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Impact of Nitrogen and Phosphorus Sources on Growth Efficiency of *Melia Azedarach* and *Populus Euphratica* in Wadi El Natrun, Egypt

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Abstract— **A Field experiment was conducted in Wadi El Natrun from 2010 to 2012 to examine the effects of mineral nitrogen (N) and phosphorus (P) and their combination (N+P) as well as biofertilizers namely phosphorene and nitrobin on vegetative growth, biomasses, content and uptake of N, P and K in leaves of Melia *azedarach* and *Populus euphratica* seedlings. Five fertilizer treatments in addition to no fertilized seedlings used as control were laid out in a complete randomized design with three replicates. Ammonium sulfate and super phosphate were added at a rate of 80 and 100 kg fed^{-1}, respectively.**

The result clearly showed that growth response of both species in terms of height, stem diameter, leaves fresh weight , leaves dry weight, stem fresh weight, stem dry weight as well as NPK content and uptake in leaves were increased by the proposed fertilization treatments compared with control. However, the growth response was vary according to treatment and species used. Nevertheless, (N+P) application enhanced the growth efficiency of *Melia azedarach* through increasing the vegetative growth, biomass and content and total uptake of N, P and K in leaves. Whereas, phosphorene was the least among the fertilizer sources, except for height and P content in leaves, which were increased progressively. In case of *Populus euphratica*, (N) and (N+P) were the highest for increasing the growth and biomasses as well as content and total uptake of foliar N, P and K. Similarly, heights and N content in leaves were responded considerably by phosphorene. Moreover, seedlings of both species were responded more, in most cases, for mineral (N, P, or N+P) than biofertilizers, suggesting that the poor status of the soils used could be the cause. The overall results suggest that the response of seedling species to fertilization will vary depending on soil properties and the species used. Under the condition of this study N and N+P fertilization are recommended in *Populus euphratica and Melia azedarach* plantation, respectively, in Wadi El Natrun district.

***Index Terms— Melia azedarach, Populus euphratica,* Nitrogen, Phosphorus**

I. INTRODUCTION

Establishment stage is that the tree concentrates growth on both root system development and top growth. Maintaining nutrition to achieve the highest growth rates possible is more critically important for the new establishing tree seedlings especially, when they are planted at desert condition such as Wadi El Natrun. Plantations can be established where adequate nutrition and appropriate fertilization are essential for successful establishing. Nitrogen and phosphorus fertilization is a common management tool to increase growth of forest trees on poor sites [1]. It is often reported that tree growth is limited by nutrient availability, particularly nitrogen [2] in areas with high N deposition [3]. High foliar nitrogen concentration is associated with high rates of photosynthesis and thus high tree productivity. Nitrogen (N) is often a limiting resource in forest ecosystems and N fertilization frequently results in increased photosynthesis and enhanced growth.

Phosphorus is the second major fertilizer after nitrogen and is supplied to the soil mainly as superphosphate. Adding P as superphosphate is precipitated rapidly to insoluble phosphate form .Phosphorus ions in soil is quite immobile element and most of the fertilizer phosphate applied is unavailable for plant uptake. In spite of the considerable addition of phosphorus to soil, the amount available for plant is usually low because, the availability of this nutrient for plants is limited by different chemical reactions especially in arid and semi-arid soils [4]. Phosphorus plays a significant role in several physiological and biochemical plant activities like photosynthesis, transformation of sugar to starch and transporting of the genetic traits. [5] reported that the advantages of feeding the plants with phosphorus are creating deeper and more abundant roots.

Bio-fertilizer can play an important role in improving plant growth and phosphate uptake efficiency by releasing phosphorus from rock or tri-calcium phosphate. The inoculation provided by microorganisms enhances an abundant population of active and effective microorganisms to the root activity zone which increases plant ability to uptake more nutrients. Phosphate dissolving bacteria are able to affect the solubility of low dissolvable inorganic acids and able to release phosphorus from phosphorus organic compounds by producing phosphate enzymes. Phosphate solubilizing bacteria not only release phosphorus but also produce other biological

