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IMPROVING THE GROWTH OF *KOELREUTERIA PANICULATA* SEEDLINGS BY THE USE OF NPK FERTILIZATION AND GROWTH REGULATORS

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ABSTRACT

This investigation was carried out in the nursery of Fac. of Agric., Minia Univ. during the two successive seasons of 2010 and 2011. The present work aimed to study the response of *Koelreuteria painculata* seedlings to three NPK fertilization treatments and two growth regulator (GA_3 and IAA).

All vegetative growth traits including plant height, stem diameter, number of leaves/ plant and dry weight of leaves, stem and roots/ plant, as well as, leaves contents of chlorophyll a and b and caroetnoids and leaves percent of N, P and K were greatly improved due to both NPK fertilization rates with the high one giving the highest values.

Both GA_3 and IAA were also effective in promoting different studied vegetative growth characters, except stem diameter which was decreased due to GA_3 at 50 and 100 ppm. The three photosynthetic pigments and N, P and K % were reduced due to GA_3 but promoted due to IAA.

The best overall vegetative growth characters were obtained due to supplying *Koelreuteria* seedlings with the high rate of NPK (2 g ammonium nitrate 33.5 % N, 1 g calcium superphosphate 15.5 % P_2O_5 and 0.6 g potassium sulphate 48.5 % K_2O / bag) and GA_3 at 100 ppm or IAA at 100 ppm.

INTRODUCTION

Koelreuteria paniculata, Laxm. (goldernrain tree) is one of the most graceful and showy ornamental flowering trees. It is a deciduous slow to moderate tree with 6-10 m tall and 3-12 m spread . The leaves are 35 cm long with 7-15 lobed leaflets, along with 3-7 cm long yellow flowers in clusters in the fall. Such beautiful tree could be successfully used as street, lawn or terrace tree in difficult soils and climates (Williamson, 1975).

The role of NPK fertilization in improving vegetative growth characters, photosynthetic pigments and/ or leaves content of N, P and K was indicated by Mahdy (2002) on *Melia azedarach*, Badran *et al* (2003) on *Acacia saligna* and Moustafa (2004) on *Dalbergia sissoo*. Similar results were revealed by Badran *et al* (2007) on *Casuarina equistifolia*, Badran *et al* (2008) on *Koelreuteria paniculata* and Badran *et al* (2009) on neem.

Meanwhile, the role of GA_3 in stimulating vegetative growth but reducing chemical composition was observed on *Acacia saligna* (Ahmed & Aly, 1998 and Mohamed, 2003); *Khaya senegalensis* (Sayed, 2001) and jojoba (Badran *et al.* 2006 a and 2006 b) .However, different authors concluded the effectiveness of IAA in promoting growth and/ or chemical composition of *Luffa cylindrica* (Badran *et al,* 1989); *Delonix regia* (Shehata, 1995); *Alnus nitida* (Thakur & Pant, 2002); *Acacia saligna* (Badran *et al,* 2003) and three ornamental shrubs (Zaky, 2003).

MATERIALS & METHODS

A pot experiment was executed in the nursery of Fac. of Agric. Minia Univ. during 2010 and 2011 seasons to study the effect of three NPK fertilization rates and five growth regulator treatments (0, GA_3 at 50 and 100 ppm and IAA at 50 and 100 ppm) on vegetative growth and chemical composition of *Koelreuteria paniculata* seedlings. The seeds of such plant were planted directly, on the second week of March 2010 and 2011, in 15x 45 cm black polyethelene bags filled with 5 kg sandy calcareous soil. Physical and chemical characters of the soil are shown in Table (a).

Table a: Physical and chemical characters of the used soil.

Characters	Value	Character	Value	Character	Value
Sand %	88.0	Org. Matter %	0.06	DTPA (Extr. ppm)	
Silt %	8.3	EC/ mmhos/ cm	1.09	Fe	1.10
Clay %	3.7	Total N %	0.02	Cu	0.43
Ca CO_3 %	14.42	Avail. P %	6.25	Zn	0.30
pH (1 : 2.5)	8.17	Extr. K mg/ 100 g	1.40	Mn	0.60

One month from planting, thinning was done by leaving one seedling / bag. The experiment was arranged in split- plot design with three replicates and five seedlings / replicate. Three NPK fertilization treatments ($N_0P_0K_0$, $N_1P_1K_1$, and $N_2P_2K_2$)represented the main plots, with N0, N1 and N2 expressed by 0, 1 and 2 g of ammonium nitrate 31.5% N; P_0, P_1 and P_2 by 0, 0.5 and 1 g of calcium superhosphate 15.5% P_2O_5 and K_0, K_1 and K_2 by 0, 0.3 and 0.6 g of potassium sulphate 48.5% % K_2O/ plant. These fertilizer amounts were supplied to the plants on the second week of April and again on the second week of May, June and July. While, five growth regulator treatments (0, GA_3 at 50 and 100ppm and IAA at 50 and 100 ppm) represented the subplots. Such treatments were foliar sprayed four times on the third week of April, May, June and July for both seasons. Other agricultural practices were performed as usual.

