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ANNUAL INCREMENT GROWTH IMPROVEMENT OF *Swietenia mahagoni* AS EFFECTED BY USING NPK FERTILIZER IN THE NEW RECLAIMED LANDS.

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ABSTRACT

In this investigate conducted during period of 2008 to 2011 to study the effect of NPK fertilizer on annual increment rate for growth of *Swietenia mahagoni*, Fam. Meliaceae. The trees were at the age seven years old, which have been planted at a distance of 3mx3m in new reclaimed land, north west of Cairo, Egypt, at the Experimental Farm of Aly Moubarak Hort. Res. Inst. Agric. Res. Center (ARC). They were fertilized with ammonium sulphate (15.5% N) at the rates of N_1 = 0.0, N_2 = 51.61 and N_3 = 103.22 g, superphosphate (40-46% P_2O_5) at the rates of P_1 = 0.0, P_2 = 64.51 and P_3 = 129.03 g and potassium sulphate (50% K_2O) at the rates of K_1 = 0.0, K_2 = 16.00 and K_3 = 32.00 g all per tree, which they were 27 treatments. The best treatments which were more effective in annual rate increment for height (ARIH) were $K_1N_2P_3$ and $K_2N_2P_1$ (88.333 and 83.333 cm) in the first year and $K_3N_1P_3$ (83.333 cm) in the second year of fertilization. The treatment of $K_3N_2P_2$ caused the high value of annual rate increment for diameter at breast height (ARIDBH) which was (3.040 cm) and high value of annual rate increment for Basal area (ARIBA) which was (56.970 cm^2) in the first year of fertilization, while, in the second one $K_2N_3P_3$ treatment produced high value of BAAI (56.843 cm^2). However, in the third year of fertilization there was no significant effect of NPK fertilizers on the previous measurements, in addition to in many treatments fertilization lead to an adverse effect on these measurements.

INTRODUCTION

In the last two decades, Forestry and Timber Trees Department, Horticulture Research Institute of Agricultural Research Center completed a lot of research to evaluation the woody trees for high economic values and suitable for the purposes of different manufacturing. Focusing on research of continuous assessment and sequential on the same species and site, specially woody trees belong Meliaceae because it is among the most useful plant families, its timbers are commercially valuable and because many of its species can be grown with relative ease in plantations, Pennington and Styles, (1975). The subfamily Swieteniodideae includes the genera Cedrela, Toona, Khaya, Entandrophragma, Carapa, and the true mahagonies in the genus Swietenia (*S. mahagoni* Jacq., *S. macrophylla* King*, and S. humilis* Zucc.*).* Mature mahogany, sometimes exceeding 45m height, 25m to the first branch, and 1.8m in diameter, is a species of grandeur and majestic proportions, Lamb, (1947) and Record, (1931). *S. mahagoni* Jacq commonly called West Indies mahogany, small leaf mahogany it grows on a variety of sites within its native range. It is tolerant of relatively high pH (up to about 8.5). It may be found on areas that receive salt spray and on soils with marl land limestone parent materials just inland from the mangroves, Craighead, (1971). The rate of height growth is modest and declines early, especially on poor sites. However, diameter growth is good for a dry forest species and steady over a long life, Storer, (1958).

