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EFFECT OF NPK FERTILIZATION AND MICRONUTRIENTS ON *DELONIX REGIA* SEEDLINGS GROWN IN SANDY SOIL

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ABSTRACT: A pot experiment was carried out to study the effect of different NPK fertilization rates and various Mn and Zn treatments on sandy soil-grown *Delonix regia* seedlings at the Nursery of Fac. of agric., Minia Univ. during 2016 and 2017 seasons.

The obtained results showed that following: all studied vegetative growth characters, i.e. plant height, stem thickness, crown diameter and leaves, stem and roots dry weights, as well as, the three photosynthetic pigments and leaves % of N, P and K were gradually increased upward parallel to the increase in the applied rate of NPK fertilizers. Similarly, the prementioned vegetative growth and chemical parameters were augmented due to the use of Mn + Zn micronutrient treatments with the effective one being Mn 75 ppm + Zn 75 ppm. It was found that supplying the seedlings with either the medium or high NPK rate combined with Mn at 75 ppm + Zn at 75 ppm was capable of producing the best growth of *Delonix regia* seedlings grown in sandy soil.

Key words: *Delonix regia*, NPK fertilization, Mn, Zn, vegetative growth, photosynthetic pigments.

INTRODUCTION

The nutritional requirements, in term of macro and microelements, for many ornamental trees grown in clay and loamy soils, had been extensively carried out. However, those grown under sandy soil conditions deserve more investigations, especially in Egyptian new towns and villages extended in the newly reclaimed regions.

Delonix regia (royal poinciana) is one of the most popular shady ornamental trees. It is the most popular shady ornamental trees. It is fast growing deciduous tree reaching 6-12 m. height. Leaves are 30-50 cm long with 20-40 pairs of oblong leaflets. The tree is almost completely covered with red showy flower 6-10 cm across during summer and autumn. In addition to the very nice structural tent-like canopy 8-10 m across.

The distinctive roles of N, P and K fertilizers in enhancing the various vegetative growth characters and stimulating chemical constituents of different ornamental woody plants were found by Badran *et al*. (2003) on *Acacia saligna*, Ali (2005) on *Sterculia diversifolia*, Abdou *et al.* (2006) on *Khaya senegalensis*, El-Sayed *et al*. (2006) on *Dalbergia sissoo*, Badran *et al.* (2008) on *Koelreuteria paniculata*, Shetta *et al.* (2014) on Leucaena, Abd-Elmola (2014) on poplar and Badran *et al.* (2016) on *Moringa oleifera*. However, those of Mn and Zn were declared by Badran *et al.* (1989) on *Luffa cylindrica*; Taha (1994) on *Parkinsonia aculeata*; Badran *et al.* (1994), Aly *et al.* (1994), Ahmed (1995) and Ahmed and Aly (1998) on Leucaena; Al-Humaid (1998) on rose and Mahdy (2002) on *Albizzia lebbek.*

MATERIALS AND METHODS

A pot experiment was conducted during 2016 and 2017 successive seasons at the Nursery of Fac. of Agric., Minia Univ. to study the effect of three NPK fertilization rates and five zinc plus manganese levels on vegetative growth, photosynthetic pigments content and leaves N, P and K % of *Delonix regia* seedlings grown in sandy soil.

One year old seedlings (average of 80 cm height and 8 mm diameter) were planted in 30 cm clay pots filled with 12 kg sandy soil on the second week of March for both seasons. A complete randomized block design in split-plot arrangement, with four replicates and five plants/replicate, was followed where three NPK fertilization rates represented the main plots and five micronutrient treatments occupied the sub-plots.

The three NPK treatments were $N_1P_1K_1$, $N_2P_2K_2$ and $N_3P_3K_3$ where the amounts of N_1, N_2 and N_3 were 12, 24 and 36 g/pot of ammonium sulphate (20.5 % N); P_1, P_2 and P_3 were 10, 20 and 30 g/pot of calcium superphosphate (15.5 % P_2O_5) and K_1, K_2 and K_3 were 5, 10 and 15 g/pot of potassium sulphate (48 % K_2O). Such fertilizer amounts were divided into four equal portions and added two months after planting date, with four weeks intervals thereafter. On the other side, Zn and Mn were foliar sprayed as zinc sulphate and manganese sulphate at the concentration of 25, 50, 75 and 100 ppm for each element, in addition to the control. Such five treatments were applied four times, with three weeks interval, three months after planting date.