At the end of the experiment, last week of Oct. for both seasons, data were recorded for plant height, stem diameter, number of leaves/ plant and dry weight of leaves, stem and roots/ plant. In addition, chlorophyll a, chlorophyll b and carotenoids contents in the fresh leaves were estimated on the second week of Aug. according to Fadl & Seri – Eldeen(1978) . Also, N, P and K % in the leaves were determined (Page *et al,* 1982). All obtained data were statistically analyzed (Little & Hills, 1978).

RESULTS

Vegetative Growth Characteristics:

Tables (1 & 2) show that all tested vegetative growth traits, plant height, stem, diameter, leaf number/ plant and dry weight pf leaves, stem and roots/ plant were significantly augmented, in both seasons, due to the application of low and high NPK fertilization treatments over those of control treatment. Moreover, the high fertilization rate ($N_2P_2K_2$), gave significantly better growth values for all studied traits than those of the low rate ($N_1P_1K_1$) in the two seasons. The role of NPK fertilization in promoting vegetative growth was emphasized by Mahdy (2002), Badran et al (2003), Moustafa (2004), Badran *et al* (2007), Badran *et al* (2008) and Badran *et al* (2009) on *Melia azedarach, Acacia saligna* , *Dalbergia sissoo*, *Casuarina equisetifolia*, *Koelreuteria paniculata* and neem , respectively.

Concerning growth regulators, both GA_3 and IAA at 50 and 100 ppm caused significant increase in both seasons, in all vegetative growth characters, except stem diameter which was reduced by GA_3 application (Tables 1 & 2). However, the high concentration (100ppm) of either GA_3 or IAA proved to be much more effective than the low one (50 ppm) . It is interesting to find out that plant height, leaf number and dry weights of leaves, stem and roots/ plant were increased by 29.2, 18.4 , 33.0, 32.2 and 26.5 % due to GA_3 at 100 ppm over those of control plants in the first season. The corresponding increasing percentage due to 100 ppm IAA for the same traits in the first season recorded 23.5, 17.4 , 29.0 , 30.7 and 24.5 % . Similar trend was observed in the second season as shown in Tables (1& 2). Many researchers emphasized that various growth traits, except stem diameter, were improved due to GA_3 such as Ahmed & Aly (1998) on *Acacia saligna*, Sayed (2001) on *Khaya senegalensis*, Mohamed (2003) on *Cacia saligna* and Badran *et al* (2006a) on jojoba. Meanwhile, Badran *et al* (1989) on *Luffa cylindrical*, Shehata (1995) on *Delonix regia*, Zaky (2003) on three ornamental shrubs and Badran *et al* (2003) on *Acacia saligna*, concluded the role of IAA in enhancing different vegetative characters.

Table 1: Effect of NPK fertilization and certain growth regulators on plant height, stem diameter and leaf number of *Koelreuteria paniculata* seedlings during 2010 and 2011 seasons.

Growth regulator treatments(B) ppm	First season				Second season			
	NPK fertilization treatments A							
	$N_0P_0K_0$	$N_1P_1K_1$	$N_2P_2K_2$	Mean B	$N_0P_0K_0$	$N_1P_1K_1$	$N_2P_2K_2$	Mean B
	Plant height cm							
0	34.3	38.4	42.3	38.3	28.3	32.1	36.3	32.2
GA_3 50	39.6	41.3	49.3	43.4	43.0	45.4	49.3	45.9
GA_3 100	45.4	48.5	54.5	49.5	46.4	50.6	59.2	52.1
IAA 50	38.4	42.6	47.9	43.0	35.7	39.6	41.1	38.8
IAA 100	42.9	46.7	52.3	47.3	39.4	42.8	44.2	42.1
Mean A	40.1	43.5	49.3		38.6	42.1	46.0	
LSD 5%	A : 2.7	B: 3.5	AB:	6.1	A : 2.9	B: 3.0	AB:	5.2
	Stem diameter mm							
0	4.22	4.42	4.94	4.53	3.81	4.19	4.52	4.17
GA_3 50	4.05	4.15	4.65	4.28	3.34	3.78	3.99	3.70
GA_3 100	3.85	4.08	4.34	4.09	3.00	3.52	3.76	3.43
IAA 50	4.46	4.87	5.26	4.86	4.17	4.30	4.58	4.35
IAA 100	4.65	5.18	5.56	5.13	4.52	4.42	4.76	4.57
Mean A	4.25	4.54	4.95		3.77	4.04	4.32	
LSD 5%	A : .18	B: .15	AB:	.26	A : .25	B: .13	AB:	.23
	Number of leaves / plant							
0	5.33	5.84	7.60	6.26	5.02	5.76	7.22	6.00
GA_3 50	5.85	6.69	8.48	7.01	5.62	6.24	7.81	6.56
GA_3 100	6.24	7.04	8.94	7.41	5.84	6.43	8.18	6.82
IAA 50	5.71	6.51	8.55	6.92	5.48	6.28	7.74	6.50
IAA 100	6.15	7.15	8.75	7.35	5.62	6.40	7.95	6.66
Mean A	5.86	6.65	8.46		5.52	6.22	7.78	
LSD 5%	A : .44	B: .36	AB:	.62	A : .60	B: .30	AB:	.52