During 2001 to 2008 we carried out the evaluation of growth and annual increment of *Swietenia mahagoni* and *Khaya senegalensis* in new reclaimed land. Height annual increment was highly significant increased in the first and second years, while in the third to sixth years was highly significant decreased of both species, the annual increment of height, ba and dbh of *K. senegalensis* were surpassed of that *S. mahagoni,* Maha and Hala, (2008) . In one large planted area in Puerto Rico, where rainfall about 1660 mm annually and soils are only a few centimeters thick over porous limestone, *S. mahagoni* averaged 0.57 m of height growth and 1.0 cm of diameter growth during 7 to 8 years, Marrero (1950). Although few studies have been performed on nutrition of tropical native species, in addition to these species are very different for responding to nutrition elements and forest planting demand knowledge of the specific nutrition requirements of each species. This investigation studied the effect of NPK fertilization to improve the annual increment in growth of *S. mahagoni.* In a study with *Trema micrantha*, Venturin *et al.* (2000) concluded that, N was the most limiting nutrient to its vertical growth, while N, P and B were the most limiting nutrients to diameter. Dünisch *et at*., (2000, a) reported that, the growth of *Swietenia macrophylla* King and *Cedrela odorata* L. was strongly limited by the reduced potassium supply of the soil, whereas *Carapa guianensis* Aubl was better adapted to less fertile soils. The cambial growth dynamics of *Swietenia, Carapa*, and *Cedrela* were correlated with the water supply of the soil Cambial dormancies were induced by dry periods in the cambium of *Swietenia* and *Cedrela. Swietenia* and *Cedrela* have a high demand of K for biomass production was found, which only can be satisfied in more fertile soils, a high portion of the biomass production of these species is correlated with the light, the water, and the nutrient supply of the site. *Swietenia* has a higher K demand for biomass production than Carapa, even in fertile soils the K uptake of *Swietenia* is lower than the K uptake of *Carapa,* which is predominately caused by anatomical and physiological differences in the root zone of these species. In soils with extremely low K contents, the K uptake of *Carapa* was significantly higher than the K uptake of *Swietenia* and *Cedrela* indicating a good adaptation of this species to poorer sites, Dünisch *et al*., (2000, b). For the growth characteristics, 200 $kg.ha^{-1}$ of phosphate fertilization was the dose that provided the high growth for mahogany, on the interval of 90 days, Santos *et al*, (2008). Limited knowledge about growth rates of subtropical tree species in these forests makes it difficult to accurately predict forest yield, biomass accumulation, and carbon sequestration. From 1980 to 2008, mean diameter at breast height periodic annual increment was 0.35 cm/year for 4,026 trees remeasured by the forest inventory of Puerto Rico; growth rate averaged0.20 cm/year in subtropical dry forests, 0.37 cm/year in subtropical moist forests, 0.36 cm/year in subtropical wet/rain forests, and 0.20 cm/year in lower montane forests, Thomas, (2009).

MATERIALS AND METHODS

The present study was carried out at the Experimental Farm of Aly Moubarak Horticulture Research Station, Horticulture Research Institute Agricultural Research Center (ARC) during the period from 2008 to 2011. Aiming to improve the annual increment the growth of *Swietenia mahagoni*, Fam. Meliaceae.

Seven- year- old trees blocks with planting distance of 3x3 m were fertilized with ammonium sulphate (15.5% N) at the rates of N_1 = 0.0, N_2 = 51.61 and N_3 = 103.22 g, superphosphate (40-46% P2O5) at the rates of P_1 = 0.0, P_2 = 64.51 and P_3 = 129.03 g and potassium sulphate (50% K2O) at the rates of K_1 = 0.0, K_2 = 16.00 and K_3 = 32.00 g all per tree. They were 27 treatments including the doses of fertilizer and all interactions among them. These treatments were added 3 times in the first week of March, May and July during 2008/09, 2009/10 and 2010/11 i.e., 172 or 344 $Kg.ha^{-1}y^{-1}$ of ammonium sulfate, 215 or 430 $Kg.ha^{-1}y^{-1}$ of superphosphate and 53 or 106 $Kg.ha^{-1}y^{-1}$ of potassium sulfate. Sprinkler irrigation was used once a week during the experimental period and weed mechanically conducted when needed.

Soil and leaves analysis were conducted before fertilization in 2008. The percentages N, P and K in leaves of *S. mahagoni* were 1.911, 0.277 and 1.455, respectively.

Some physical and chemical properties of soil were tabulated in (Table, 1).

Table (1): Soil analysis before fertilization during 2008.

Soil samples	SP	pH	EC dsm^{-1}	Cations meq / L				Anions meq / L				Aval. $mgkg^{-1}$		
				Ca^{++}	Mg^{+}	Na^{+}	K^{+}	$Co_3^{=}$	Hco_3^{-}	$C1^{-}$	$So_4^{=}$	total N	P	K
Block of *S. mahagoni*	18	8.4	0.5	1.4	0.6	2.5	1.0	—	3.2	2.0	0.3	16.8	0.9	42.4

Recorded data :

In February annually during 3 years the next data were recorded and calculated the annual rate increment for each parameter: tree height (m), basal area (ba) cm^2 and diameter at breast height (dbh) cm.

