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PHYSIOLOGICAL STUDIES ON *Ficus benjamina* PLANTS: 2:EFFECT OF PHOSPHORUS FERTILIZATION AND BIOFERTILIZERS ON SEEDLING GROWTH

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ABSTRACT

Ficus benjamina, L. plants which known as a weeping fig, is an important shade as well as a component of indoor ornamental plant. Since growth of plants is greatly improved by fertilization this experiment was carried out for two seasons 2002 and 2003 to investigate the effect of 1, 2, 4 and 8 g/pot of calcium superphosphate and biofertilizers; Biogen, Microbein, Phosphorene, Biogen + Phosphorene or Microbein +Phosphorene. One-year-old *F. benjamina* transplants were transplanted in clay pots filled with 8 kg of a sandy soil and peatmoss (95: 5 by volume). Calcium superphosphate and 5 g of biofertilizers were mixed with the soil before transplanting.

Both phosphorus fertilization and biofertilizers significantly improved plant growth. Plant height, stem thickness, and branch and leaf number were increased by increasing the level of calcium superphosphate from 1 to 4 g/pot and decreased when was added at 8 g/pot. Microbein significantly increased most measured parameters over the non-biofertilized plants. However, there was no significant difference between Biogen and non-biofertilized plants. The highest plant height, stem thickness, branch and leaf number and shoot and root biomass were obtained when *F. benjamina* plants were fertilized with 4 g/pot of calcium superphosphate + Microbein + Phosphorene.

INTRODUCTION

Ficus benjamina, L. plant that commonly, known as a weeping fig, is a native species to tropical South-east Asia, belonging to Family Morarceae. It is an important component of the foliage interior landscape (Florida Nurserymen and Growers Association, 1997 and Veneklass *et al.,* 2002).

Growth of ornamental trees can be greatly improved through regular care. Fertilizer application is one of the most important factors, which affect tree growth. Lack of fertilization lead to some symptoms such as small leaves, light green or off-color foliage and less elongation of branches and general lack of thriftiness or vigor (Melvin and James 2001). Nitrogen is one of the basic plant nutrients that is built into the body of simple and conjugated proteins and many of organic substances of plant cell. Also, phosphorus is considered one of the important macroelement nutrients, which restrict plant growth. Oxidized phosphorus compounds are an absolute necessary for all living organisms since it is an essential compound for nucleic acids. So that, plants which suffer from nitrogen or phosphorus deficiency exhibit specific symptoms (Yagodin, 1984). The impact of N and P in seedling growth of different tree seedlings has been shown by Thomas and Teoh (1983) on *F. macrophylla*, Ahmad (1995) on *Leucaena leucocephala*, Abd El-Aziz (2000) on *Azadirachta indica*, Abdou and El-Sayed (2002) on Peltophorum and El-Sayed and Abdou (2002) on Khaya. However, Puri and Swamy (2001) treated *Azadirachta indica* with different rates of N and P and found that only nitrogen has a significant effect on seedling biomass. Therefore, the application of nitrogen and phosphate fertilizers are considered an essential horticultural practice for better growth. However, the availability of P is a serious problem as it is fixed in the soil and lowers the utilization efficiency of added P fertilizer by the plant.

Some free-living bacteria such as *Azotobacter*, *Azosprillium* and *Pseudomonas* which are dominant inhabitant in arable soil, have the capability to fix nitrogen. They help also in soil aggregation (Subba-Rao, 1991). Other soil microorganisms play a significant role in mobilizing P by lowering the pH in rhizospheric soil as well as producing chelating substances, which lead to solubilization of phosphates. In addition to nitrogen fixation and P mobilization microorganisms increase plant growth by secretion of growth promoting substances and improving soil properties by leaving organic residues (Kannaiyan, 2002).

Biofertilizers are important source for supplementing plant nutrients. They have a special significance in the context of both the cost and environmental impact of mineral fertilizers (Kannaiyan, 2002). Microbein is a multi-strain biofertilizer consists of symbiotic and asymbiotic nitrogen fixation as well as other micro-organism for mobilizing certain macro-elements for plant absorption. Phosphorene is a biofertilizer contains *Bacillus spp* bacteria which lower the pH in rhizospheric soil and produce chelating substances, which lead to solubilization of phosphates. Application of biofertilizers such as Biogen , Microbein and Phosphorene enhanced growth and nutritional status of different plants
(Subba-Rao 1991, Helmy and Azzazy, 1996 and Attia and Saad, 2001).