On the second week of October for both seasons, data were recorded for plant height, stem thickness, crown diameter and leaves, stem and roots dry weight. In addition, chlorophyll a, b and carotenoids contents according to Fadl and Seri-Eldeen (1978) and leaves N, P and K % according to Page *et al.* (1982) were determined. All obtained data were statistically analyzed following the method of Little and Hills (1978).

RESULTS AND DISCUSSION

Vegetative growth parameters:

All studied vegetative growth parameters were gradually increased parallel to the increase in the applied NPK rate, in both seasons. Within the three NPK rates both medium ($N_2P_2K_2$) and high ($N_3P_3K_3$) ones gave significantly higher values than the low one ($N_1P_1K_1$) for plant height, stem thickness, crown diameter and stem dry weight with no significant differences between the medium and high ones as shown in Tables (1 & 2) for both seasons. Numerically, plant height, stem thickness and crown diameter were increased by 15.6, 10.4 and 13.6 % in the first season and 15.3, 10.8 and 14.3 % in the second one due the high rate over the low one. In agreement with these results were those of Badran *et al*. (2003) on *Acacia saligna*, El-Sayed *et al*. (2006) on *Dalbergia sissoo*, Abdou *et al.* (2006) on *Khaya senegalensis*, Badran *et al.* (2008) on *Koelreuteria paniculata*, Shetta *et al.* (2010) on Leucaena and Badran *et al.* (2016) on *Moringa oleifera*.

Table a. Physical and chemical analysis of the used soil.

Properties	Values	Properties		Values
Sand (%)	91.0	**P mg/100 (g)**		3.92
Silt (%)	5.8	**Exchangeable K^+ mg/100 g soil**		0.21
Clay (%)	3.2		**Fe**	1.22
Organic matter (%)	0.08	**DTPA**	**Cu**	0.44
$CaCO_3$ (%)	12.7	**Ext. (ppm)**	**Zn**	0.23
pH (1:2.5)	8.12		**Mn**	0.41
E.C. mmhose/cm	1.09			
Total N (%)	0.02			

Table 1. Effect of NPK and micronutrient fertilization treatments on plant height, stem thickness and crown diameter of *Delonix regia* seedlings during 2016 and 2017 seasons.

Micro nutrient treatments (B)	NPK fertilization rates (A)							
	1st season (2016)				2nd season (2017)			
	$N_1P_1K_1$	$N_2P_2K_2$	$N_3P_3K_3$	Mean (B)	$N_1P_1K_1$	$N_2P_2K_2$	$N_3P_3K_3$	Mean (B)
Plant height (cm)								
Control	122	134	139	132	125	137	143	135
Mn 25 + Zn 25	140	161	163	155	144	162	165	157
Mn 50 + Zn 50	145	164	166	158	148	168	170	162
Mn 75 + Zn 75	153	175	177	168	156	174	178	169
Mn 100 + Zn 100	147	165	169	160	149	167	172	163
Mean (A)	141	160	163		144	162	166	
L.S.D. at 5 %	A: 12	B: 10	AB: 17		A: 10	B: 8	AB: 14	
Stem thickness (mm)								
Control	11.4	12.5	13.5	12.5	11.6	12.9	13.6	12.7
Mn 25 + Zn 25	15.2	16.8	17.2	16.4	15.8	17.2	17.8	16.9
Mn 50 + Zn 50	16.8	17.7	18.0	17.5	17.2	17.7	18.4	17.8
Mn 75 + Zn 75	17.1	17.9	18.4	17.8	17.5	18.6	19.4	18.5
Mn 100 + Zn 100	16.6	17.4	17.9	17.3	16.7	17.6	18.2	17.5
Mean (A)	15.4	16.5	17.0		15.8	16.8	17.5	
L.S.D. at 5 %	A: 0.8	B: 1.2	AB: 2.1		A: 0.9	B: 1.4	AB: 2.4	
Crown diameter (m)								
Control	1.65	1.72	1.76	1.71	1.73	1.78	1.84	1.78
Mn 25 + Zn 25	1.90	2.11	2.18	2.06	1.94	2.09	2.21	2.08
Mn 50 + Zn 50	1.96	2.20	2.24	2.13	2.00	2.31	2.34	2.22
Mn 75 + Zn 75	2.06	2.36	2.41	2.28	2.12	2.39	2.48	2.33
Mn 100 + Zn 100	1.98	2.22	2.28	2.16	2.03	2.29	2.33	2.22
Mean (A)	1.91	2.12	2.17		1.96	2.17	2.24	
L.S.D. at 5 %	A: 0.10	B: 0.12	AB: 0.21		A: 0.13	B: 0.14	AB: 0.24	