Chemical analyses: Soil and leaves samples were taken in September 2011to determine : Nitrogen using the Microkjeldahl method according to Piper (1950), phosphorus was calorimetrically determined according to Troug and Meyer (1939) and potassium was estimated using the flame photometer according to Brown and Lilliland (1946).

Statistical design : A completely randomized block design was designed for all fertilizer treatment.

Statistical analysis : For all determinations, statistical analysis were factorial experiment, first factor was nitrogen (N) in three levels (N_1, N_2 and N_3), second factor was phosphorus (P) in three levels (P_1, P_2 and P_3) and potassium (K) in three levels (K_1, K_2 and K_3), i.e., 27 fertilization treatments, each treatments contained three replicates, one tree per replication.

Less significant differences (LSD) uses for testing the differences among the means of annual increment during three years for each parameter according the methods of Armitage (1971).

RESULTS AND DISCUSSION

1- Effect of nitrogen (N), phosphorus (P) and potassium (K) on annual rate increment for height, diameter at breast height (DBH) and basal area (BA) of *S. mahagoni.*

Data presented in Table (2) showed that, application of nitrogen fertilization alone was significant effective on annual rate increment for height (ARIH), annual rate increment for diameter at breast height (ARIDBH) and annual rate increment basal area (ARIBA) of *S. mahagoni* during three years of fertilization. With exception of third year of fertilization there is no-significant differences of three levels of N on these characters. The low level of nitrogen (N_2) was significant increased ARIH, ARIDB H and ARIBA during first year, while in the second and third years of fertilization the treatments omitted of nitrogen (N_1) gave increasing of ARIH and ARIDBH, but the high level of nitrogen (N_3) gave highly significant increased of ARIBA as compared to N_1 and N_2 during second year only.

Table (2): Effect of nitrogen (N), phosphorus (P) and potassium (K) on annual rate increment for height, diameter at breast height (DBH) and basal area (BA) of *S. mahagoni.*

Treatments	Height (cm)			DBH (cm)			BA (cm^2)		
(g/tree)	2008/09	2009/10	2010/11	2008/09	2009/10	2010/11	2008/09	2009/10	2010/11
N:									
N1 (0)	40.370	46.667	51.481	0.703	0.933	1.018	11.113	24.071	22.758
N2 (51.61)	51.667	43.704	38.519	1.170	0.653	0.880	21.559	25.720	20.857
N3 (103.22)	38.704	34.815	30.556	0.880	0.841	0.674	13.233	31.876	19.131
Sig.	*	*	*	**	*	**	**	**	NS
LSD	10.85	9.91	11.76	0.22	0.21	.27	4.27	6.62	--
P:									
P1 (0)	45.556	38.704	39.630	0.934	0.781	0.771	13.974	22.026	24.554
P2 (64.51)	36.852	43.148	45.000	0.967	1.049	0.948	19.860	25.383	24.095
P3 (129.03)	48.333	43.333	35.926	0.853	0.597	0.853	12.071	34.259	14.099
Sig.	NS	NS	NS	NS	**	NS	**	**	**
LSD	--	--	--	--	.27	--	4.27	6.62	6.76
K									
K1 (0)	49.444	38.148	43.148	0.857	0.756	0.925	12.953	29.973	21.811
K2 (16.0)	37.593	38.889	40.370	0.864	0.836	0.693	14.835	30.123	20.647
K3 (32.0)	43.704	48.148	37.037	1.032	0.835	0.953	18.117	21.571	20.289
Sig.	NS	NS	NS	NS	NS	*	**	**	NS
LSD	--	--	--	--	--	0.21	4.27	6.62	--

Application of phosphorus fertilization alone was not effected on ARIH and ARIDBH during three years, with exception of second year that the low level of phosphorus (P_2) gave highly significant increased ARIDBH as compared to P_1 and P_3. However, there is highly significant differences of ARIBA resulted from applying of phosphorus alone during three years. In the first year low level of P (P_2) induced highly significant increase of ARIBA, while in the second year high level (P_3) gave highly significant increased ARIBA. In third year , P_1 (without P) and P_2 induced highly significant increased ARIBA as compared to P_3.

