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Effect of fertilizers on quality seedling production in *Swietenia macrophylla* King

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Abstract
An experiment was conducted to know the influence of different blends of chemical fertilizers, biofertilizers and organic fertilizers on quality seedling production in *Swietenia macrophylla* King by using seedlings (> 21 cm height at 51 DAS) in polybags (15 x 25 cm^2) filled with standard soil mixture 3:1 (Soil: FYM) with three levels of nitrogen (0, 1 and 2g N $seedling^{-1}$) as Urea, three levels of phosphorus (0,1 and 2 g P_2O_5 $seedling^{-1}$) as Single Super Phosphate and three levels of potassium (0, 1 and 2 g of K_2O $seedling^{-1}$) as Muriate of Potash along with vermicompost (50 g) and bio-fertilizers Viz., *Azophos* (5g) and VAM (5g) $seedling^{-1}$. There were twelve treatments (mixture of different fertilizers in polybag) arranged in a completely randomised design with three replications @ 30 polythene bags per treatment per replication. The results show that at 120 DAT the treatment T_9 (the application of 1g of each NPK with vermicompost (50 g) and *Azophos* (5 g) $seedling^{-1}$) performed significantly better in visual parameters *i.e.* shoot length (53.47 cm), root length (39.71 cm), collar diameter (3.63 mm), leaf area (cm^2) and number of leaflets (27.1 No's), quality indices *i.e.* volume index (7.03 cm^3), quality index (0.2661) and sturdiness quotient (14.75) as well as bio chemical parameters *i.e.* chlorophyll a content (1.679 mg g^{-1}), Chlorophyll b content (1.160 mg g^{-1}) and total chlorophyll content (3.306 mg g^{-1}). Hence, the optimal mixture of nutrients 1g of each NPK with vermicompost (50 g) and *Azophos* (5 g) $seedling^{-1}$ is ideal for production of quality seedlings with reduced nursery duration.

Keywords: Quality Seedling Production, fertilizers, *Swietenia macrophylla* King, *Azophos,* chlorophyll content

Introduction

Swietenia macrophylla King (*Meliaceae*) is one of the most commercially important timber tree species in neo-tropical forests (price around USD 1700 $feet^{-3}$) which comes under vulnerable category of IUCN (IUCN red data list, 2016) [27]. The species also have potential for reforestation and afforestation, particularly for improving soil. However, due to uncontrolled commercial exploitation of this species, the population has depleted severely, Hence with concern of future of this species, it was listed in Appendix II (species that may face extinction if trade is not controlled) of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in 2002 (Grogan and Barreto 2005) [9].

As conditions are not always optimums for quality seedlings production in nursery beds, the seedling quality can be manipulated with the use of different fertilizers. Continuous usage of soil in the nursery affects their physico-chemical properties and become poor in nutrient status restricting the seedling growth. Efficient use of fertilizers helps to achieve maximum growth and economize production by decreasing fertilizer inputs and their run off (Marschner, 1995) [16]. There is no adequate work regarding quality seedling production through integrated nutrient application has been done, with this need the present experiment has been designed and carried out to know the combined effect of organic, inorganic and biofertilizer application on the growth and quality indices of *Swietenia macrophylla* King seedlings.

Material and Methods

The experiment was conducted at Forest College and Research Institute, Mettupalayam, located at 11°19'N latitude and 77°56'E longitudes with an altitude of 320 m above MSL The experimental soil was red sandy loam (Typic ustropept) in texture. The initial soil was low in available nitrogen, 134.40 kg ha-1 (Subbaiah and Asija, 1956) [25] and organic carbon, 4.40 g kg-1 (Walkley and Black, 1934), low in available phosphorus, 9.83 kg ha-1 (Olsen *et al*., 1954) [18] and high in available potassium, 282.98 kg ha-1 (Stanford and English, 1949) [24].