The aim of this study was to determine the effect of phosphorus fertilizer and three different types of commercial biofertilizers; Biogen, Microbein and phosphorene on growth of *F. benjamina* transplants.

MATERIALS AND METHODS

This pot experiment with 3 replicates was conducted in the greenhouse at Dept. of Horticulture Fac. of Agric. Minia Univ. during two consecutive seasons, 2002 and 2003. One-year-old uniform *F. benjamina* plants (25-30 cm height) were individually planted on the first of April of both seasons in 30 cm diameter new clay pots. Pots were filled with 8 kg of sandy soil and peatmoss (95: 5 % v/v). Soil analyses are shown in Table (1). Potting media were sterilized before transplanting by spraying 2% formalin solution and kept under plastic cover for 24 hr. Thereafter, the cover was removed and soil was left for ten days before planting. All plants were fertilized with 4 g of ammonium sulphate (20.6 %N) divided into two doses on May first and June first. Also, 2 g/pot potassium sulphate (48 % K_2O) were added as one dose on May. A phosphorus fertilizer was applied at 1, 2, 4 or 8 g/pot of calcium superphosphate (15.5 % P_2O_5), as one dose before planting.

Biogen, Microbein and Phosphorene biofertilizers were obtained from the Ministry of Agriculture, produced by the General Organization for

Agric. Equalization. Before transplanting soil of each pot was mixed with 5 g of Biogen, Microbein, Phosphorene, Biogen + phosphorene or Microbein + phosphorene. A factorial experiment 4 X 6 was used in each season in a randomized complete blocks design with 3 replecates and weach replicate contained 5 pots. Plants were irrigated as needed.

At the end of the experiment, on Oct. 30th of both seasons plant height (cm), stem thickness (cm) at 5 cm above the medium surface and branch and leaf number/plant were recorded. Randomly 5 leaves of the middle part of each plant were used to estimate chlorophyll a and b content as described by Fadl and Seri-El-Deen (1978). Shoots and roots were dried at 70°C to estimate their biomass (g).

Nitrogen and phosphorus percentages were estimated in the dry leaves according to Page *et al* (1982).

Experimental results were submitted to an analysis of variance (ANOVA) and means were compared using LSD test ($p<0.05$) (Gomez and Gomez, 1984). This analysis was performed using MSTATC.

Table 1: Some physical and chemical analysis of the experiment soil in the two seasons

Character	Value	Character	Value
Particle size distribution sand	90.4 %	$CaCO_3$ %	14.3
Silt	4.2 %	Total N %	0.03
Clay	5.4 %	Available K (mg/kg)	22.1
Texture grade	sandy soil	DTPA- Extractable P mg/kg	2.50
Organic matter	0.08%	Fe (mg/kg)	2.01
pH 1:2.5	7.5	Mn (mg/kg)	0.25
EC dSm^{-1}	1.07	Zn (mg/kg)	0.10

RESULTS AND DISCUSSION

1- Plant height and stem thickness

In the first season phosphorus fertilization significantly affected *F. benjamina* plant height and stem thickness as shown in Table 2. The shortest and tallest plant height (34.2 and 41.4 cm respectively) were observed when plants were fertilized with 1 and 4 g/pot of calcium superphosphate. However, plant height was significantly reduced to 38.2 cm when plants were fertilized with the highest concentration of calcium superphosphate. Similar trends of stem thickness were observed by plants which were fertilized with 1g /pot had a stem thickness of 0.28 cm however, plants fertilized with 4 g/pot of calcium superphosphate had the thickest stem (0.36 cm). Stem thickness was reduced to 0.31 cm when plants were fertilized by the highest level of phosphorus. However this value did not significantly differ than that of plants fertilized with 1 or 2 g/pot of calcium superphosphate.

As shown in Table 2 biofertilizers significantly increased plant height and stem thickness in both seasons. There were no significant differences in both parameters between non-biofertilized plants (34.3 and 0.27 cm, respectively) and plants that treated with Biogen (35.1 and 0.29 cm, respectively). All other treatments significantly increased plant height and stem thickness over the control plants. In both seasons there were significant differences in plant height and stem thickness between plants fertilized with phosphorene or Biogen. Plants treated with Microbein + phosphorene had the tallest plant height and stem thickness (41.8 and 0.35 cm, respectively). However, the difference in plant height or stem thickness of plants fertilized with Phosphorene + Biogen or Phosphorene + Microbein were not significant.