Table 2: Effect of NPK fertilization and certain growth regulators on dry weight of leaves, stem and roots / plant of *Koelreuteria paniculata* seedlings during 2010 and 2011 seasons.

Growth regulator treatments(B) (ppm)	First season				Second season			
	NPK fertilization treatments A							
	$N_0P_0K_0$	$N_1P_1K_1$	$N_2P_2K_2$	Mean B	$N_0P_0K_0$	$N_1P_1K_1$	$N_2P_2K_2$	Mean B
	Leaves dry weight / plant g							
0	1.81	2.16	2.65	2.21	1.64	1.97	2.31	1.97
GA_3 50	2.24	2.50	3.18	2.64	2.06	2.32	2.71	2.36
GA_3 100	2.53	2.77	3.52	2.94	2.31	2.64	3.04	2.66
IAA 50	2.18	2.46	3.16	2.60	2.03	2.28	2.68	2.33
IAA 100	2.44	2.68	3.44	2.85	2.27	2.59	2.91	2.59
Mean A	2.24	2.51	3.19		2.06	2.36	2.73	
LSD 5%	A : .22	B: .24	AB:	.42	A : .20	B: .18	AB:	.31
	Stem dry weight / plant g							
0	1.71	2.03	2.41	2.05	1.40	1.58	2.22	1.73
GA_3 50	2.13	2.29	2.96	2.46	1.74	1.92	2.52	2.06
GA_3 100	2.34	2.51	3.27	2.71	1.91	2.21	2.74	2.29
IAA 50	2.15	2.34	2.84	2.44	1.68	1.85	2.51	2.01
IAA 100	2.31	2.50	3.23	2.68	1.87	2.18	2.66	2.24
Mean A	2.13	2.33	2.94		1.72	1.95	2.53	
LSD 5%	A : .09	B: .11	AB:	.19	A : .10	B: .08	AB:	.14
	Roots dry weight / plant g							
0	1.38	1.81	2.68	1.96	1.30	1.72	2.38	1.80
GA_3 50	1.64	2.18	2.94	2.25	1.53	2.05	2.77	2.12
GA_3 100	1.83	2.36	3.24	2.48	1.70	2.21	2.93	2.28
IAA 50	1.60	2.12	2.85	2.19	1.49	2.08	2.71	2.09
IAA 100	1.75	2.40	3.18	2.44	1.66	2.18	2.79	2.21
Mean A	1.64	2.17	2.98		1.54	2.05	2.72	
LSD 5%	A : .16	B: .12	AB:	.21	A : .13	B: .11	AB:	.19

The interactions between NPK fertilization treatments and growth regulator concentrations were significant, in both seasons, for all six examined characters (Tables 1 & 2). The best results were obtained due to $N_2P_2K_2$ plus 100 ppm GA_3 or IAA except stem diameter which reached the maximum value due to $N_2P_2K_2$ in combination with IAA at 100 ppm.

Chemical Composition:

Tables (3 & 4) show that both low and high fertilization rates ($N_1P_1K_1$ and $N_2P_2K_2$) caused significant increase in the three photosynthetic pigments and leaves percent of nitrogen, phosphorus and potassium, in the two seasons, over those of control plants. Furthermore, the high rate gave significantly higher values than the low rate. In agreement with those results concerning photosynthetic pigments were those of Badran *et al* (2003) on *Acacia saligna*, Badran *et al* (2007) on *Casuarinas equitifolia*, Badran *et al* (2009) on neem. While, Mahdy (2002) on *Melia azedarach*, Moustafa (2004) on *Dalbergia sissoo*, Badran *et al* (2007) on *Cauarian equistifolia* and Badran *et al* (2008) on *Koelreuteria panicualta* insured the role of NPK in promoting N, P and K %.