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compounds like hormones such as auxin and gibberellic acid as well as vitamins. Many investigators reported that phosphate dissolving bacteria enhance vegetative growth, improve fruit yield and increase nutrient uptake [6-8]. *Azotobacter sp,* are free-living aerobic bacteria dominantly found in soils, present in alkaline and neutral soils. They are non- symbiotic heterotrophic bacteria capable of fixing an average 20kg N/ha/year. Besides, it also produces growth promoting substances (IAA and other auxins, such as (gibberllins and cytokinins) and vitamins. *Azotobacter* is capable of converting nitrogen to ammonia, which in turn is taken up by the plants and is shown to be antagonistic to pathogens [**9** and 10] **.**

Melia azedarach is a species of deciduous tree in the mahogany family Meliaceae. The adult tree has a rounded crown, and commonly measures attain a height of 7–12 meters.. The main utility of chinaberry is its timber. This is of medium density, and ranges in colour from light brown to dark red.. *Melia azedarach* in keeping with other members of the family Meliaceae has a timber of high quality, but as opposed to many almost-extinct species of mahogany it is under-utilized [11] *Populus euphratica* tree is a medium-sized deciduous tree that may grow to a height of about 15 m and a girth of 2.5 m where conditions are favorable. The stem is typically bent and forked; old stems have thick, rough, olive-green bark. While the sapwood is white, the heartwood is red, darkening to almost black at the centre. It grows well on land that is seasonally flooded and is tolerant of saline and brackish water. It is used in agroforestry to provide leaves as fodder for livestock, timber and, potentially, fiber for making paper. It is also used in afforestation programs on saline soils in desert regions, and to create windbreaks and check erosion [12 and 13].

The objective of this study is evaluating different sources of nitrogen and phosphorus on growth of *Populus euphratica* and *Melia azedarach* seedlings as well as, the content and uptake of N, P, K in leaves of both species were evaluated.

II. MATERIALS AND METHODS

Study Site

This study was applied at the resort of Al- Ezbaa Investment Company, 46 Km from El- Alamien road, and Wadi El Natrun district, Egypt from March 2010 to October 2012. One sector of this area about 6 Fed was used for this experiment. The climate of this area as whole area of Wadi El Natrun is characterized by an extreme arid condition where the mean annual rainfall, evaporation and temperature are 41.4 mm, 114.3 mm and 21ºC, respectively. The soil of the studied area is sandy in texture and organic matter content is low and so, accordingly, are the total N and Available P. The soil physical and chemical properties are given in **Table 1**. The origin of the underground water in the area is seepage from the Nile stream, due to its proximity and low level. **Table 2** shows the chemical analysis of the irrigation water used in this study.

Experimental procedure

One-year-old seedlings of *Melia azedarach* and *Populus euphratica* were used for this study; *Melia* averaged 45 cm in height and 29 mm in diameter, while, *Populus* averaged 40 cm in height and 81 mm in diameter. Stem diameter was conducted at 5 cm from the soil surface. On April 2010, the seedlings of *Melia azedarach* and *Populus euphratica* were planted at three feddans per each species with 4X4 m distance in-between. The seedlings were supported against the wind using woody sticks.

The studied treatments were: control, ammonium sulfate (N), super phosphate (P), ammonium sulfate + super phosphate (N+P), nitrobin and phosphorene. These six fertilizer treatments were tested for *Melia azedarach* and *Populus euphratica*. Super- phosphate (15.5 % P_2O_5) was added one time before seedlings plantation at a rate of 500 g/seedling. Ammonium sulfate (20.6 % N) was added at a rate of 250 g /seedling which divided in three equal doses after 30, 60 and 90 days from planting around the stem. A basic application of potassium sulfate (48% K_2O) was added at a rate of 250 g/seedling that divided in two equal doses during the growing period. Nitrobin and phosphorene biofertilizers were added as recommended and mixed thoroughly with the root-zone soil of each seedling directly during planting. Nitrobin and phosphorin are commercial biofertilizers for N-fixing bacteria (*Azotobacter chroococcum*) and P- dissolving bacteria (*Bacillus megaterium phosphaticum*) bacteria, respectively. The biofertilizers were supplied by Soil, Water, and Environment Res. Institute, ARC, Egypt.