The interaction between phosphorus fertilization and biofertilizers was significant, only in the second season , for both measured parameters, with the use of 4 g/pot calcium superphosphate + biofertilizer mixture of Microbein and phosphorene giving the best results.

Table 2: Effect of calcium superphosphate and biofertilizers on plant height and stem thickness of *F. benjamina* plants in two seasons

Biofertilizers (B)	calcium superphosphate (g/pot) (A)									
	1 st season					2 nd season				
	1	2	4	8	Mean B	1	2	4	8	Mean B
Pant height (cm)										
Control	32.0	33.9	36.9	34.3	34.3	31.0	32.6	36.0	33.8	33.4
Bio.	32.6	34.8	38.1	35.0	35.1	31.9	33.9	38.0	35.1	34.7
Mic.	33.6	35.6	39.2	36.6	36.2	33.2	35.4	39.6	36.7	36.2
Phos.	34.5	39.0	43.3	40.1	39.2	34.6	36.8	41.3	38.3	37.7
Bio+Phos	35.5	40.6	44.4	41.1	40.4	35.7	38.1	42.9	39.6	39.1
Mic.+ Phos.	36.8	42.1	46.4	41.8	41.8	36.9	38.8	44.4	41.8	40.5
Mean A	34.2	37.7	41.4	38.2		33.9	35.3	40.4	37.6	
LSD 0.05	A 1.5		B 1.3		AB N.S	A 1.1		B 1.4		AB 2.8
stem thickness (cm)										
control	0.25	0.28	0.31	0.27	0.27	0.24	0.26	0.29	0.27	0.28
Bio.	0.27	0.30	0.34	0.28	0.29	0.26	0.29	0.33	0.27	0.30
Mic.	0.27	0.30	0.35	0.29	0.30	0.27	0.31	0.34	0.29	0.30
Phos.	0.28	0.33	0.36	0.32	0.32	0.28	0.34	0.35	0.31	0.32
Bio+Phos	0.29	0.35	0.38	0.34	0.34	0.29	0.35	0.36	0.33	0.34
Mic.+ Phos.	0.30	0.36	0.40	0.34	0.35	0.31	0.29	0.38	0.34	0.36
Mean	0.28	0.32	0.36	0.31		0.27	0.31	0.34	0.31	
LSD 0.05	A 0.04		B 0.03		AB N.S.	A 0.04		B 0.03		AB 0.7

Bio. = biogen, Mic. = Microbein, Phos. = phosphorene and N.S = not significant

2- Branch and leaf number

In the first season, Table (3) shows that phosphorus fertilization significantly affected both of branch and leaf number of *F. benjamina* plants. There was no significant difference in these parameters between plants fertilized with 2 and 8 g/pot of calcium superphosphate. The largest branch and leaf number/plant (15.3 and 111.2, respectively) were produced when plants were fertilized with 4 g/pot of calcium superphosphate. However, plants fertilized with 8g/pot had branch and leaf number less than plants fertilized with 4 g/pot of calcium superphosphate.

Table 3: Effect of calcium superphosphate and biofertilizers on branch and lea number of *F. benjamina* plants in two seasons