Concerning micronutrient treatments, each of plant height, stem thickness, crown diameter and leaves and stem dry weights were significantly increased due to all applied micronutrient concentrations in comparison with control treatment. Such increase was gradually parallel to the increase in Mn + Zn concentration up to 75 ppm. Such trend was evident in the two seasons as shown in Tables (1 and 2). The best treatment (Mn at 75 ppm + Zn at 75 ppm) increased plant height, stem thickness, leaves crown diameter, leaves dry weight and stem dry weight, respectively, by 27.3, 42.4, 33.3, 32.4 and 32.7 % in comparison with the values of the control treatment in the first season. Nearly similar values were almost obtained in the second season for the same respective traits and treatments. In accordance with these results were the findings of Badran *et al*. (1989) on *Luffa cylindrica*; Taha (1994) on *Parkinsonia*

Table 2. Effect of NPK and micronutrient fertilization treatments on the dry weights of leaves, stem and roots of *Delonix regia* seedlings during 2016 and 2017 seasons.

Micro nutrient treatments (B)	NPK fertilization rates (A)							
	1st season (2016)				2nd season (2017)			
	$N_1P_1K_1$	$N_2P_2K_2$	$N_3P_3K_3$	Mean (B)	$N_1P_1K_1$	$N_2P_2K_2$	$N_3P_3K_3$	Mean (B)
Leaves dry weight (g)								
Control	59.8	64.3	66.6	63.6	63.3	68.0	70.5	67.3
Mn 25 + Zn 25	70.8	72.6	74.2	72.5	73.7	76.7	78.6	76.3
Mn 50 + Zn 50	77.6	79.4	81.8	79.6	82.0	85.3	88.6	85.3
Mn 75 + Zn 75	82.0	84.7	85.9	84.2	87.2	88.8	90.3	38.8
Mn 100 + Zn 100	77.9	81.6	82.4	80.6	81.8	84.4	87.1	84.4
Mean (A)	73.6	76.5	78.2		77.6	80.6	83.0	
L.S.D. at 5 %	A: N.S.	B: 5.6	AB: 9.7		A: N.S.	B: 7.0	AB: 12.1	
Stem dry weight (g)								
Control	24.2	27.4	29.9	27.9	26.2	28.4	31.1	28.6
Mn 25 + Zn 25	29.8	34.3	36.6	33.6	30.3	34.9	36.5	33.9
Mn 50 + Zn 50	31.7	34.9	37.0	34.5	33.8	36.3	37.2	35.8
Mn 75 + Zn 75	32.8	37.5	37.9	36.1	35.1	38.8	39.8	37.9
Mn 100 + Zn 100	31.1	35.3	35.8	34.1	34.2	35.3	37.3	35.6
Mean (A)	29.9	33.9	35.4		31.9	34.7	36.4	
L.S.D. at 5 %	A: 2.4	B: 2.7	AB: 4.7		A: 2.0	A: 2.8	B: 4.9	
Roots dry weight (g)								
Control	112	118	122	117	115	121	124	120
Mn 25 + Zn 25	114	123	125	121	119	124	128	124
Mn 50 + Zn 50	118	124	127	123	122	127	130	126
Mn 75 + Zn 75	122	126	131	126	126	130	135	130
Mn 100 + Zn 100	119	123	128	123	121	128	131	127
Mean (A)	117	123	127		121	126	130	
L.S.D. at 5 %	A: N.S.	B: N.S.	AB: N.S.		A: N.S.	B: N.S.	AB: N.S.	