In October of 2010 stem height was initially measured to the nearest centimeter using a meter stick and basal diameter was measured at 5 cm above the ground line to the nearest millimeter using a caliper diameter at ground level of selected seedlings were recorded. Also, at the end of study (November 2012) the stem height and diameter of above mentioned seedlings were measured. Furthermore, two random seedlings of each replicate were harvested and then both fresh and dry biomasses of leaves and stems were determined. After that, dried leaves ground with a tissue grinder and stored in sealed paper bags for chemical analysis.

Statistical analysis

Data obtained were analyzed by one way ANOVA randomized complete blocks design with three replicates. Then, means were compared by Duncan's multiple range tests at 0.05 probability using CoStat software.

Analytical methods

To determine the various physical and chemical soil properties of the study site, representative soil samples were taken from 0–30 cm depth before planting. These samples were air-dried, sieved through a 2-mm screen, and analyzed. Soil physical and chemical properties were analyzed using the procedures described by **Klute *et. al*.** [14] **and Page *et. al*.** [15]**.** Nitrogen, phosphorous and potassium content in leaves were measured by methods recommended by **Chapman and Pratt** [16].

Table (1).
Some physical and chemical properties of the planting soil

Soil characteristics	value
Physical properties	
Sand %	89
Silt %	5
Cay %	6
Texture	Sand
Chemical properties	
E.C. dS/m (1: 2.5 soil :water ratio)	1.6
pH (1: 2.5 soil :water ratio)	7.51
$CaCO_3$ %	2.80
O.M %	0.034
Total N %	0.022
Available P (Olsen), mg/kg soil	2.20
Soluble cations, meq/ l	
Ca^{2+}	4.0
Mg^{2+}	4.0
Na^{+}	7.5
K^{+}	0.2
Soluble anions , meq/l	
HCO^{-}_3	3.0
Cl^{-}	12.5
SO^{--}_4	0.20

Table (2)
Average of chemical analysis of the irrigation water throughout two successive seasons

E.C. dS /m	pH	*(a) Soluble cations (meq /l)*				*(b) Soluble anions (meq /l)*				SAR*
		K^{+}	Na^{+}	Mg^{2+}	Ca^{2+}	SO_4^{2-}	Cl^{-}	HCO_3^{-}	CO_3^{2-}	
2.58	8.3	0.27	23.94	3.53	2.57	5.45	18.60	3.68	–	13.16

* SAR= $Na^{+}/[(Ca^{2+}+Mg^{2+})/2]^{1/2}$, all contents are expressed in meq/l

III. RESULTS AND DISCUSSION

Effect of fertilizer sources on vegetative growth

Melia azedarach

The fertilizer sources were differed significantly in their effect on height growth and stem diameter of *Melia azedarach* seedlings after two seasons (**Fig. 1**). Phosphorene was the superior source that increased the height growth by 33.3% compared with control treatment. The next higher effect was obtained from ammonium sulfate plus super phosphate (N+P) source that increased the height growth by 30.6% more than control. Next it followed by superphosphate (P), nitrobin and ammonium sulfate (N) that increased the height growth by 27.6, 11.8 and 9.2% more than control, respectively. In contrast, (N+P) source had the highest effect on stem diameter of *Melia azedarach* that was 47.2% wider than control, followed by (N) and (P) sources that increased the stem diameter by 37.2 and 22.2 % more than control, respectively. The poorest effect was obtained from phosphorene (Ph) source that was not differing significantly with control.

Populus euphratica

Fertilizer sources were differed significantly according to their effect on height growth and stem diameter of *Populus euphratica* seedlings after two seasons (**Fig. 2**). Nitrobin was the best source that increased the height growth by 21.1% more than control treatment, then, (P) and (N+P) sources that increased the height growth by 10.6 and 10.4%, respectively, more than control. Then, it followed by phosphorene that increased the height growth by 6.5% more than control. On the other hand, (N+P) source recorded the wider stem diameter of *Populus euphratica* which was 12.7% more than control (**Fig.2**). Ammonium sulfate (N) was the next fertilization source that increased the stem diameter by 9.8% more than control. Phosphorene, super- phosphate (P) and nitrobin had the least effect on stem diameter that recorded 5.5, 5.2 and 4.0% more than control, respectively.

Phosphorus appears to be an effective fertilization element that enhance the height growth of *Melia azedarach* that is in parallel with [17] who studied the effects of phosphorus fertilization at time of planting and soil type on *Acacia koa* growth for three years therefore, they found that phosphorus, at rates of at least 300 kg P ha^{-1}, significantly increased height and basal stem diameter. They concluded that N increased overall diameter at breast height (dbh) growth, and P increased height growth. 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 [18 and 19].