Fertilizers (B)	calcium superphosphate (g/pot) (A)									
	1 st season					2 nd season				
	1	2	4	٨	Mean B	1	2	4	٨	Mean B
Branch number/plant										
control	١٠,٥	١٣,٦	١٣,٧	١٣,٢	١٢,٧	١١,٢	١٢,٩	١٤,٤	١٣,٤	١٣,٠
Bio.	١٠,٨	١٤,٠	١٣,٢	١٣,١	١٢,٨	١١,٧	١٤,٠	١٥,٢	١٤,٠	١٣,٧
Mic.	١٢,٣	١٤,٢	١٣,٢	١٣,١	١٣,٢	١٢,٣	١٥,٠	١٤,٨	١٥,٠	١٤,٣
Phos.	١٣,٥	١٥,٢	١٦,٢	١٤,١	١٤,٧	١٣,٦	١٥,٢	١٧,١	١٤,٧	١٥,١
Bio+Phos	١٤,٠	١٥,٨	١٧,٣	١٥,٠	١٥,٥	١٤,٦	١٦,١	١٨,٠	١٥,٧	١٦,١
Mic.+ Phos.	١٢,٤	١٥,٩	١٨,٤	١٦,٠	١٥,٧	١٥,٨	١٦,٧	١٩,٠	١٦,٠	١٦,٩
Mean A	١٢,٣	١٤,٨	١٥,٣	١٤,١		١٣,٢	١٥,٠	١٦,٤	١٤,٨	
LSD 0.05	A 0.9		B 1.1		AB N S	A 0.4		B 0.5		AB 1.0
Leaf number/plant										
control	٧٢,٨	٩١,٨	٩٤,٣	٨٨,٢	٨٥,٠	٧٥,٢	٨٧.٢	١١٢,٧	٨٩,٦	٩١,٢
Bio.	٧٧,٨	٩١,٨	١٠١,٤	٩٤,١	٩١,٢	٧٩,٥	٩٣,٠	٩٨,٣	٩٤,٠	٩١,٢
Mic.	٨٣,١	١٠٠,٧	١٠٨,٣	١٠١,٠	٩٨,٢	٨٣,٥	٩٦,٥	١٠٥,٠	١٠٠,٤	٩٦,٣
Phos.	٩١,٣	١٠٤,٤	١١٧,٠	١٠٧,٨	١٠٥,١	٩١,٧	١٠٥,٦	١١١,٠	١١٣,٠	١٠٥,٣
Bio+Phos	٩٩,١	١١٠,٦	١١٩,٣	١١٤,٠	١١١,٠	٩٨,٥	١١١,٤	١٢١,٦	١١٨,٣	١١٢,٤
Mic.+ Phos.	١٠٧,١	١١٥,٣	١٢٦,٨	١٢٠,٤	١١٧,٤	١٠٢,٢	١١٩,٤	١٢٨,١	١٢٠,٥	١١٧,٥
Mean A	٨٨,٥	١٠١,١	١١١,٢	١٠٤,٢		٨٨,٤	١٠٢,٢	١١٣,٠	١٠٦,٠	
LSD 0.05	A 5.6		B 6.9		AB N.S	A 4.4		B 5.4		AB 10.8

Bio. = biogen, Mic. = Microbein, Phos. = phosphorene and N.S = not significant

All types of biofertilizers significantly increased branch and leaf number of *F. benjamina* plants. In both seasons the differences in branch or leaf number between non-biofertilized and Biogen fertilized plants was not significant. Also, the differences in branch or leaf number between plants fertilized with Microbein + Phosphorene or Biogen + Phosphorene were not significant except for branch number in the first season. In both seasons plants fertilized with Microbein + Phosphorene had the largest branch and leaf number (e.g. 15.7 and 117.4 respectively in the first season).

The interaction between phosphorus fertilization and biofertilizers was significant, only in the second season for both of branch or leaf number / plant . The highest values were obtained due to the use of 4g/pot calcium superphosphate + Microbein and Phosphorene mixture .

3- Shoot and root biomass

Plants, fertilized with 1 g/pot calcium superphosphate, had significantly the lowest shoot and root biomass of 13.6 and 7.10 g/plant, respectively. Shoot as well as roots biomass of *F. benjamina* plants were significantly increased by increasing levels of calcium superphosphate from 1 up to 4 g/pot thereafter, these values were significantly decreased (Table 4). Biofertilizers significantly increased shoot as well as roots biomass of *F. benjamina*. Plants that were fertilized with Phosphorene had shoot and root biomass (16.5 and 7.9 g/plant) were significantly higher than control or Biogen-fertilized plants. Plants which fertilized with Microbein + phosphorene had significantly the highest shoot biomass of 18.7g/plant. These plants had the highest root biomass of 8.21 g/plant but, this value was not differ significantly than values of plants fertilized with Biogen + Phosphorene.