Well decomposed and uniformly dried Farm Yard Manure (FYM with 0.50 % N, 0.20 % P and 0.50 % K) and Vermicompost (1.25 % N, 0.30 % P and 0.50 % K) were used as organic manure. Urea (46 % N), Single Super Phosphate (16 % P) and Muriate of Potash (60 % K) were used as inorganic sources of nitrogen, phosphorus and potassium respectively. The microbial inoculants viz., *Azophos* (prepared using peat soil as carrier with the population of 108 bacteria cells gram^{-1} of carrier) and Vesicular Arbuscular Mycorrhizae (VAM with vermiculite based mixed inoculum (*Glomus*, *Gigaspora* and *Aculospora*) containing 110 spores gram^{-1} of vermiculite) were used as biofertilizers. The high quality and graded seeds of *Swietenia macrophylla* were pre soaked in water for twelve hours and sown in raised nursery bed of size 10 x 1 m^2 by uniform broadcasting. Seedlings of uniform quality and with > 21 cm heights at 51 DAS (days after showing) were pricked out and randomly allotted to the all treatments.

The polythene bags of size 25 x 15 cm^2 (200 gauge thickness) were filled with soil mixture of Soil:FYM @ 3:1. The bags were arranged in a completely randomised design (CRD) as described by Snedecor and Cochran (1967) with three replications @ 30 polythene bags per treatment per replication. There are twelve treatments with 90 bags per treatment (Table 1).

Table 1: Treatments detail for experiment

Treatment	Nutrient combination levels
T1	Soil and FYM in 3:1 ratio
T2	T1 + Azophos (5 g) seedlings-1
T3	T1 + VAM (5 g) seedlings-1
T4	T1 + 1 g each of NPK seedlings-1
T5	T1 + 2 g each of NPK seedlings-1
T6	T1 + Vermicompost (50 g) seedlings-1
T7	T4 + Vermicompost (50 g) seedlings-1
T8	T5 + Vermicompost (50 g) seedlings-1
T9	T4 + Vermicompost (50 g) + Azophos (5 g) seedlings-1
T10	T5+ Vermicompost (50 g) + Azophos (5 g) seedlings-1
T11	T4 + Vermicompost (50 g) + VAM (5 g) seedlings-1
T12	T5 + Vermicompost (50 g) + VAM (5 g) seedlings-1

The calculated quantity of organic manure (Vermicompost) and bio-fertilizer (*Azophos* and VAM) were applied as per the treatments before planting and mixed well in soil. Inorganic fertilizer *viz.,* Single Super Phosphate (SSP) and Muriate of Potash (MOP) were applied as basal dose while filling Polybags. Urea was applied in three splits to each seedling in the form of aqueous solution at fifteen days after transplanting and at fifteen days intervals. At each split application time, the calculated amount of Urea for each treatment was diluted in water to make into volume of 900 ml fresh aqueous solution and 10 ml of this solution applied carefully to each seedling. The uniform and needful irrigation and plant protection measures were provided to all treatments.

Visual parameters *i.e.* shoot length, root length, mean collar diameter and number of leaflets along with quality indices *i.e.* volume index (Hatchell, 1985) [11], quality index ((Ritchie, 1984) and sturdiness quotient (Ritchie, 1984) were recorded at 30, 60, 90 and 120 days after transplanting (DAT) from the randomly selected five seedlings per treatment per replication and the mean value for each parameter was calculated. The bio chemical parameters *i.e.* the chlorophyll a content, chlorophyll b content and total chlorophyll content of the representative matured fresh leaf sample (third leaf from the top) were estimated and expressed as mg gram^{-1} of fresh weight of leaves (Yoshida *et al.*, 1971) [30].

Results and Discussions

A study shows that various combination of fertilizers influencing significantly different on various parameters of the *S. macrophylla* seedlings across the growth stages the same has presented here.

Shoot Length

At Initial stage (at T) there was no significant variation in the values of shoot length. At 30 DAT the T_9 (29.50 cm), T_{11} (29.42 cm), T_{10} (29.13 cm) and T_{12}(28.74 cm) were on par with each other and performing significantly better than other treatments. At 60 DAT T_9 (37.29 cm) and T_{11} (36.31 cm) were on par with each other and performed significantly superior. The same trend was followed for 90 and 120 DAT. The T_1 was the poorest performer with the values of 24.95, 28.65, 33.00 and 37.32 cm respectively at the same growth stages (Table 2).