Data in Tables (3 & 4) show that all studied chemical constituents including chlorophyll a, chlorophyll b and caroenoids contents, as well as, leaves percent of N, P and K were decreased due to GA_3 application, but were increased due to IAA application. However, the high concentration (100 ppm) of either material was much more effective than the low one (50 ppm). In accordance with these results were those reported by Ahmed and Aly (1998) and Mohamed (2003) on *Acacia saligna*, Sayed (2001) on *Khaya senegalensis* and Badran *et al* (2006b) on jojoba concerning GA_3; and those of Badran *et al* (1989) on *Luffa cylindrical*, Shehata (1995) on *Delonix regia*, Zaky (2003) on three shrubs and Badran *et al* (2003) on *Acacia saligna* concerning IAA.

The interactions between NPK treatments and growth regulators were significant for chlorophyll b, carotenoids, nitrogen % and phosphorus % as indicated in Tables (3 & 4) . The highest values for these four chemical parameters were due to $N_2P_2K_2$ in combination with IAA at 100 ppm.

Table 3: Effect of NPK fertilization and certain growth regulators on chlorophyll a, chlorophyll b and carotenoids content of *Koelreuteria paniculata* seedlings during 2010 and 2011 seasons.

Growth regulator treatments(B) (ppm)	First season				Second season			
	NPK fertilization treatments A							
	$N_0P_0K_0$	$N_1P_1K_1$	$N_2P_2K_2$	Mean B	$N_0P_0K_0$	$N_1P_1K_1$	$N_2P_2K_2$	Mean B
	Chlorophyll a content mg/g F.W.							
0	2.96	3.18	3.45	3.20	2.74	2.90	3.16	2.93
GA_3 50	2.91	3.16	3.41	3.16	2.71	2.87	3.13	2.90
GA_3 100	2.87	3.12	3.37	3.12	2.66	2.83	3.11	2.87
IAA 50	3.00	3.22	3.50	3.24	2.78	2.94	3.19	2.97
IAA 100	3.04	3.25	3.53	3.27	2.81	2.98	3.23	3.01
Mean A	2.96	3.19	3.45		2.74	2.90	3.16	
LSD 5%	A : .06	B: .05	AB:	N.S.	A : .06	B: .05	AB:	N.S
	Chlorophyll b content mg/g F.W.							
0	.746	.788	.864	.796	.707	.736	.784	.742
GA_3 50	.712	.781	.858	.784	.701	.728	.774	.734
GA_3 100	.694	.774	.852	.773	.694	.722	.772	.729
IAA 50	.751	.796	.871	.806	.713	.743	.789	.748
IAA 100	.772	.804	.876	.817	.719	.749	.796	.755
Mean A	.733	.789	.864		.707	.736	.783	
LSD 5%	A : .012	B: .016	AB:	.028	A : .707	B: .022	AB:	.038
	Carotenoids content mg/g F.W.							
0	2.31	2.42	2.57	2.43	2.05	2.22	2.38	2.22
GA_3 50	2.29	2.40	2.55	2.41	2.04	2.20	2.36	2.20
GA_3 100	2.26	2.36	2.55	2.39	2.03	2.17	2.35	2.18
IAA 50	2.34	2.47	2.61	2.47	2.07	2.26	2.41	2.25
IAA 100	2.36	2.48	2.64	2.49	2.09	2.29	2.43	2.27
Mean A	2.31	2.43	2.58		2.06	2.23	2.39	
LSD 5%	A : .04	B: .03	AB:	.05	A : .05	B: .03	AB:	.05

Table 4: Effect of NPK fertilization and growth regulators on leaves nitrogen , phosphorus and potassium % of *Koelreuteria paniculata* seedlings during 2010 and 2011 seasons.