Table 4: Effect of calcium superphosphate and biofertilizers on dry weights of vegetative and root of *F. benjamina* plants in two seasons

Fertilizers (B)	calcium superphosphate (g/pot) (A)									
	1 nd season					2 nd season				
		2	4	8	Mean B	0	2	4	8	Mean B
control	11.2	13.0	14.5	13.5	13.0	11.6	13.4	15.0	13.7	13.4
Bio.	12.0	14.1	15.7	14.4	14.0	12.3	14.5	15.8	14.4	14.2
Mic.	13.0	15.5	17.2	15.5	15.2	13.0	15.6	17.5	15.4	15.3
Phos.	14.0	16.8	18.6	16.5	16.5	14.2	18.0	19.8	17.3	17.3
Bio+Phos	15.3	17.8	20.2	17.9	17.8	15.2	18.8	21.0	18.1	18.2
Mic.+ Phos.	16.5	18.5	21.4	18.4	18.7	16.5	19.4	22.0	18.4	19.1
Mean A	13.6	16.0	18.0	16.0		13.8	16.6	18.5	16.2	
LSD 0.05	A 0.4		B 0.5		AB 0.9	A 0.3		B 0.4		AB 0.8
	Roots biomass (g)									
control	6.39	6.85	7.50	7.35	7.03	6.87	7.22	7.74	7.11	7.24
Bio.	6.70	7.12	8.30	7.68	7.45	6.98	7.41	7.67	7.27	7.33
Mic.	6.97	7.43	8.66	8.01	7.77	7.20	7.58	8.22	7.68	7.67
Phos.	7.75	7.01	7.06	8.77	7.90	7.28	8.26	9.09	8.39	8.26
Bio+Phos	7.26	7.80	9.00	8.01	8.02	7.44	8.52	9.27	8.60	8.46
Mic.+ Phos.	7.50	7.73	9.33	8.27	8.21	7.74	8.84	9.73	8.75	8.76
Mean	7.10	7.49	8.31	8.01		7.25	7.97	8.62	7.97	
LSD 0.05	A 0.22		B 0.27		AB 0.54	A		B		AB

Bio. = biogen, Mic. = Microbein, Phos. = phosphorene and N.S. = non significant

Under any level of calcium superphosphate plants which fertilized with Microbein + phosphorene had the highest biomass.

The interaction between phosphorus fertilization and biofertilizers was significant in both seasons. The highest shoot and root biomass (21.4 and 9.33 g/plant) were obtained when plants were fertilized with 4 g/pot calcium superphosphate + Microbein + phosphorene. Similar results were obtained in the second season.

4- Chlorophyll a and b content

Plants, fertilized with 1g/pot calcium superphosphate, had significantly the lowest chlorophyll a and b content of 2.734 and 0.899 mg/g, respectively Table (5). While plants, which had 4 g/pot of calcium superphosphate, had the highest content of chlorophyll a and b (2.902 and 0.957 mg/g). There were no significant difference in chlorophyll b content of *F. benjamina* leaves between plants fertilized with 1 or 2 g/pot of calcium superphosphate, in both seasons

Table 5: Effect of calcium superphosphate and biofertilizers on chlorophyll a and b of *F. benjamina* leaves in two seasons