Table 2: Effect of various (fertilizers) treatments on biometric parameters at different growth stages of *S.macrophylla* seedlings

Treatment	Shoot length (cm)					Root length (cm)				
	At T	30 DAT	60 DAT	90 DAT	120 DAT	At T	30 DAT	60 DAT	90 DAT	120 DAT
T1	21.38	24.95	28.65	33.00	37.32	6.90	13.13	16.70	21.31	25.06
T2	21.34	26.09	31.61	37.19	42.75	6.84	14.17	19.03	24.83	30.21
T3	21.35	25.36	29.41	33.72	37.94	6.86	13.61	17.49	22.11	25.83
T4	21.24	27.15	32.65	38.46	44.23	6.87	15.31	20.57	26.12	31.97
T5	21.44	26.00	30.89	37.53	44.08	6.84	14.33	18.87	25.79	31.39
T6	21.43	26.04	31.94	37.67	43.37	6.87	14.22	19.30	25.10	30.51
T7	21.39	28.16	34.69	41.62	48.46	6.84	16.36	22.38	29.90	35.35
T8	21.40	28.00	33.17	39.93	46.56	6.85	15.99	21.04	27.47	33.56
T9	21.58	29.50*	37.29*	45.34*	53.47*	6.83	17.51*	25.29*	32.47*	39.71*
T10	21.24	29.13*	35.37	42.92	50.64	6.87	17.39*	23.27	30.60	37.33
T11	21.33	29.42*	36.31*	44.52*	52.77*	6.89	17.43*	24.42	31.85*	39.01*
T12	21.47	28.74*	35.36	42.37	49.23	6.91	16.74	23.13	30.29	35.75
MEAN	21.40	27.38	33.11	39.52	45.90	6.87	15.52	20.96	27.32	32.97
SEd	0.1341	0.4386	0.5660	0.6733	0.8945	0.0299	0.3047	0.4149	0.7400	0.6763
CD (P=0.05)	NS	0.9053	1.1681	1.3896	1.8462	NS	0.6289	0.8563	1.5274	1.3959
		S**	S**	S**	S**		S**	S**	S**	S**

The finding revealed that judicious combination of organic, inorganic and biofertilizers may provide sufficient nutrient supply to plants in available forms in sustained manner by the quick release inorganic fertilizers at the initial stages and the slow releaser organic manures and biofertilizers at the later stages. Further biofertilizers like *Azophos* may help to mobilize nutrients and make available to plants.

Rathakrishnan *et al.*, (2004) [21] stated that the combined application of *Azospirillum* and PSB has resulted in increasing shoot length of *Simaruba glauca* seedlings. Bharath (2011) [2] revealed that the application of *Phosphobacteria*, vermicompost and *Azospirillum* along with recommended NPK gained the maximum shoot length (52.59 cm) of *Acrocarpus fraxinifolius* seedlings. The same response of growth in *Dendrocalamus hamiltonii* was reported by Suveena *et al.*, (2015) [26].

Root Length

In beginning there was no significant difference for the root length values. At 30 DAT the on par treatments T_9 (17.51 cm), T_{11} (17.39 cm) and T_{10} (17.43 cm) were on par and significantly superior to other treatments. At 60 DAT the significant by the highest root length was recorded in T_9 (25.29 cm) and this was followed by T_{11} (24.42 cm). At 90 DAT treatments T_9 (32.47 cm) and T_{11} (31.85 cm) were on par and significantly superior, the same trend was followed at 120 DAT. The T_1 with the value of 13.13, 16.70, 21.31 and 25.06 cm respectively at 30, 60, 90 and 120 DAT was poorest performer (Table 2).