Application of potassium fertilization alone was non-significant effect on ARIH and ARIDBH during three years, except in third year, the low level of potassium (K_2) gave significantly decreased ARIDBH as compared to K1 (without K) and K3 (high level). However, there is highly significant differences of ARIBA resulted from potassium fertilization alone during first and second years of fertilization, in the first year K_3 significantly increased ARIBA as compared to K_1. In the second year, K_1 and K_2 highly significant increased this character comparison with K_3.

In the end of experiment (third year of fertilization), the results showed that nitrogen, phosphorus and potassium (each element alone) were non-significant effect or induced opposite effect on ARIH, ARIDBH and ARIBA. These results are in harmony with Chen *et al.,* (1997) who reported that, N fertilizer decreased the growth. Also George *et al.,* (1997) who reported that, the response to nutrient supply varies depending on the species and may only occur when trees are nutrient deficient.

2- Effect of interaction among nitrogen (N), phosphorus (P) and potassium (K) on annual rate increment for height, diameter at breast height (DBH) and basal area (BA) of *S. mahagoni.*

Data in Table (3) revealed that, there is no significant effect of the second combination N with P, N with K or K with P fertilization on HAI at all levels of fertilization during three years. Except to, the combination K with P only in the first year, which the most effective interaction was $K_1 \times P_3$ on ARIH (63.889 cm). However, the effect of the second degree of interaction on ARIDBH and ARIBA was significant differences, the most effective of the combination N×P was $N_2 \times P_2$ (1.677 cm and 31.429 cm^2) in the first year of fertilization. While in the second year, $N_3 \times P_2$ was more effective on ARIDBH (1.307 cm) and $N_3 \times P_3$ on ARIBA (39.081 cm^2). In third year, $N_2 \times P_2$ was more effective on ARIDBH (1.291 cm).

Thus the interaction of K×N, the most effective was $K_3 \times N_2$ on ARIDBH and ARIBA in the first year of fertilization, which were (1.386 cm and 25.828 cm^2). In the second year, $K_3 \times N_1$ was most effective on ARIDBH (1.201 cm) and $K_1 \times N_3$ and $K_2 \times N_3$ on ARIBA (37.843 and 37.657 cm^2), in this trend Sheedy, (1995) who reported that, fertilizer application is effective in stimulating growth and the best results were reported with treatments that included K. However, in third year ARIDBH was significant and highly significant increased in case of unfertilized trees ($K_1 \times N_1$) as compared to majority of the interaction between K×N.

Table (3): Effect of second interaction among nitrogen (N), phosphorus (P) and potassium (K) on annual rate increment for height, diameter at breast height (DBH) and basal area (BA) of *S. mahagoni.*