Fertilizers (B)	calcium superphosphate (g/pot) (A)									
	1 st season					2 nd season				
	1	2	4	٨	Mean B	1	2	4	٨	Mean B
	Chlorophyll a (mg/g)									
Control	٢٫٦٢٣	٢٫٧٢٠	٢٫٧٥٠	٢٫٧٢٣	٢٫٧١٩	٢٫٥٤٧	٢٫٦٦٠	٢٫٧٢٧	٢٫٦٤٧	٢٫٦٢٥
Bio.	٢٫٧٦٠	٢٫٨٠٠	٢٫٨٧٣	٢٫٨١٣	٢٫٧٩٤	٢٫٦٤٣	٢٫٦٩٧	٢٫٨٢٣	٢٫٧٠٧	٢٫٧١٨
Mic.	٢٫٧٦٤	٢٫٨١٠	٢٫٨٩٧	٢٫٨١٣	٢٫٨١٥	٢٫٦٦٣	٢٫٧٢٧	٢٫٨٥٣	٢٫٧٢٧	٢٫٧٤٣
Phos.	٢٫٧٧	٢٫٨٤٠	٢٫٩٢٣	٢٫٨١٧	٢٫٨٣٧	٢٫٦٦٣	٢٫٧٦٠	٢٫٨٨٧	٢٫٧٦٠	٢٫٧٦٢
Bio+Phos	٢٫٧٧٣	٢٫٨٧٧	٢٫٩٥٧	٢٫٨٢٣	٢٫٨٨٧	٢٫٧٨٠	٢٫٧٨٠	٢٫٩٣٠	٢٫٨٣	٢٫٨٣١
Mic.+ Phos.	٢٫٧٨	٢٫٨٧٧	٢٫٩٧٣	٢٫٨٣	٢٫٨١٥	٢٫٧٩٠	٢٫٨١٠	٢٫٩٤٠	٢٫٨٥٣	٢٫٨٤٨
Mean	٢٫٧٢٤	٢٫٨٣٩	٢٫٩٠٢	٢٫٨٠٥		٢٫٦٨٩	٢٫٧٣١	٢٫٨٦٠	٢٫٧٤٩	
LSD 0.05	A 0.028		B 0.035		AB N.S	A 0.035		B 0.045		AB 0.069
	Chlorophyll b (mg/g)									
Control	٠٫٨٤٦	٠٫٨٧٠	٠٫٩١٦	٠٫٨٧٩	٠٫٨٨١	٠٫٨٧٧	٠٫٩٠٨	٠٫٩٤٩	٠٫٩٠٦	٠٫٩٠٩
Bio.	٠٫٨٧٩	٠٫٨٩٩	٠٫٩٤٤	٠٫٨٩٩	٠٫٩٠٥	٠٫٩٠٣	٠٫٩٢٢	٠٫٩٥٧	٠٫٩٢٠	٠٫٩٢٦
Mic.	٠٫٨٨٨	٠٫٩١٠	٠٫٩٤٤	٠٫٩٠٥	٠٫٩١٤	٠٫٩١٤	٠٫٩٢٨	٠٫٩٦٤	٠٫٩٢٣	٠٫٩٢٨
Phos.	٠٫٩٠٩	٠٫٩٢٢	٠٫٩٤٥	٠٫٩١٧	٠٫٩٢٨	٠٫٩٢٤	٠٫٩١٦	٠٫٩٧٣	٠٫٩٢٦	٠٫٩٤٥
Bio+Phos	٠٫٩٢٦	٠٫٩٢٧	٠٫٩٧٧	٠٫٩٢٦	٠٫٩٤٢	٠٫٩٢٦	٠٫٩٤٦	٠٫٩٨٤	٠٫٩٢٧	٠٫٩٤٣
Mic.+ Phos.	٠٫٩٢٦	٠٫٩٢٧	٠٫٩٨٤	٠٫٩٤٧	٠٫٩٥٠	٠٫٩٢٩	٠٫٩٦٦	٠٫٩٨٩	٠٫٩٢٤	٠٫٩٥٢
Mean	٠٫٨٩٩	٠٫٩١١	٠٫٩٤٧	٠٫٩١٣		٠٫٩١٣	٠٫٩٤١	٠٫٩٦٦	٠٫٩٢٠	
LSD 0.05	A 0.056		B 0.069		AB N.S	A 0.056		B 0.069		AB 0. 112

Bio. = biogen, Mic. = Microbein, Phos. = phosphorene and N.S. = non significant

Plants that received no biofertililizers had the lowest chlorophyll a and b content (2.719 and 0.881 mg/g respectively). All biofertilizers treatments significantly increased chlorophyll a and b content of *F. benjamina* leaves over the control plants. No significant difference in chlorophyll a or b content between plants fertilized with phosphorene or Microbein in both seasons. There was no significant difference in chlorophyll b content between control plants and all other biofertilizers treatments except when plants were fertilized with Microbein + Phosphorene.

The interaction between phosphorus fertilization and biofertilizers was significant only in the second season with the use of 4g/pot calcium superphosphate + a mixture of Microbein and phosphorene giving the highest chlorophyll a and b contents .

5- Nitrogen and phosphorus %

In the first season no significant differences were observed in the percentage of nitrogen content of *F. benjamina* leaves due to phosphorus fertilization or biofertilizers. Also, no significant interaction between both of studied factors was observed. In the second season (Table 6) shows a significant difference in N% due to phosphorus fertilization. Plants, fertilized with 4 g/pot of calcium superphosphate had the highest N% (3.106 %) which was significantly higher than plants fertilizes with 1 g/pot calcium superphosphate.Biofertilizers had no significant effect on N percentage of *F. benjamina* leaves. However, all biofertilizer treatments had N% higher than the control plants. There was no significant interaction between phosphorus fertilization and biofertilizers.