The *Azophos* may perform best with vermicompost and lower dose of inorganic fertilizer of 1 g each of NPK which might have contributed for better P availability and favoring vigorous root growth. The *Phosphobacteria* inoculation may engineer the rhizosphere to promote root growth.

Deswal *et al.*, (2001) [6] showed that the combination of N and P at 40, 20 mg seedling^{-1} respectively resulted in increased root length of *Acacia nilotica* seedlings. This is in harmony with Amol (2009) [1] who stated that the application of *Phosphobacteria*, and *Azospirillum* along with NPK recorded the highest improvement in root length (41.16 cm) of *Bambusa vulgaris* seedlings.

Collar Diameter

It exhibited a significant variation among the treatments at all the growth stages starting from 30 DAT. At 30 DAT the T_9(2.63 mm), T_{11}(2.63 mm), T_{10}(2.62 mm) and T_{12}(2.60 mm) were on par and recorded the significant by the highest collar diameter. At 60 DAT T_9 (2.93 mm) perform significantly better than other treatment followed by T_{11} (2.90 mm), the same trend was followed at 90 DAT. However at 120 DAT T_9 (3.63 mm) was on par with T_{11} (3.61 mm) and significantly superior over other treatments. The lowest collar diameter of 2.41, 2.65, 3.02 and 3.15 mm were observed under control (T_1) at same stages respectively (Table 3).

This might be due to facts that higher root and shoot growth enhanced the nutrient and food availability. The stem needs to store this reserve and this was displayed by higher collar diameter growth.

Ramasamy (2009) [20] postulated that the combined application of *Phosphobacteria*, vermicompost and *Azospirillum* along with NPK enhanced the collar diameter (0.914 cm) of *Bixa orellana* seedlings. Brahmi *et al.* (2010) [3] reported the higher plant height and collar diameter in seedlings of *Acacia catechu* when bio-fertilizers integrated with chemical fertilizers. These results are in accordance with studies conducted by Krishnan (2001) [13] on *Simaruba glauca* and Chandrakhanth (2011) on *Eucalyptus pellita*.

Number of Leaflets

The different treatments influenced number of leaflets significantly at all stages starting from 30 DAT. At 30 DAT the T_9 (5.8), T_{11} (5.7) and T_7(5.7) were on par and significantly best over other treatments. At 60 DAT the treatments T_9 (9.4) and T_{11} (9.4) were on par and significantly best over remaining treatments. At 90 DAT T_9 (18.5) was significantly best which is followed by T_{11} (17.7) and the same growth trend was recorded at 120 DAT. The control (T_1) was the poorest performer with the values of 5.3, 5.7, 9.9 and 15.1 number of leaflets at same stages respectively (Table 3).

Table 3: Effect of various (fertilizers) treatments on biometric parameters at different growth stages of *S.macrophylla* seedlings

Treatment	Collar diameter (mm)					Number of leaflets (number)				
	At T	30 DAT	60 DAT	90 DAT	120 DAT	At T	30 DAT	60 DAT	90 DAT	120 DAT
T1	2.15	2.41	2.65	3.02	3.15	3.6	5.3	5.7	9.9	15.1
T2	2.14	2.46	2.69	3.04	3.17	3.7	5.6	7.7	11.5	20.3
T3	2.16	2.44	2.68	3.03	3.16	3.8	5.5	7.2	14.3	15.5
T4	2.14	2.54	2.74	3.12	3.23	3.7	5.5	7.8	14.3	23.9
T5	2.15	2.51	2.73	3.09	3.23	3.7	5.5	6.7	13.5	20.3
T6	2.17	2.48	2.72	3.06	3.20	3.9	5.6	9.0	13.9	18.3
T7	2.14	2.58	2.79	3.17	3.41	3.6	5.7*	7.8	15.7	22.7
T8	2.19	2.56	2.76	3.14	3.30	3.7	5.3	7.3	15.6	19.9
T9	2.18	2.63*	2.93*	3.28*	3.63*	3.9	5.8*	9.4*	18.5*	27.1*
T10	2.14	2.62*	2.88	3.22	3.55	3.7	5.0	8.3	15.4	23.6
T11	2.16	2.63*	2.90	3.24	3.61*	3.6	5.7*	9.4*	17.7	25.7
T12	2.17	2.60*	2.85	3.19	3.46	3.8	5.0	8.2	14.7	22.5
MEAN	2.16	2.5372	2.7756	3.1317	3.3417	3.78	5.47	7.86	14.57	21.23
SEd	0.0088	0.0182	0.0068	0.0089	0.0151	0.0577	0.0694	0.0609	0.0527	0.0561
CD (P=0.05)	NS	0.0376	0.0140	0.0184	0.0311	NS	0.1432	0.1256	0.1088	0.1158
	X	S**	S**	S**	S**		S**	S**	S**	S**