aculata, Badran *et al.* (1994), Ahmed (1995) and Ahmed *et al.* (1998) on Leucaena and Mahdy (2002) on *Albizzia lebbek.*

The interaction between NPK and microelement treatments was significant in both seasons for all studied vegetative growth characters except for roots dry weight as indicated in Tables (1 and 2). The best results were obtained due to $N_2P_2K_2$ or $N_3P_3K_3$ in combination with the treatment of Mn at 75 ppm + Zn at 75 ppm as clearly shown in Tables (1 and 2).

Photosynthetic pigments content:

The three photosynthetic pigments, *i.e.* chlorophyll a, b and carotenoids were gradually increased, in both seasons, according to the gradual increase in NPK rate. Significant differences were detected with the highest values being obtained due to the high rate ($N_3P_3K_3$) for the three pigments as indicated in Table (3). The beneficial role

Table 3. Effect of NPK and micronutrient fertilization treatments on the contents of photosynthetic pigments of *Delonix regia* seedlings during 2016 and 2017 seasons.

Micro nutrient treatments (B)	NPK fertilization rates (A)							
	1st season (2016)				2nd season (2017)			
	$N_1P_1K_1$	$N_2P_2K_2$	$N_3P_3K_3$	Mean (B)	$N_1P_1K_1$	$N_2P_2K_2$	$N_3P_3K_3$	Mean (B)
Chlorophyll a content (mg/g f.w.)								
Control	2.24	2.28	2.33	2.28	2.29	2.32	2.37	2.33
Mn 25 + Zn 25	2.28	2.31	2.37	2.32	2.32	2.36	2.39	2.36
Mn 50 + Zn 50	2.30	2.32	2.39	2.34	2.35	2.39	2.42	2.39
Mn 75 + Zn 75	2.34	2.38	2.42	2.38	2.38	2.40	2.46	2.41
Mn 100 + Zn 100	2.28	2.30	2.36	2.31	2.34	2.39	2.40	2.38
Mean (A)	2.29	2.32	2.37		2.34	2.37	2.41	
L.S.D. at 5 %	A: 0.05	B: N.S.		AB: N.S.	A: 0.04	B: N.S.		AB: N.S.
Chlorophyll b content (mg/g f.w.)								
Control	1.08	1.18	1.20	1.15	1.11	1.20	1.24	1.18
Mn 25 + Zn 25	1.11	1.23	1.23	1.19	1.14	1.24	1.28	1.22
Mn 50 + Zn 50	1.14	1.26	1.25	1.22	1.17	1.26	1.30	1.24
Mn 75 + Zn 75	1.18	1.30	1.32	1.27	1.22	1.29	1.33	1.28
Mn 100 + Zn 100	1.15	1.28	1.28	1.24	1.20	1.28	1.31	1.26
Mean (A)	1.13	1.25	1.26		1.17	1.25	1.29	
L.S.D. at 5 %	A: 0.04	B: 0.04		AB: 0.07	A: 0.03	B: 0.04		AB: 0.07
Carotenoids content (mg/g f.w.)								
Control	1.44	1.58	1.67	1.56	1.54	1.60	1.71	1.62
Mn 25 + Zn 25	1.49	1.66	1.71	1.62	1.60	1.64	1.73	1.66
Mn 50 + Zn 50	1.51	1.67	1.73	1.64	1.66	1.69	1.75	1.70
Mn 75 + Zn 75	1.62	1.75	1.78	1.72	1.71	1.77	1.80	1.76
Mn 100 + Zn 100	1.48	1.71	1.74	1.64	1.68	1.73	1.76	1.72
Mean (A)	1.51	1.67	1.73		1.64	1.69	1.75	
L.S.D. at 5 %	A: 0.05	B: 0.06		AB: N.S.	A: 0.04	B: 0.04		AB: N.S.

of NPK fertilization in promoting the photosynthetic pigments was revealed also by Badran *et al*. (2003), Ali (2005), Abdou *et al.* (2006), Abd-Elmola (2014) and Badran *et al.* (2016) on *Acacia saligna*, *Sterculia diversifolia*, *Khaya senegalensis*, poplar and *Moringa oleifera*, respectively.