Treatments	Height (cm)			DBH (cm)			BA (cm^2)		
	2009	2010	2011	2009	2010	2011	2009	2010	2011
NxP									
N1xP1	38.333	42.222	43.889	0.714	0.957	0.786	7.283	14.291	27.002
N1xP2	33.333	40.000	70.000	0.493	1.223	1.136	12.643	29.206	23.964
N1xP3	49.444	57.778	40.556	0.901	0.619	1.132	13.413	28.717	17.308
N2xP1	63.889	38.333	38.333	1.026	0.628	0.589	17.744	24.642	23.362
N2xP2	40.556	47.778	40.000	1.677	0.616	1.291	31.429	17.541	24.289
N2xP3	50.556	45.000	37.222	0.808	0.716	0.760	15.503	34.978	14.921
N3xP1	34.444	35.556	36.667	1.061	0.760	0.939	16.893	27.143	23.297
N3xP2	36.667	41.667	25.000	0.730	1.307	0.417	15.507	29.402	24.031
N3xP3	45.000	27.222	30.000	0.850	0.456	0.666	7.298	39.081	10.067
Sig.	NS	NS	NS	**	**	**	**	**	NS
LSD	--	--	--	0.39	0.47	0.47	7.39	11.47	--
KxN									
K1xN1	40.000	39.444	52.778	0.453	1.003	1.262	7.666	21.273	27.330
K1xN2	63.889	51.667	45.556	1.120	0.587	0.632	18.527	30.801	20.301
K1xN3	44.444	23.333	31.111	0.998	0.677	0.881	12.667	37.843	17.802
K2xN1	34.444	46.667	52.222	0.846	0.594	0.594	15.574	27.101	20.779
K2xN2	49.444	33.333	42.222	1.004	0.733	1.008	20.322	25.612	22.353
K2xN3	28.889	36.667	26.667	0.743	1.181	0.478	8.608	37.657	18.810
K3xN1	46.667	53.889	49.444	0.810	1.201	1.197	10.100	23.839	20.166
K3xN2	41.667	46.111	27.778	1.386	0.639	1.000	25.828	20.748	19.918
K3xN3	42.778	44.444	33.889	0.900	0.664	0.662	18.423	20.127	20.782
Sig.	NS	NS	NS	**	**	**	**	**	NS
LSD	--	--	--	0.39	0.47	0.47	7.39	11.47	--
KxP									
K1xP1	41.111	35.000	36.667	0.990	0.650	0.954	10.611	27.550	30.652
K1xP2	43.333	38.889	53.333	0.762	0.953	1.169	14.940	25.347	21.770
K1xP3	63.889	40.556	39.444	0.819	0.663	0.652	13.308	37.021	13.011
K2xP1	40.556	33.333	49.444	0.886	0.723	0.597	10.718	22.459	18.609
K2xP2	30.556	43.889	42.778	0.591	1.006	0.778	19.381	26.117	28.399
K2xP3	41.667	39.444	28.889	1.117	0.780	0.706	14.406	41.794	14.934
K3xP1	55.000	47.778	32.778	0.926	0.971	0.762	20.592	16.068	24.400
K3xP2	36.667	46.667	38.889	1.547	1.187	0.897	25.258	24.686	22.116
K3xP3	39.444	50.000	39.444	0.623	0.347	1.200	8.501	23.960	14.350
Sig.	*	NS	NS	**	*	*	**	*	*
LSD	18.88	--	--	0.39	0.36	0.36	7.39	8.77	8.95

For the interaction of K×P was significant differences of ARIDBH during three years. The high level of potassium with low level of phosphorus fertilization ($K_3 \times P_2$) gave high ARIDBH in the first and second years. While in third year, the most effective of this interaction was $K_3 \times P_3$ which it was non-significant differences as compared to $K_1 \times P_1$ (unfertilized trees). The effect of interaction K×P on ARIBA, the most effective was $K_3 \times P_2$ (25.258 cm^2) in the first year and $K_2 \times P_3$ (41.794 cm^2) in the second year of fertilization, while in third year the unfertilized trees ($K_1 \times P_1$) was more effective on ARIBA (30.652 cm^2).

These results are in line with those obtained by Hillman and Takyi (1998) who showed that, NK increased the basal area and volume growth. PK treatments showed little effects on growth.

3- Effect of third interaction among nitrogen (N), phosphorus (P) and potassium (K) on annual rate increment for height, diameter at breast height (DBH) and basal area (BA) of *S. mahagoni*.

Data presented in Table (4) showed that, the fertilization with three elements (K, N and P) resulted in significant differences on ARIH during first and second year of fertilization, while in third year there is non-significant differences on ARIH. The most effective treatments on ARIH was $K_1N_2P_3$ (88.333 cm) then $K_2N_2P_1$ (83.333 cm) during first year, while in second year was $K_3N_1P_3$ (83.333). On other hand, the lowest effect treatments on ARIH was $K_2N_3P_1$ (18.333 cm) and $K_1N_3P_1$ (15.00 cm) in first and second year, respectively.