This may be due to real time availability of nutrients as per need of seedling growth by the mixture of organic, inorganic and biofertilizers. Continues supply of nutrients from different fertilizer like organic, inorganic and biofertilizer coupled with irrigation has helped in more leaf production for photosynthetic activity to produce more food for growth.

The number of leaflets may significantly increase by nutrient boost from various fertilizers has been postulated by different scientists in their earlier studies. As combined application of NPK along with vermicompost and *azophos* boost number of leaves in *Melia dubia* reported by Lebba (2011) [15], when 75 mg Urea and 60 mg SSP were added in *Khaya ivorensis* revealed by Focho *et al.*, (2011) [8] and application of complex fertilizers at 1.0 g $seedling^{-1}$ in *Gmelina arborea* as concluded by Vivekananda (2016).

Quality indices

1. Volume index

At 30 DAT treatments T_9(2.04), T_{11}(2.04) and T_{10}(1.99) were on par and significantly best over remaining treatments. At 60 DAT T_9(3.19) was significantly best followed by T_{11}(3.06), the same trend was recorded at 90 DAT. However, at 120 DAT significantly best performance recorded under on par treatments T_9 (7.03) and T_{11}(6.86). The control recorded the lowest volume index with values of 1.45, 2.01, 3.01 and 3.70 cm^3 at the same growth stages respectively (Table 4).

2. Sturdiness quotient

At 30 DAT the treatments T_9 (11.23), T_{11} (11.18), T_{10} (11.13), T_{12}(11.07), T_8(10.95) and T_7(10.91) were on par and significantly superior. At 60 DAT the significantly best on par treatments were T_9 (12.74), T_{11} (12.51), T_{12} (12.42) and T_7(12.45). However, at 90 DAT significant best and on par treatments were T_9 (13.84) and T_{11} (13.75). Beyond this at 120 DAT on par treatments T_9 (14.75), T_{11}(14.63), T_{10}(14.27), T_{12}(14.22) and T_7(14.21) were significantly better. The T_1 was poorest performer with the values of 10.34, 10.81, 10.93 and 11.85 at same stages respectively (Table 4).

Table 4: Effect of various fertilizers treatments on various quality indices at different growth stages of *S.macrophylla* seedlings