In regard to micronutrients, the contents of the three photosynthetic pigments were gradually increased by the gradual increase in the micronutrients concentration up to Mn 75 ppm + Zn at 75 ppm in both seasons. However, significant differences were detected for chlorophyll b and carotenoids only as shown in Table (3) with the highest values being given by Mn 75 ppm + Zn 75 ppm. In accordance with these results were the findings of Badran *et al.* (1989) on *Luffa cylindrica*, Taha (1994) on *Parkinsonia aculeata*, Ahmed (1995) and Ahmed and Aly (1998) on Leucaena and Mahdy (2002) on *Albizzia lebbek.*

Table (3) shows that the interaction between NPK and Mn/Zn treatments did not reach the level of significance, in the two seasons, except for that of chlorophyll b.

Leaves percent of nitrogen, phosphorus and potassium:

Table (4) illustrates that both medium and high NPK rates significantly augmented each of N, P and K leaves %, in both seasons, over those of the low rate. It is interesting to note that non-significant differences were existed between medium ($N_2P_2K_2$) and high ($N_3P_3K_3$) rates in this concern. The findings of Ali (2005), El-Sayed *et al.* (2006), Badran *et al.* (2008), Abd-Elmola (2014) and Badran *et al.* (2016) on *Sterculia diversifolia*, *Dalbergia sissoo*, *Koelreuteria paniculata*, poplar and *Moringa oleifera*, respectively were in close agreement with our results.

Table 4. Effect of NPK and micronutrient fertilization treatments on nitrogen, phosphorus and potassium percentages of *Delonix regia* seedlings during 2016 and 2017 seasons.

Micro nutrient treatments (B)	NPK fertilization rates (A)							
	1st season (2016)				2nd season (2017)			
	$N_1P_1K_1$	$N_2P_2K_2$	$N_3P_3K_3$	Mean (B)	$N_1P_1K_1$	$N_2P_2K_2$	$N_3P_3K_3$	Mean (B)
	Leaves nitrogen (%)							
Control	2.43	2.55	2.59	2.52	1.96	2.15	2.24	2.12
Mn 25 + Zn 25	2.48	2.59	2.64	2.57	1.99	2.22	2.26	2.16
Mn 50 + Zn 50	2.51	2.67	2.69	2.62	2.10	2.30	2.30	2.23
Mn 75 + Zn 75	2.58	2.71	2.73	2.67	2.13	2.28	2.35	2.25
Mn 100 + Zn 100	2.56	2.65	2.68	2.63	2.03	2.26	2.32	2.20
Mean (A)	2.51	2.63	2.67		2.04	2.24	2.29	
L.S.D. at 5 %	A: 0.08	B: 0.06	AB: 0.10		A: 0.11	B: 0.08	AB: 0.14	
	Leaves phosphorus (%)							
Control	0.328	0.351	0.356	0.345	0.271	0.302	0.308	0.294
Mn 25 + Zn 25	0.333	0.355	0.360	0.349	0.278	0.312	0.317	0.302
Mn 50 + Zn 50	0.336	0.362	0.365	0.354	0.281	0.319	0.322	0.307
Mn 75 + Zn 75	0.340	0.364	0.369	0.358	0.285	0.325	0.330	0.313
Mn 100 + Zn 100	0.332	0.357	0.363	0.351	0.279	0.313	0.321	0.304
Mean (A)	0.334	0.358	0.363		0.279	0.314	0.320	
L.S.D. at 5 %	A: 0.010	B: N.S.	AB: N.S.		A: 0.012	B: N.S.	AB: N.S.	
	Leaves potassium (%)							
Control	2.76	2.98	3.04	2.93	2.23	2.42	2.46	2.37
Mn 25 + Zn 25	2.81	3.04	3.07	2.97	2.29	2.51	2.56	2.45
Mn 50 + Zn 50	2.83	3.10	3.14	3.02	2.33	2.58	2.66	2.52
Mn 75 + Zn 75	2.88	3.16	3.21	3.08	2.40	2.62	2.69	2.57
Mn 100 + Zn 100	2.86	3.11	3.13	3.03	2.38	2.57	2.64	2.53
Mean (A)	2.83	3.08	3.12		2.33	2.54	2.60	
L.S.D. at 5 %	A: 0.09	B: 0.07	AB: 0.12		A: 0.12	B: 0.08	AB: 0.14	