Growth regulator treatments(B) (ppm)	First season				Second season			
	NPK fertilization treatments A							
	$N_0P_0K_0$	$N_1P_1K_1$	$N_2P_2K_2$	Mean B	$N_0P_0K_0$	$N_1P_1K_1$	$N_2P_2K_2$	Mean B
	Leaves nitrogen %							
0	3.12	3.35	3.65	3.37	2.94	3.10	3.31	3.12
GA_3 50	3.08	3.33	3.61	3.34	2.91	3.08	3.30	3.09
GA_3 100	3.03	3.30	3.55	3.29	2.86	3.06	3.26	3.06
IAA 50	3.16	3.40	3.72	3.43	2.97	3.12	3.34	3.14
IAA 100	3.19	3.42	3.80	3.47	3.02	3.13	3.37	3.17
Mean A	3.12	3.36	3.67		2.94	3.10	3.32	
LSD 5%	A : .10	B: .06	AB:	.10	A : .08	B: .05	AB:	.09
	Leaves phosphorus %							
0	.371	.388	.392	.384	.342	.361	.377	.360
GA_3 50	.355	.361	.364	.360	.321	.345	.355	.340
GA_3 100	.347	.354	.359	.353	.314	.340	.344	.333
IAA 50	.381	.416	.426	.408	.372	.383	.392	.382
IAA 100	.423	.431	.443	.432	.377	.395	.408	.393
Mean A	.375	.390	.397		.345	.365	.375	
LSD 5%	A : .007	B: .010	AB:	.017	A : .008	B: .007	AB:	.012
	Leaves potassium %							
0	3.44	3.61	3.72	3.59	3.11	3.22	3.38	3.24
GA_3 50	3.40	3.59	3.70	3.56	3.07	3.19	3.35	3.20
GA_3 100	3.35	3.56	3.68	3.53	3.04	3.15	3.32	3.17
IAA 50	3.48	3.64	3.74	3.62	3.14	3.24	3.41	3.26
IAA 100	3.53	3.66	3.76	3.65	3.15	3.26	3.45	3.29
Mean A	3.44	3.61	3.72		3.10	3.21	3.38	
LSD 5%	A : .05	B: .03	AB:	N.S.	A : .06	B: .03	AB:	N.S.

DISCUSSION

The roles of N, P and K essential minerals supplied to *Koelreuteria paniculata* seedlings in the form of N, P and K fertilizers in improving vegetative growth and chemical constituents could be realized in the light of their well- known vital physiological roles in plant growth and development. In addition, Takei *et al* (2001) stated that N availability in the root zone may initiate cytokinins to be transported across the roots to the shoots. Moreover, Bravdo (2000) observed that the differences in the mobility of various elements expose the roots to a wide range of mineral availability and rapid branching of small rootlets which reflect, by sequence, in better growth of different plant parts.

Concerning gibberellic acid and indoleacetic acid, both are among the naturally occurring plant growth hormones. The application of such materials aids in promoting stem elongation, stimulating cambial activity, initiating root primordia and involved in apical dominance, synthesis of specific enzymes and respiration, (Delvin, 1975).

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Improving the growth of *koelreuteria paniculata* seedlings

تحسين نمو شتلات الكولرتاريا بانيكيولاتا باستعمال الأسمدة الكيماوية ومنظمات النمو

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أجريت هذه التجربة بمشتل كلية الزراعة جامعة المنيا خلال موسمين متتاليين ٢٠١٠، ٢٠١١ لدراسة استجابة شتلات الكولرتاريا بانيكيولاتا لثلاثة معاملات من الأسمدة الكيماوية (NPK) واثنين من منظمات النمو (حامض الجبرليك ، واندول حامض الخليك).

أشارت النتائج إلى زيادة كبيرة لجميع الصفات الخضرية وهى طول النبات وقطر الساق وعدد الأوراق والوزن الجاف للأوراق والساق والجذور للنبات وكذلك محتوى الأوراق من كلوروفيل أ وكلوروفيل ب ، وكاروتينويدات والنسبة المئوية لعناصر النيتروجين والفوسفور والبوتاسيوم بالأوراق وذلك نتيجة استعمال المستويين العالى والمنخفض من التسميد الكيماوى (NPK) مقارنة بالكنترول مع ملاحظة ان المستوى العالى أعطى أعلى القيم لكل الصفات والتقديرات السابقة .

كذلك حدثت زيادة ملحوظة فى كل الصفات الخضرية تحت الدراسة نتيجة استعمال حامض الجبرليك واندول حامض الخليك فيما عدا قطر الساق الذى انخفض نتيجة استعمال حامض الجبرليك بتركيزى ٥٠ ، ١٠٠ جزء فى المليون أما بالنسبة لصبغات البناء الضوئى الثلاثة وعناصر النيتروجين والفوسفور والبوتاسيوم بالأوراق فقد انخفضت نتيجة استعمال حامض الجبرليك ولكنها زادت نتيجة استعمال اندول حامض الخليك.

تم الحصول على أفضل نتائج النمو الخضرى نتيجة امداد شتلات الكولرتاريا بالمعدل العالى من التسميد الكيماوى (NPK) بالتداخل مع أى من حامض الجبرليك او اندول حامض الخليك بتركيز ١٠٠ جزء فى المليون.