Table (3).
Effect of different fertilizer sources on fresh and dry biomasses of both *Melia azedarach* and *Populus euphratica* after two successive seasons

Fertilizer source	LFW (g)	LDW (g)	SFW (g)	SDW (g)
		Melia azedarach		
Control	76.50 e	38.94 f	89.60 f	41.34 f
N	325.00 c	115.21 c	670.00 b	376.82 b
P	130.00 d	65.30 d	290.00 d	191.91 d
N+P	630.00 a	205.63 a	1800.00 a	1167.35 a
Nitrobin	360.00 b	128.71 b	540.00 c	322.90 c
Phosphorene	83.00 e	56.83 e	110.00 e	75.50 e
		Populus euphratica		
Control	930.00 c	461.28 d	985.00 e	797.85 b
N	3800.00 a	2090.15 a	5880.00 a	3474.55 a
P	1000.00 c	451.50 d	1585.00 d	1114.50 b
N+P	3800.00 a	1850.65 b	4730.00 b	3277.21 a
Nitrobin	2010.00 b	924.62 c	3020.00 c	2006.41 b
Phosphorene	970.00 c	485.73 d	630.00 f	455.54 b

Means followed by a similar letter within a column are not significantly different at the probability level 0.05 using Duncan's Multiple Range Test.

Effect of fertilizer sources on leaves and stems biomass

Melia azedarach

Table (3) shows that, the highest values of biomass characters expressed as fresh and dry weight of leaves and stems were obtained from application of (N+P) treatment (630.00 and 205.63 g for leaves) and (1800.0 and 1167.35 g for stems), respectively. Afterward, both fresh and dry weights of *Melia azedarach* leaves increased by nitrobin fertilizer source that were 360.00 and 128.71 g, respectively followed by ammonium sulfate (N) then super phosphate (P). Conversely, (N) addition had the next higher of both fresh and dry weights of seedling stems (670.00 and 376.82 g, respectively) followed by nitrobin then superphosphate (P) fertilizer. However, phosphorene had the least effect of fresh and dry biomasses of leaves and stems compared with other fertilizer sources.

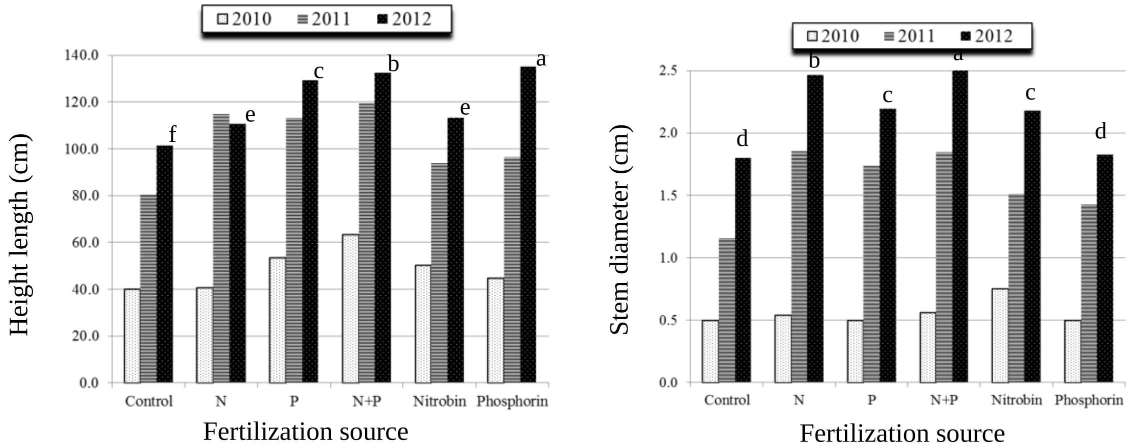

Figure 1. Effect of different fertilizer sources on height and diameter of *Melia azedarach* seedling after two successive seasons