The percentage of P of *F. benjamina* leaves significantly increased from 0.848 to 0.914 when plants were fertilized with 4 g/pot of calcium superphosphate rather than one g/pot. All other calcium superphosphate treatment had no significant difference in % of phosphorus. However, Table (6) shows that plants fertilized with 8 g/pot calcium superphosphate had P% lower than plants fertilized with 4 g/pot calcium superphosphate. Biofertilizers had no significant effect on % of P in both seasons.

Table 6: Effect of calcium superphosphate and biofertilizers on N and P% of *F. benjamina* leaves in two seasons

Fertilizers (B)	Calcium superphosphate (g/pot) (A)									
	2 nd season					2 nd season				
	1	2	4	8	Mean B	1	2	4	8	Mean B
					N %					
Control	3.013	2.990	3.030	3.000	3.085	3.020	3.050	3.073	3.000	3.036
Bio.	3.020	3.030	3.050	3.020	3.030	3.030	3.070	3.080	3.010	3.047
Mic.	3.030	3.037	3.053	3.030	3.064	3.040	3.070	3.090	3.020	3.056
Phos.	3.060	3.030	3.000	30.37	3.092	3.070	3.080	3.113	3.053	3.079
Bio+Phos	3.080	3.090	3.120	3.080	3.101	3.070	3.100	3.130	3.080	3.095
Mic.+ Phos.	3.030	3.090	3.140	3.083		3.080	3.110	3.150	3.060	3.000
Mean	3.08	3.046	3.082	3.042		3.050	3.081	3.106	3.037	
LSD 0.05	A N.S	B N.S		AB N.S		A 0.056		B N.S.	AB: N.S.	
					P%					
Control	0.820	0.850	0.873	0.863	0.852	0.830	0.860	0.833	0.893	0.867
Bio.	0.846	0.877	0.903	0.887	0.877	0.853	0.890	0.917	0.893	0.888
Mic.	0.863	0.900	0.900	0.893	0.889	0.863	0.907	0.923	0.893	0.897
PFhos.	0.833	0.860	0.927	0.880	0.875	0.837	0.897	0.893	0.833	0.877
Bio+Phos	0.857	0.897	0.933	0.903	0.897	0.850	0.910	0.927	0.897	0.897
Mic.+ Phos.	0.873	0.920	0.947	0.920	0.915	0.870	0.920	0.867	0.910	0.892
Mean	0.848	0.884	0.914	0.891		0.851	0.897	0.902	0.895	
LSD 0.05	A 0.056	B N.S.		AB 0.112		A 0.056		B N.S	AB 0. N.S.	

Bio. = biogen, Mic. = Microbein, Phos. = phosphorene and N.S. = non significant

However, the interaction between P fertilization and biofertilizers was significant in the first season only. A significant difference in percentage of P was observed only when plants were fertilized with the 4 g/pot of calcium superphosphate + Microbein + Phoasphorene rather than non biofertilizer treatment + the lowest level of calcium superposphate.

DISCUSSION

Present study showed that the growth of *F. benjamina* seedlings was significantly affected with calcium superphosphate fertilization. Plant height, stem thickness, branch and leaf number, shoot and root biomass were increased by calcium superphosphate rates from 1 to 4 g/pot due to application of the most suitable dose of calcium superphosphate. Whereas all these parameters were decreased when calcium superphosphate was raised up to 8 g/pot. The negative effect of the highest level of calcium superphosphate reflects the crucial of nutrient concentration in the soil, which affect the nutrient use efficiency, (Turvey *et al.*, 1992)

Several studies have demonstrated that phosphorus fertilization promotes establishment and increases biomass production of woody species (Hawkins *et al.*, 2000). Moreover, Thomas and Teoh (1983) on *F.*

macrophylla, Ahmad (1995) on *Leucaena leucocephala* , Abd El-Aziz (2000) on *Azadirachta indica* and Abdou and El-Sayed (2002) on *Peltophorum* has shown the beneficial effect of phosphorus on vegetative growth. Phosphorus fertilization significantly increased chlorophyll a and b content as well as the N and P% of *F. benjamina* plants. Marler *et al.*, (2001) treated *Populus fremontii, Salix gooddingii*, and *Tamarix ramosissima* seedlings with different levels of phosphorus and found that all species grew significantly taller, produced more leaves or stems, produced greater biomass and had the higher concentration of phosphorus. 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 (Plaxton and Carswell , 1999 and Raghothama ,1999).