Table (4): Effect of third interaction among nitrogen (N), phosphorus (P) and potassium (K) on annual rate increment for height, diameter at breast height (DBH) and basal area (BA) of *S. mahagoni*.

Treatments	height			dbh			BA		
	2009	2010	2011	2009	2010	2011	2009	2010	2011
K1xN1xP1	35.000	40.000	40.000	0.380	0.807	0.950	3.730	16.380	35.390
K1xN1xP2	35.000	33.333	80.000	0.360	1.357	1.830	13.030	5.957	21.600
K1xN1xP3	50.000	45.000	38.333	0.620	0.847	1.007	6.237	41.483	25.000
K1xN2xP1	50.000	50.000	30.000	1.020	0.390	0.640	17.357	23.367	29.663
K1xN2xP2	53.333	55.000	50.000	1.457	0.470	0.960	13.270	27.673	28.590
K1xN2xP3	88.333	50.000	56.667	0.883	0.900	0.297	24.953	41.363	2.650
K1xN3xP1	38.333	15.000	40.000	1.570	0.753	1.273	10.747	42.903	26.903
K1xN3xP2	41.667	28.333	30.000	0.470	1.033	0.717	18.520	42.410	15.120
K1xN3xP3	53.333	26.667	23.333	0.953	0.243	0.653	8.733	28.217	11.383
K2xN1xP1	20.000	50.000	65.000	0.660	0.580	0.503	7.797	20.107	8.697
K2xN1xP2	25.000	45.000	68.333	0.620	0.620	0.583	17.410	29.233	43.347
K2xN1xP3	58.333	45.000	23.333	1.257	0.583	0.697	21.517	31.963	10.293
K2xN2xP1	83.333	23.333	61.667	1.313	0.680	0.483	21.187	24.287	31.620
K2xN2xP2	28.333	35.000	40.000	0.533	0.647	1.430	24.047	15.973	10.237
K2xN2xP3	36.667	41.667	25.000	1.167	0.873	1.110	15.733	36.577	25.203
K2xN3xP1	18.333	26.667	21.667	0.683	0.910	0.803	3.170	22.983	15.510
K2xN3xP2	38.333	51.667	20.000	0.620	1.750	0.320	16.687	33.143	31.613
K2xN3xP3	30.000	31.667	38.333	0.927	0.883	0.310	5.967	56.843	9.307
K3xN1xP1	60.000	36.667	26.667	1.103	1.483	0.903	10.323	6.387	36.920
K3xN1xP2	40.000	41.667	61.667	0.500	1.693	0.993	7.490	52.427	6.947
K3xN1xP3	40.000	83.333	60.000	0.827	0.427	1.693	12.487	12.703	16.630
K3xN2xP1	58.333	41.667	23.333	0.743	0.813	0.643	14.690	26.273	8.803
K3xN2xP2	40.000	53.333	30.000	3.040	0.730	1.483	56.970	8.977	34.040
K3xN2xP3	26.667	43.333	30.000	0.373	0.373	0.873	5.823	26.993	16.910
K3xN3xP1	46.667	65.000	48.333	0.930	0.617	0.740	36.763	15.543	27.477
K3xN3xP2	30.000	45.000	25.000	1.100	1.137	0.213	11.313	12.653	25.360
K3xN3xP3	51.667	23.333	28.333	0.670	0.240	1.033	7.193	32.183	9.510
Sig.	*	*	NS	**	NS	NS	**	**	**
LSD	32.74	29.92	--	0.66	--	--	12.74	19.78	20.20

Thus, the high level of nitrogen (N_3) gave negative effect on ARIH than N_1 and N_2 in the presence or absence of potassium and absence of phosphorus.These results are in agreement with Abd El-Dayem (1988).

As regard to the effect of combination (K×N×P) was highly significant effect on ARIDBH after the first year of fertilization only. The treatment of $K_3N_2P_2$ was more appreciable effect on increasing of ARIDBH which was (3.040 cm).