Leaves % of N, P and K were gradually increased parallel to the increase in the used micronutrient rates up to Mn 75 ppm + Zn 75 ppm, in the two seasons, in comparison with control treatment. However, the differences were significant for N and K % only as shown in Table (4). On the line with these results were those reported by Aly *et al*. (1994), Ahmed (1995) and Ahmed and Aly (1998) on Leucaena; Al-Humaid (1998) on rose and Mahdy (2002) on *Albizzia lebbek*.

Table (4) shows that the interaction between NPK and Mn/Zn treatments was significant only with N % and K %, with the best results being given by either the medium or the high NPK rate in combination with 75 Mn ppm + 75 ppm Zn.

The importance of N, P and K elements in inducing vegetative growth parameters, as well as, chemical composition of *Delonix regia* seedlings could be recognized in the light of their well-known physiological roles in plant growth and development. Meanwhile, Takei *et al*. (2001) revealed that N availability in the root zone may initiate cytokinins to be transported across the roots to the shoots. Moreover, Bravdo (2000) stated that the differences in the mobility of various elements expose the roots of the plant to a wide range of mineral availability and rapid branching of small rootlets which reflect, by sequence, in better growth of the different plant parts.

Concerning the two microelements, manganese has an important role in photosynthesis as it is involved in the sequences of reactions by which electrons are derived from water and oxygen is liberated. It is widely involved in catalytic roles in plants such as krebs cycle and nitrogen metabolism. It may also have a structural role in chloroplasts which become light sensitive in its absence and ultimately lose their structure under conditions of extreme Mn shortage (Delvin, 1975 and Bidwell, 1974). Zinc on the other hand, is involved in the biosynthesis of the plant auxin, indole-3-acetic acid and as such its deficiency may produce shortened, stunted plants with poorly developed apical dominance. It is also an obligatory activator of a number of important enzymes and involved in protein synthesis (Devlin, 1975 and Bidwell, 1974).

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تأثير التسميد بالعناصر الكبرى NPK والعناصر الصغرى على شتلات البوانسيانا في الأراضي الرملية

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أجريت تجربة أصص لدراسة تأثير التسميد بمعدلات مختلفة من الأسمدة النتروجينية والفوسفاتية والبوتاسية وبعض معاملات التسميد بالمنجنيز والزنك على شتلات البوانسيانا النامية في تربة رملية بمشتل كلية الزراعة جامعة المنيا خلال موسمي ٢٠١٦، ٢٠١٧.

وجد أن كل الصفات الخضرية مثل طول النبات وسمك الساق وقطر التاج والوزن الجاف للأوراق والساق والجذور، وكذلك صبغات التمثيل الضوئي الثلاثة ونسبة النتروجين والفوسفور والبوتاسيوم بالأوراق حدثت بها زيادات تدريجية بالتوازي مع الزيادة التدريجية في معدل أسمدة العناصر الكبرى المضافة. كذلك حدثت زيادة في الصفات الخضرية والكيماوية السابق ذكرها نتيجة استعمال العناصر الصغرى (المنجنيز والزنك) وعلى وجه الخصوص معاملة المنجنيز بتركيز ٧٥ جزء في المليون + الزنك بتركيز ٧٥ جزء في المليون. ولقد تبين أن إمداد شتلات البوانسيانا بالمستوى المتوسط أو العالي من أسمدة العناصر الكبرى NPK بالتداخل مع التسميد بالمنجنيز بتركيز ٧٥ جزء في المليون + الزنك بتركيز ٧٥ جزء في المليون تسبب في إنتاج أفضل نمو خضري لشتلات البوانسيانا النامية في الأراضي الرملية.