Treatment	Volume index (cm3)				Sturdiness quotient				Quality Index			
	30 DAT	60 DAT	90 DAT	120 DAT	30 DAT	60 DAT	90 DAT	120 DAT	30 DAT	60 DAT	90 DAT	120 DAT
T1	1.45	2.01	3.01	3.70	10.34	10.81	10.93	11.85	0.0946	0.1193	0.1475	0.1742
T2	1.58	2.29	3.43	4.30	10.61	11.75	12.25	13.49	0.1064	0.1375	0.1750	0.2044
T3	1.51	2.11	3.09	3.80	10.39	10.99	11.14	11.99	0.0986	0.1256	0.1574	0.1869
T4	1.75	2.46	3.74	4.62	10.70	11.90	12.34	13.68	0.1089	0.1413	0.1798	0.2089
T5	1.64	2.30	3.58	4.59	10.35	11.33	12.16	13.66	0.1125	0.1487	0.1840	0.2111
T6	1.60	2.36	3.52	4.44	10.51	11.76	12.32	13.55	0.1093	0.1409	0.1787	0.2083
T7	1.87	2.69	4.18	5.64	10.91*	12.45*	13.13	14.21*	0.1139	0.1485	0.1883	0.2242
T8	1.83	2.53	3.95	5.07	10.95*	12.00	12.70	14.11	0.1106	0.1477	0.1859	0.2164
T9	2.04*	3.19*	4.87*	7.03*	11.23*	12.74*	13.84*	14.75*	0.1280*	0.1729*	0.2300*	0.2661*
T10	1.99*	2.93	4.46	6.38	11.13*	12.30	13.31	14.27*	0.1191	0.1608	0.2050	0.2414
T11	2.04*	3.06	4.66	6.86*	11.18*	12.51*	13.75*	14.63*	0.1208	0.1650	0.2161	0.2500
T12	1.94	2.87	4.30	5.91	11.07*	12.42*	13.30	14.22*	0.1188	0.1528	0.2006	0.2384
MEAN	1.7706	2.5661	3.8978	5.1956	10.7822	11.9136	12.5978	13.7003	0.1118	0.1467	0.1874	0.2192
SEd	0.0389	0.0468	0.0711	0.1083	0.1962	0.2055	0.2174	0.2738	0.0018	0.0019	0.0028	0.0038
CD (P=0.05)	0.0804	0.0967	0.1468	0.2235	0.4050	0.4241	0.4486	0.5651	0.0037	0.0040	0.0059	0.0078
	S**	S**	S**	S**	S**	S**	S**	S**	S**	S**	S**	S**

3. Quality index

Quality index was significantly influenced by different treatments at all growth stages starting from 30 DAT. The treatment T_9 (0.1280) recorded the significantly highest value of quality index followed by T_{11}(0.1208) and the lowest value of the same was recorded in T_1(0.0946) at 30 DAT. The same trend was recorded at 60, 90 and 120 DAT stages (Table 4).

The better attainment of quality parameters are indicators of balanced and ensured superior seedling growth. Seedlings needs for nutrients and food increased with time and plants try to achieve it with specific and systematic growth which leads in quality improvement with higher growth. biofertilizers *Azospirillum*, *Phosphobacteria* and vermicompost may increase efficiency of nutrient supply in available forms and improve the growth.

Several authors also evidenced similar findings as like Kumar (2007) in *Ailanthus excelsa*, David camus (2008) [5] in *Melia dubia*, Bharath (2011) [2] in *Acrocarpus fraxinifolius* and Vivekananda (2016) in *Gmelina arborea*.

Chlorophyll Content

At 30 DAT the significant by highest value of Chlorophyll 'a' content was recorded with T_9 (1.589 mg g^{-1}). At 60 DAT treatments T_9 (1.597 mg g^{-1}), T_{11} (1.571 mg g^{-1}) and T_{10}(1.559 mg g^{-1}) were on par and superior to other treatments. At 90 DAT the on par treatments T_9 (1.625 mg g^{-1}), T_{11} (1.619 mg g^{-1}), T_{10}(1.594 mg g^{-1}) and T_{12}(1.581 mg g^{-1}) were best over remaining treatments and the same growth trend recorded for 120 DAT. The T_1 recorded poorest performance for all stages of growth (Table 5).

Table 5: Effect of various fertilizers treatments on biochemical parameter at different growth stages of *S. macrophylla* seedlings

