laeta	1.13	1.25	1.83	3.12	1.83	1.02	1.12	1.65	2.81	1.65
A. albida	0.07	0.12	0.18	0.24	0.15	0.07	0.12	0.17	0.23	0.15
A. nilotica	0.70	0.80	1.02	1.16	0.92	0.65	0.75	0.95	1.08	0.86
A. farnesiana	0.74	1.22	1.05	1.00	1.00	0.70	0.82	0.99	0.94	0.86
T. indica	0.70	0.93	1.00	1.42	1.01	0.64	0.85	0.92	1.30	0.93
H. campechianum	0.08	0.12	0.05	0.04	0.07	0.08	0.12	0.05	0.04	0.07
Mean	0.57	0.74	0.86	1.16		0.53	0.63	0.79	1.07	
L.S.D. 5%	Trees: 0.07 P level: 0.08 Interaction: 0.20					Trees: 0.03 P level: 0.08 Interaction: 0.19				
	Root dry weight (gm/plant)									
A. laeta	0.24	0.35	0.45	0.68	0.43	0.23	0.34	0.43	0.64	0.41
A. albida	0.02	0.03	0.05	0.04	0.03	0.02	0.03	0.05	0.04	0.03
A. nilotica	0.07	0.08	0.16	0.26	0.14	0.07	0.08	0.15	0.25	0.14
A. farnesiana	0.06	0.08	0.14	0.23	0.13	0.06	0.08	0.13	0.22	0.12
T. indica	1.12	0.80	0.72	0.58	0.80	1.06	0.75	0.68	0.54	0.76
H. campechianum	0.03	0.07	0.03	0.02	0.04	0.03	0.07	0.03	0.02	0.04
Mean	0.26	0.24	0.26	0.30		0.25	0.22	0.25	0.29	
L.S.D. 5%	Trees: 0.04 P level: 0.03 Interaction: 0.07					Trees: 0.04 P level: 0.03 Interaction: 0.07				

Leaf content of nitrogen and phosphorus:

Phosphorus application showed considerable effects on leaf N and P concentrations in different tree species (Table 4). Leaf content of nitrogen of the tested species was significantly increased with increasing phosphorus levels in both seasons and the highest shoot length was recorded with 1.8 gm P_2O_5/kg soil application. The maximum leaf content of nitrogen was recorded with *T. indica*, followed by *A. nilotica* for both seasons. The results also showed that *T. indica* fertilized with 1.2 and 1.8 gm P_2O_5/kg soil produced the highest values of leaf content of nitrogen compared to the other treatments. On the other hand, data indicated that the effect of phosphorus levels and tree species effected on leaf content of phosphorus were significant and their interaction was also significant. The highest leaf content of phosphorus was found in *T. indica*, followed by *A. laeta* compared to the other tree species in both seasons. The minimum leaf content of phosphorus was recorded by *A. albida*. Results of the effect of various P levels showed that the highest leaf content of phosphorus was recorded in 1.2 gm/kg soil compared to the other treatments in both seasons. Regarding the interaction between tree species and P fertilization, the maximum leaf content of phosphorus was obtained by *T. indica* fertilized by phosphorus at 1.2 followed by 0.6 gm P_2O_5/kg soil.

Table (4): Effect of phosphorus application on the leaf content of nitrogen and phosphorus (mg/gm^{-1} leaf DW) of different leguminous trees during 2012 and 2013 seasons.

Legume species/ P level(g/ kg soil)	First season (2012)					Second season (2013)				
	0	0.6	1.2	1.8	Mean	0	0.6	1.2	1.8	Mean
	Nitrogen (mg/gm^{-1} leaf DM)									
A. laeta	21.67	23.15	24.08	25.25	23.54	21.05	23.48	23.80	24.96	23.32
A. albida	18.42	20.01	20.48	21.33	20.06	18.75	20.41	21.28	21.97	20.60
A. nilotica	22.32	22.74	23.19	23.40	22.91	22.49	23.35	23.75	23.73	23.33
A. farnesiana	19.22	20.09	21.41	21.83	20.52	19.45	20.84	21.48	23.16	20.99
T. indica	23.15	25.14	26.48	26.44	25.30	22.95	24.23	26.07	26.90	25.04
H. campechianum	17.89	19.29	19.25	19.91	19.08	18.75	19.63	19.86	20.55	19.70
Mean	20.44	21.74	22.48	22.95		20.57	21.99	22.71	23.38	
L.S.D. 5%	Trees: 0.56 P level: 0.33 Interaction: 0.81					Trees: 0.51 P level: 0.41 Interaction: 0.99				
	Phosphorus (mg/gm^{-1} leaf DM)									
A. laeta	1.60	1.90	1.80	1.90	1.80	1.77	1.83	1.87	1.91	1.84
A. albida	0.80	0.90	1.10	1.20	1.00	0.85	0.94	1.16	1.28	1.06
A. nilotica	1.50	1.58	1.70	1.60	1.60	1.49	1.68	1.80	1.72	1.67
A. farnesiana	1.30	1.50	1.40	1.50	1.43	1.41	1.58	1.60	1.63	1.55
T. indica	1.80	2.00	2.10	2.00	1.98	1.87	2.06	2.14	2.02	2.02
H. campechianum	0.80	1.00	1.10	0.90	0.95	0.94	1.06	1.16	0.98	1.04
Mean	1.30	1.48	1.53	1.52		1.39	1.52	1.62	1.59	
L.S.D. 5%	Trees: 0.09 P level: 0.07 Interaction: 0.17					Trees: 0.12 P level: 0.07 Interaction: 0.16				