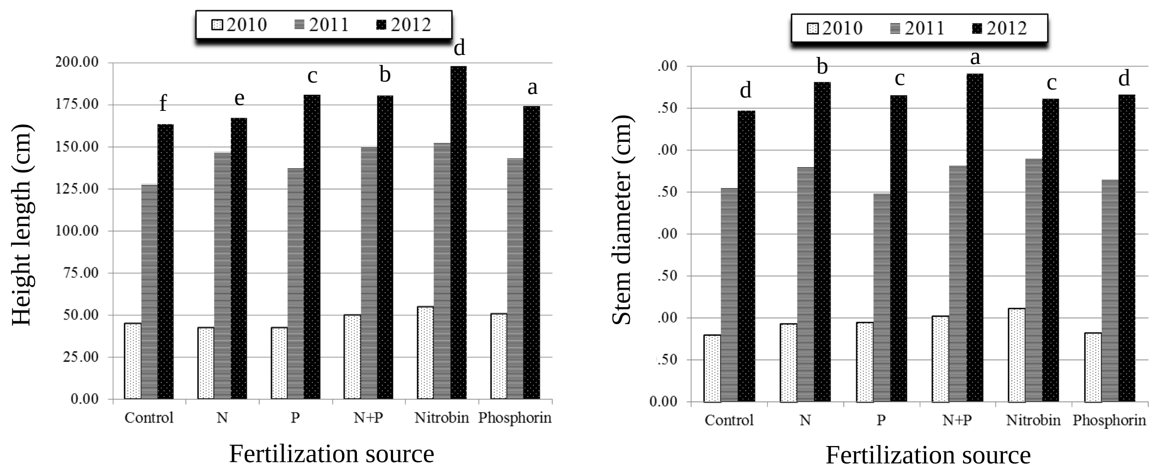

Figure 2. Effect of different fertilizer sources on height and diameter of *Populus euphratica* seedling after two successive seasons

Populus euphratica

Data in **Table (3)** show that ammonium sulfate (N) was superior in giving biomass characters of *Populus euphratica* expressed in terms of leaves fresh and dry weights (3800.0 and 2090 g, respectively). Whereas, the heaviest stems fresh weights (5880.0 and 4730.0 g) as well as, stem dry weights (3474.55 and 3277.21 g), were obtained with ammonium sulfate (N) and (N+P) respectively. The phosphorene fertilizer gave the lowest values for fresh and dry weights of leaves or stems.

This result was matched with [20] who found that after one year of N fertilization, the total biomass of Douglas-fir seedlings was increased. Also, [21] treated *Azadirachta indica* with different rates of N and P and found that only nitrogen had a significant effect on seedling biomass. The superior effect of nitrogen sources (N, N+P and nitrobin) may attributed that nitrogen is a major component in all proteins and pigments that involved in photosynthesis with a large proportion of foliar N distributed between photosynthetic machinery associated with both light and dark reactions [22] Also, **Ripullone *et al.*** [23] **Manter *et al.*** [20] **and Bown *et al.*** [24] concluded that the photosynthetic parameters such as maximum carboxylation capacity and maximum electron transport are strongly correlated with foliar N content. Meanwhile the planting soil is virgin which was poor in minerals content and organic matter which maybe explain the slight effect of phosphorene fertilizer. **Kim *et al.*** [25] indicated that the population of phosphorus solubilizing bacteria depends on cultural activities and different soil properties (physical and chemical properties, organic matter and soil phosphorus content).

Effect of fertilizer sources on content and uptake of N, P, and K in leaves

Data presented in Table 4 show the effect of mineral N, P and their combination as well as microbial inoculation with nitrobin and phosphorene on content and uptake of N, P, and K in leaves of *Melia azedarach* and *Populus euphratica***.**

Melia azedarach

The results revealed that nitrogen application did not affect N content in leaves. Moreover, N content in leaves was the highest under super-phosphate followed by (N+P) treatment. Fertilizer treatments significantly increased P content in leaves compared with control, but no significant differences were found between fertilizers sources regarding P content. The highest level of K content in leaves occurred in N treated seedlings, while phosphorene treatment was the least.
Application of fertilizers sources to seedling significantly increased N absorption in leaves with varying degree. Combining ammonium sulfate plus super phosphate (N+P) gave the highest values of foliar nitrogen, phosphorous, and potassium contents recorded 6.09, 0.21, and 5.63 g, respectively, followed by nitrobin which gave 3.31, 0.11 and 2.52 g, respectively. Finally, phosphorene recorded the least foliar nitrogen, phosphorous, and potassium uptake reached to 1.26, 0.06, and 1.38 g, respectively.