Treatment	Chlorophyll 'a' content (mg g^{-1})				Chlorophyll 'b' content (mg g^{-1})				Total chlorophyll content (mg g^{-1})			
	30 DAT	60 DAT	90 DAT	120 DAT	30 DAT	60 DAT	90 DAT	120 DAT	30 DAT	60 DAT	90 DAT	120 DAT
T1	0.538	0.541	0.550	0.559	0.288	0.297	0.324	0.350	0.968	0.991	1.021	1.053
T2	0.818	0.831	0.852	0.894	0.422	0.448	0.461	0.476	1.372	1.383	1.400	1.422
T3	0.749	0.757	0.763	0.770	0.336	0.360	0.379	0.399	1.224	1.250	1.283	1.318
T4	0.891	0.895	0.900	0.909	0.593	0.650	0.690	0.732	1.792	1.838	1.890	1.947
T5	0.825	0.841	0.874	0.906	0.540	0.543	0.556	0.560	1.527	1.553	1.600	1.677
T6	0.808	0.825	0.840	0.900	0.511	0.523	0.536	0.533	1.495	1.515	1.569	1.627
T7	1.449	1.510	1.531	1.553	0.739	0.745	0.767	0.793	2.222	2.256	2.297	2.342
T8	1.327	1.412	1.515	1.537	0.670	0.682	0.693	0.703	1.926	1.956	1.992	2.030
T9	1.589*	1.597*	1.625*	1.679*	1.001*	1.045*	1.101*	1.160*	2.835*	2.964*	3.133*	3.306*
T10	1.514	1.559*	1.594*	1.630*	0.794	0.818	0.860	0.906	2.668	2.697	2.729	2.766
T11	1.528	1.571*	1.619*	1.651*	0.957*	1.013*	1.053*	1.097*	2.694	2.773	2.830	2.890
T12	1.493	1.525	1.581*	1.637*	0.748	0.789	0.818	0.849	2.456	2.499	2.548	2.600
MEAN	1.1273	1.1553	1.1869	1.2188	0.6333	0.6597	0.6860	0.7131	1.9315	1.9728	2.0244	2.0816
SEd	0.0180	0.0232	0.0314	0.0485	0.0322	0.0299	0.0434	0.0647	0.0255	0.0487	0.0751	0.1050
CD (P=0.05)	0.0370	0.0479	0.0648	0.1001	0.0664	0.0617	0.0896	0.1336	0.0526	0.1004	0.1550	0.2167
	S**	S**	S**	S**	S**	S**	S**	S**	S**	S**	S**	S**

At 30 DAT the maximum values of Chlorophyll 'b' content was recorded with treatment T_9 (1.001 mg g^{-1}) followed by on par treatment T_{11} (0.957 mg g^{-1}) and the lowest value of the same were recorded with T_1(0.288 mg g^{-1}). The similar trend was recorded for 60, 90 and 120 DAT (Table 5).

At 30 DAT the significant by highest value of total chlorophyll content was recorded in T_9 (2.835 mg g^{-1}) followed by T_{11} (2.694 mg g^{-1}) and the T_1(0.968 mg g^{-1}) was the poorest performer. The same trend followed at 60, 90 and 120 DAT growth stages (Table 5).

This might be credited to that the plant had better balanced nutrition especially N and K from inorganic source and P from both inorganic and bio-fertilizers with organic manure sources and hence enhanced chlorophyll content. Further, biofertilizers improve eco physiological efficiency of plants which may leads to more growth in source tissues with higher chlorophyll content.

Palanikumaran and Jaisankar (2014) [19] studied in *Dalbergia sissoo* seedlings postulated that the treatment with NPK along with vermicompost, *Azophos* and VAM showed significantly the maximum chlorophyll 'a' content, chlorophyll 'b' and total chlorophyll content.

The similar findings were recorded by, Amol (2009) [1], Ramasamy (2009) [20] Bharath (2011) [2] and Vivekanand (2016) [28] respectively in *Bambusa vulgaris, Bixa orellana*, *Acrocarpus fraxinifolius* and *Gmelina arborea* seedlings. Grzesik *et al.*, (2017) [10] confirmed that biofertilizers can improve the chlorophyll contain of *Salix viminalis*.

Conclusion

From this study it can be concluded that a judicious combination of 1 g each of NPK along with vermicompost (50 g) and *Azophos* (5 g) seedling^{-1} could fetch the best quality seedling comparatively with shorter nursery duration by providing the optimum nutrient supply.

These seedlings may ensure reduced field mortality by having balanced growth and adequate food reserve. Further, the same type experiments may carry out in field for availing the same information for open field condition.

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