Biofertilizers improved *F. benjamina* seedling growth. However, there were a significant difference between the different types of biofertilizers and the control plants. Most estimated parameters were not significantly increased when plants were fertilized with Biogen. Phosphorene was more efficient as a biofertilizer than Biogen. The significant difference between different types of biofertilizers is an expected result as these biofertilizers contain different types and different strains of microorganisms. Among the evaluated biofertilizers Microbein was the most efficient biofertilizer for improving *F. benjamina* growth. All growth parameters of Microbein-fertilized plants were significantly higher than control or biogen-fertilized plants. Biofertilizers containing *Azotobacter* and *Azospirillum* have been widely tested with non-legumes under field condition in different agrclimatic regions. These field trials which indicated growth improving of different trees as well as their either nutritional status have been reviewed (Subba-Rao, 1991; Mansour, 1998 and Wani and Lee, 2002). Kannaiyan, (2002) revealed that this impact of biofertilizers in plant growth is attributed to the role of these microorganism in nitrogen fixation, P mobilization as well as the secretion of growth promoting substance.

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دراسات فسيولوجية على نباتات الفيكس بنجامينا

٢: تأثير التسميد الفوسفورى و الأسمدة الحيوية على نمو الشتلاتص

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تمثل نباتات الفيكس بنجامينا و التى تعرف باسم التين الباكى أهميه كبيرة كأشجار ظل كما أن لها أهمية فى التنسيق الداخلى. وحيث أن نمو النباتات عموما يتأثر تأثرا كبيرا بالتسميد فقد أجريت هذه التجربة فى عامى ٢٠٠٢ ، ٢٠٠٣ لدراسة تأثير التسميد الفوسفاتى وكذلك بعض مصادر التسميد الحيوى على نمو شتلات الفيكس بنجامينا عمر سنه واحدة. ولقد تم زراعة الشتلات فى أصص فخارية مملوءة بـ ٨ كجم تربه مكونه من الرمل والبيت موسى بنسبه ٩٥ : ٥. تم خلط السماد الفوسفاتى فى التربة قبل نقل الشتلات إليها بمعدل ١ ،٢، ٤، ٨ جم / نبات من سوبر فوسفات الكالسيوم وكذلك تم إضافة ٥ جم من المستحضر التجارى بيوجين - ميكروبين - فوسفورين - بيوجين + فوسفورين - ميكروبين + فوسفورين بالإضافة إلى معامله غير ملقحه.

أظهرت النتائج أن كل من السماد الفوسفاتى والأسمدة الحيوية لها تأثير معنوى على نمو الشتلات وكذلك محتواها من النتروجين والفوسفور وكذلك الكلوروفيل أ و ب. وكانت هناك زيادة فى طول النباتات - قطر الساق - عدد الأفرع وكذلك الأوراق بزيادة معدل أضافه السوبر فوسفات من ١ إلى ٤ جم / نبات. ثم حدث انخفاض فى هذه المقاييس عند أضافه ٨ جم / نبات من سماد السوبر فوسفات الكاسيوم. وكان الميكروبين افضل الأسمدة الحيوية منفردا حيث كانت هناك زيادة فى معظم هذه المقاييس. أما البيوجين فلم يؤدى إلى تحسن كبير فى معظم المقاييس مقارنا مع النباتات الغير معاملة. أشارت النتائج إلى أن أكثر النباتات طولا وأكبرها قطرا والتي تحمل أكبر عددا من الأفرع والأوراق وأكبر وزنا بالنسبة للمجموع الخضري والجذري قد حدثت نتيجة لتسميد النباتات بـ ٤ جم / نبات سوبر فوسفات الكالسيوم + الميكروبين + الفوسفورين. ومن ثم توصى الدراسة بتسميد شتلات الفيكس بنجامينا النامية في هذه التربة بهذه المعدلات السمادية للحصول على أعلى معدلات من النمو.