Populus euphratica

Again, nitrogen content in leaves was not affected by nitrogen application, while phosphorene treatment showed the highest level of N content. The lowest value N content was recorded for nitrobin treatments. Phosphorus content in leaves was the highest under nitrogen treatment (N) or under nitrogen + superphosphate treatment (N+P), while was the least under phosphorene treatment. Potassium content in leaves was the highest under nitrogen fertilizer treatment, while it was the lowest under phosphorene fertilizer.

Table (4) also, demonstrated that nitrogen sulfate (N) fertilizer source increased the N, P, and K in *Populus euphratica* leaves compared with control. Uptake of foliar N , P and K were the highest due to ammonium sulfate (N) application (36.58, 2.61 and 70.23 g, respectively). Then, ammonium sulfate plus super phosphate (N+P) that recorded 27.20, 2.55, and 54.22 g, respectively for foliar N, P, and K uptake. Foliar N and P uptake were not significantly differed due to Superphosphate (P), nitrobin and phosphorene applications.

Because N is the most important factor for plant growth in many soils, the application of N fertilizer usually results in large increases in shoot dry weight. Unless accompanied by increased mineral absorption rates, N-fertilizer-induced increases in shoot dry weight may dilute the contents mineral elements in shoots [26].

Table (4).
Effect of different fertilizer sources on content (g/kg) and total uptake (g) of N, P, and K in leaves of *Melia azedarach* and *Populus euphratica* after two successive seasons

Fertilizer source	Nutrient content (g/kg)			Nutrient uptake (g)		
	N	P	K	N	P	K
			Melia azedarach			
Control	22.4d	0.40c	27.40b	0.87 e	0.01d	1.07e
N	22.4d	1.10a	28.20a	2.58 c	0.13b	3.25b
P	33.4a	1.10a	19.90d	2.18 c	0.07c	1.30d
N+P	29.6b	1.00ab	27.40b	6.09 a	0.21a	5.63a
Nitrobin	25.7c	0.90b	19.60e	3.31 b	0.11b	2.52c
Phosphorene	22.2e	1.00ab	24.20c	1.26 d	0.06c	1.38d
			Populus euphratica			
Control	17.3b	0.50c	33.20b	7.98c	0.23b	15.31d
N	17.5b	1.30a	33.60a	36.58a	2.61a	70.23a
P	16.6c	0.80b	31.70c	7.49c	0.34b	14.31e
N+P	14.7d	1.40a	29.30d	27.20b	2.55a	54.22b
Nitrobin	7.9e	0.60c	27.40e	7.30c	0.58b	25.33c
Phosphorene	18.0a	0.50c	29.30d	8.74c	0.24b	14.23e

Means followed by a similar letter within a column are not significantly different at the probability level 0.05 using Duncan's Multiple Range Test.

In the present study, as growth increased with N fertilizer treatment, leaves concentrations of N slightly affected or decreased in leaves of both species, although those soils used have very low N-content (0.03%). Phosphorous and potassium fertilizers were applied in a band near the seedlings. Thus these elements were readily available for root absorption, even in plants given no N fertilizer. If nitrogen fertilizers applied, root growth as well as the volume of soil explored by roots, uptake of soil-immobile nutrient elements may increase [26] **.** The results showed that N fertilizer application increased growth and also increased leaves P and K. This synergistic response between growth in terms of dry weight accumulation and K and P accumulation may have been the result of greater root growth and metabolic activity as N fertilizer applied. The results of N fertilizer effects on growth parameters and content and uptake of NPK were more evident in *Populus euphratica compared with Melia azedarach.*

IV. CONCLUSION

Application of biological nitrogen fertilizer only without mineral N- fertilizer increased growth and mineral contents of studied species through N-fixation either directly by inoculants strains or indirectly by stimulating activity of associated rhizosphere community. However, there was a lack of response of growth and foliar nutrient contents to bio-fertilizer used (in most cases) in this study the poor fertility status of the soil used could be the cause. In conclusion, under the condition of this study N and P fertilization are recommended in *Populus euphratica and Melia azedarach* plantation in Wadi El Natrun region.

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