However, the application of NPK fertilization caused highly significant differences in ARIBA during three years of fertilization. The highest value of ARIBA (56.970 cm^2) was produced from treatment of $K_3N_2P_2$ in first year of fertilization which it was highly significant increased ARIBA comparison with all combination of K×N×P. while, in second year there were numbers of treatments gave highly significant increased ARIBA comparison with unfertilized trees, and which they were non-significant differences among them. However, the most effective treatment was $K_2N_3P_3$ which gave (56.843 cm^2). In third year of fertilization, ARIBA for unfertilized trees was non-significant differences in comparison to the majority of treatments which gave high value of ARIBA. These results are agreement with Abd El-Dayem (1988) found that, the treatment of $N_2P_2K_1$ was more effect on stem length and diameter of *S. mahagoni.*

4- Effect of fertilization treatments on chemical composition of *Swietenia mahagoni* in leaves and soil during 2011.

Data in Table (5) showed that, all treatments of fertilization (NPK) caused increased in soil contains of N , P and K.

The higher contains of N in soil when treated by K_1 N_2 P_1 and $K_3N_3P_2$. The higher contains of P was in soil without fertilization. However, the higher contains of K in soil when treated by $K_3N_2P_3$.

As regard to, the leaves contains of N was variable with fertilization treatments, sometimes decreased or increased in comparison with untreated trees. The higher percentage of N in leaves resulted from treated by K_1 N_2 P_1 and K_2 N_2 P_1. The highest percentage of P (0.269, 0.255 and 0.255%) in leaves resulted from treated by K_1 N_2 P_1, K_3 N_2 P_3 and K_2 N_3 P_1 , respectively.

The highest percentage of K (1.294, 1.265, 1.236 and 1.236%) resulted from treated by K_1 N_2 P_3 , K_3 N_3 P_3 , K_3 N_3 $P_1$and K_2 N_1 $P_{3,}$ respectively.

Leaves contains of N, P and K in 2008 (before fertilization) were decreased in comparison with leaves contains of N, P and K in 2011 (third year of fertilization). This results explain that, fertilization was non-significant effect on growth or it was an adverse effect on growth.

Table (5) : Effect of fertilization treatments on chemical composition of *Swietenie mahagoni* in leaves and soil during 2011.

Treatments	Leaves			Soil		
	N%	P%	K%	N%	P%	K%
K1 N1 P1	1.544	0.163	1.035	30	25	136
K1 N1 P2	1.351	0.143	1.093	30	15	152
K1 N1 P3	1.351	0.15	0.949	30	20	80
K2 N1 P1	1.544	0.122	1.208	30	13	192
K3 N1 P1	1.158	0.157	1.121	25	12	72
K2 N1 P2	0.965	0.212	1.064	25	19	48
K3 N1 P2	1.158	0.225	1.035	25	25	160
K2 N1 P3	1.931	0.243	1.236	25	22	144
K3 N1 P3	1.931	0.21	1.093	25	20	80
K1 N2 P1	2.51	0.269	0.978	40	17	80
K1 N2 P2	1.738	0.168	1.064	25	22	136
K1 N2 P3	1.931	0.218	1.294	20	23	168
K2 N2 P1	2.51	0.199	1.236	20	22	160
K3 N2 P1	1.544	0.194	1.15	20	21	72
K2 N2 P2	1.931	0.158	1.035	20	22	120
K3 N2 P2	1.351	0.232	1.121	20	22	224
K2 N2 P3	1.931	0.233	1.064	20	23	152
K3 N2 P3	1.544	0.255	1.007	25	24	304
K1 N3 P1	1.158	0.184	1.179	25	20	136
K1 N3 P2	1.931	0.126	1.093	30	23	264
K1 N3 P3	1.544	0.119	1.179	30	24	160
K2 N3 P1	1.351	0.255	1.064	30	17	80
K3 N3 P1	0.965	0.155	1.236	40	20	272
K2 N3 P2	1.351	0.151	1.035	30	22	176
K3N3 P2	1.544	0.11	1.15	20	24	80
K2 N3 P3	1.738	0.179	1.208	20	23	80
K3 N3 P3	1.931	0.22	1.265	20	22	144