Discussions:

The current study showed that growth characteristics of the tested tree species were significantly affected by P fertilization. Shoot and root length as well as stem diameter were increased by P doses, the most suitable dose of P fertilizer was 1.2

gm P_2O_5/ kg soil. Whereas, 1.8 gm P_2O_5/kg soil was the most suitable for shoot and root fresh and dry weights. The embryo grows at the expense of the food materials which it absorbs from the cotyledons or endosperm when it is present (Amjad *et al*., 2001). These results showed that phosphorus may promote an increase the shoot and root length as well as stem diameter of the tested trees and contribute towards enabling the plants to be established in the field. Cruz *et al.* (2014) had also indicated that the concept of P-fertilization is highly significant for the growth of the *Spondias tuberosa*. Plants take up phosphorus in the inorganic form, mainly as orthophosphate H_2PO_4 ions. Phosphorus supports early phase of crop development, synchronizes the germination process and leads to enhance the final yield, especially in P deficient soil.

Several studies pointed out that phosphorus fertilization promotes establishment and increases biomass production of woody species (Taiki *et al.*, 2010). However, Cruz *et al.* (2014) revealed that the least value of total dry mass was obtained when the umbu plants (*Spondias tuberosa*) were cultivated in the absence of P. This could be attributed to the role of phosphorus in different aspects of cell division and growth, energy transfer, signal transduction, biosynthesis of macromolecules, photosynthesis and respiration (Raghothama, 1999). Several explanations might account for the prolonged effect of P fertilizer; internal recycling of P fertilizer was efficient and elaboration of root systems was proportional to the rate of fertilization. However, the inherent variation associated with large-scale field trials should also be taken into consideration when evaluating the field trial results. A reason for better performance of tree species is due to roots better exploring a larger soil volume cross-section (Tyree *et al.* 1998). Moreover, George *et al.* (2006) stated that the placement of phosphorus fertilizer was a more important factor than timing of application on affecting seedling growth and establishment. The fact that shoot length and diameter as well as root length of the tested seedlings were lower under the higher rate of P application (1.8 gm/ kg soil) in the current study is in accordance to findings of Handreck (1997) who also observed that high rates of P fertilizer application can be detrimental to the root growth of eucalyptus seedlings. Our results indicate that fertilization rate is a more rapid method for obtaining targeted plant size in the nursery. In respect of N and P in leaves, P fertilization increased P concentration in the leaves. These results are in accordance with those obtained by Hagagg *et al.* (2012). In our study, as a result of the higher accumulation of dry matter, the total P and N accumulation was higher for the tested tree species.

Conclusions:

Phosphorus application positively influenced all the growth characteristics evaluated for the leguminous tree species. In this sense, the tested trees showed a moderate demand for phosphorus during its early growth stages. Phosphorus fertilization positively influenced the nitrogen accumulation in trees. Phosphorus was important in inducing shoot and root length as well as stem diameter, as it can improve the plant establishment in the nursery and field. A detailed field investigation is therefore recommended to ensure the long term growth performance of selected legume species in response to P fertilizer application for seedlings at different ages.

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تأثير التسميد الفوسفاتى على المراحل الأولى للنمو ومحتوى الأوراق من العناصر لبعض الأشجار البقولية

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الملخص:

أجريت الدراسة بهدف دراسة تأثير ثلاث مستويات من السماد الفوسفاتى (سوبر فوسفات ثلاثى P_2O_5) وهى ٠,٦ ، ١,٢ ، ١,٨ جم / كجم تربة بالاضافة الى معاملة المقارنة (بدون سماد) على نمو بادرات بعض الأشجار البقولية (أكاسيا لياتا، أكاسيا ألبيدا، الفتنة، السنط العربى، بالاضافة الى أشجارالتمر الهندى، والبقم) وكذلك محتوى الأوراق من الفوسفور والنتروجين.

أظهرت النتائج تأثيرا معنويا للمعاملة بالسماد الفوسفاتى والأنواع الشجرية والتفاعل بينهما على قياسات النمو للشتلة الناتجة. وأعطت أشجار التمر الهندى أعلى القيم الخاصة بالوزن الطازج والجاف للجذور مقارنة بباقى الأشجار. كما نتج عن أشجار أكاسيا لياتا أعلى القيم الخاصة بقطر الساق والوزن الطازج والجاف للأجزاء الهوائية للشتلة. في حين تميزت أشجار السنط العربى والفتنة بأفضل طول للجذور. وكان أعلى محتوى من عنصرى النيتروجين والفوسفور فى أوراق التمر الهندى، وكان أقل محتوى بأوراق شتلات البقم مقارنة بباقى الأشجار. ولوحظت زيادة معنوية في قياسات الصفات الناتجة مع استخدام السماد الفوسفاتى، وكان للمستوى ١,٢ جم/ كجم تربة تفوقاً معنوياً في قطر الساق وطول الجذور، في حين أدي استخدام ١,٨جم/ كجم تربة الى الحصول على أفضل أوزان طازجة وجافة لكل من السوق والجذور. وتم تسجيل زيادة تدريجية في محتوى أوراق الشتلات الناتجة من عنصر النيتروجين تدريجيا بزيادة مستوى السماد الفوسفاتى ، بينما لوحظ أعلى محتوى من الفوسفور عند استخدام المستوى٢ .١جم/ كجم تربة.