Conclusions

The results of this study explained that, the nutrient requirements of *S. mahagoni* are variable with the development of different stages of growth so, this research recommended to fertilize 7-year-old *S. mahagoni* with NPK whenever the treatment contained low level of nitrogen fertilizer N_2 (51.61 g per tree) with low level of phosphorus P_2 (64.51 g per tree) with high level of potassium K_3 (32 g per tree) i.e., $K_3N_2P_2$ treatment induced high thickness of stem i.e., maximum of annual rate increment for diameter at breast height (ARIDBH) and annual rate increment for basal area (ARIBA). However, the maximum annual rate increment for height (ARIH) resulted from N_2 with P_3 (129.03 g per tree) i.e., $K_1N_2P_3$ and N_2 with K_2 (16.00 g per tree) i.e., $K_2N_2P_1$. In 8-year-old, treatments of $K_3N_1P_3$ gave maximum of ARIH and $K_2N_3P_3$ gave maximum of ARIBA. In 9-year-old, the fertilizer of NPK was non-significant effect on ARIH, ARIDBH and ARIBA , and may lead to inverse effect many treatments. So this research suggest that, application of trace elements such as Zn, B and S accompanied with NPK fertilizers (low level of these elements) that is may be improved response to NPK and improve growth of *S. mahagoni* in the following years.

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تحسين معدل النمو السنوي للماهوجني الاسباني باستخدام التسميد بال N P K في اراضي الاستصلاح الجديده

مها فاروق محمد إسماعيل، منى مصطفى عباس و هالة مصطفى كمال
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في هذا البحث تم دراسة تأثير إضافة السماد النتروجينى والفوسفورى و البوتاسى على معدل الزيادة السنوية لنمو الماهوجنى الاسباني التابع لعائلة الماهوجنى عمر سبع سنوات والمنزرع في الاراضى المستصلحة في مزرعة على مبارك البحثية التابعة لمعهد بحوث البساتين بمركز البحوث الزراعية والتي تقع شمال غرب القاهرة بجمهورية مصر العربية وكانت مسافات الزراعة ٣x٣ م . خلال السنوات من ٢٠٠٨ إلى ٢٠١١ حيث تم التسميد بسلفات الأمونيوم (١٥,٥ % ن) بمعدل ن١ =٠,٠ , ن٢ =٥١,٦١ , ن٣ = ١٠٣,٢٢ جم للشجرة وسوبر فوسفات (٤٠-٤٦% فو٢ أ٥) بمعدل فو١ =٠,٠ , فو٢ =٦٤,٥١, فو٣ =١٢٩,٠٣ جم للشجرة وسلفات البوتاسيوم (٥٠% بو٢ أ) بمعدل بو١ = ٠,٠ , بو٢ = ١٦ , بو٣ =٣٢ جم للشجرة حيث تم عمل ٢٧ معاملة فكانت أفضل المعاملات تأثيرا في الزيادة السنوية للارتفاع بو١ ن٢ فو٣ و بو٢ ن٢ فو١ (٨٨,٣٣٣, ٨٣,٣٣٣ سم) في السنة الأولى والمعاملة بو٣ ن١ فو٣ في السنة الثانية والتي أعطت (٨٣,٣٣٣ سم) . المعاملة بو٣ ن٢ فو٢ أعطت أعلى قيمة لمعدل الزيادة السنوية في القطر عند ارتفاع الصدر والتي كانت (٣,٠٤٠ سم) وأعلى قيمة لمعدل الزيادة السنوية في المساحة القاعدية والتي كانت (٥٦,٩٧٠ سم٢) في السنة الأولى من التسميد. بينما في السنة الثانية المعاملة بو٢ ن٣ فو٣ أحدثت أعلى قيمة في معدل الزيادة السنوية في المساحة القاعدية (56.843سم٢) في حين انه في السنة الثالثة من التسميد لم يكن هناك تأثير معنوي للتسميد على القياسات السابقة الذكر وفى كثير من المعاملات أدى التسميد إلى تأثير عكسي على هذه القياسات .

قام بتحكيم البحث

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