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Effect of inorganic, organic and Biofertilizers on growth characteristics of *Albizzia lebbeck* (L.) Benth at seedling stage

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Abstract
The study entitled "Effect of inorganic, organic and biofertilizers on growth characteristics of *Albizzia lebbeck* (L.) Benth at seedling stage" was conducted in research plots of faculty of forestry, BAU, Ranchi during the session 2018-2019. The nursery layout was made according to the requirements of the study. The study was conducted for time period of 6 months. The various treatment compositions were made by using inorganic, organic and biofertilizers with various levels. The seed characteristics were studied before sowing into the polybag. The germination, growth and quality parameters of *Albizzia lebbeck* under the influence of various treatments were studied. The growth parameters showed variation among the treatment combinations. *Albizzia lebbeck* seedlings under influence of applied treatment combinations showed that maximum was in PSB and Urea (40.73 cm), maximum was in PSB and Urea (29.10 cm), maximum was in *Brady rhizobium japonicum* and Karanj cake (5.07 mm). The quality parameters were found to be significantly different between treatments *Albizzia lebbeck* seedlings under influence of applied treatment combinations showed that maximum was in treatment containing sole Urea (1.29),vigour index (V.I) of *Albizzia lebbeck* seedlings under influence of applied treatment combinations showed that maximum was in treatment in PSB and Urea combination (6486.65),sturdiness quotient (S.Q) of *Albizzia lebbeck* seedlings under influence of applied treatment combinations showed that maximum was in PSB and Urea combination (8.95) and Dickson quality index (Q.I) of *Albizzia lebbeck* seedlings under influence of applied treatment combinations showed that maximum was in *Brady rhizobium japonicum*(1.92). The available nitrogen was found maximum in treatment combinations of *Brady rhizobium japonicum* and Karanj cake (T_7) i.e. 371.2 kgha$^{-1.}$ While available phosphorous was found maximum in treatment combinations of PSB and Urea (T_8) i.e. 37.83 Kgha^{-1}.

Keywords: Organic, inorganic, biofertilizers, *Albizzia lebbeck*, seedling

Introduction
Leguminous nitrogen fixing tree species (NFTs) can be implemented in agroforestry systems; they play a major role in improving productivity of degraded soils. Nitrogen fixation is a pattern of nutrient cycling which has successfully been used in perennial agriculture for millennia. Nitrogen fixing trees are especially valuable in subtropical and tropical agroforestry. They can be integrated into an agroforestry system to restore nutrient cycling and fertility self-restoration.

NFTs are often deep rooted, which allows them to gain access to nutrients in subsoil layers. Their constant leaf fall enriches soil life, which in turn can support other plants. The extensive root system achieves near soil equilibrium, while constantly growing and degenerating itself, adding organic matter to the soil while creating suitable conditions for aeration. There are many species of NFTs that can also provide numerous useful products and functions, including food, wind protection, shade, animal fodder, fuel wood, living fence, and timber, in addition to providing nitrogen to the ecological system. NFTs establish readily, grow rapidly, and regrow quite fast from pruning activities. They are perfectly suitable to jump-start organic matter production on an area, creating large and constant source of nutrient-rich mulch for other plants. Nitrogen fixing tree are important in afforestation of degraded lands and are widely grown in India. The nitrogen fixing tree such as *Albizia lebbeck* which is the focus point of the present study has immense potential as multipurpose tree species (MPTs) and as well as biological nitrogen fixation (BNFs). *A. lebbeck* is a dominant species in semi-evergreen forest in areas with a mean annual rainfall of 1300-1500 mm and a very dry winter. It can withstand long, hot, dry periods and cold winters. Agroforestry systems in which huge amount of nutrients are removed in harvested products are less likely to be sustainable without fertilization.

Fertilizers are defined as any organic or inorganic material which is added to a soil to supply certain elements essential to the growth of plants (Soil Science Society of America, 1987). Fertilizer requirement varies from species to species. Therefore, there is need to find out the optimum dose of different nutrients for proper growth and development of plants. Planting stock is a necessary pre-requisite for the success of any agroforestry programme. Fertilizers play an important role in boosting the initial growth and development of the plants in nursery. Judicious fertilizer application is one of the important factors considered for successful production of healthy seedlings in the nursery (Blatchford, l978) [9] as both inadequate and the excess doses of fertilizer are harmful for plant growth. *Albizia lebbeck* is nitrogen fixing leguminous tree which has immense potential in state like Jharkhand where basically trees like *Cassia siamea*, *Melia azedarach*, *Gmelia arborea*, *Pongamia pinnata*, and *Dalbergia sisoo* are mostly used in agroforestry system. It is not *Rhizobium* specific and native strains are nearly always capable of producing an abundance of nodules. This particular characteristics make this tree exceptional than other leguminous tree species. Suitable combined doses of Inorganic, organic and Bio-fertilizers for growing planting stock which will be boon in nursery for Jharkhand state where this species has yet to achieve its full potential.

Materials and Method

The experiments were conducted at nursery of Faculty of forestry, Birsa Agricultural University, Ranchi, Jharkhand. It is located in between 20°20' N to 23° 43' N latitude and 84° 0'E to 85° 54'E longitude. The altitude is about 611 m above the mean sea level.The soil of the site is lateritic, developed from granite-gneiss. The texture is sandy loam, well drained with low water holding capacity and poor consistency. The soil is hard when it is dried after raining. According to the recent classification the soil comes under mixed hyperthermic, typic hapludalf. The nature of the soil is sedentary.

The experimental design was CRD with 11 treatments including the control having 3 replications (T_0= Soil+FYM+Sand (control), T_1 =Urea, T_2 = Pongamia pinnata cake, T_3 = Phosphorous solubilizing bacteria, T_4 = Brady rhizobacterium japonicum, T_5= Urea+ Pongamia cake, T_6= PSB+ Pongamia cake, T_7= BRJ+ Pongamia cake, T_8= PSB+Urea, T_9= BRJ+Urea, T_{10}= combination of all. The layout of the experiment was followed according to the standard methodological procedures followed in the polybag experiments in the nursery site conditions. The observations that were taken are shoot length, root length, collar diameter, vigour index, sturdiness quotient, Dickson quality index and root-shoot ratio. The Physico-chemical characteristics were also observed before and after completion of the research. Average of 5 randomly selected samples was recorded at which seedlings are matured enough for transplanting to the main field. The data are collected and computed and statistically analyzed. The analyzed data was subjected to ANOVA with critical difference values tabulated at five percent level of significance of corresponding degree of freedom.

Result and Discussion

Shoot length of *Albizzia lebbeck* seedlings under influence of applied treatment combinations showed that maximum shoot length was found in combinations of PSB and Urea (40.73 cm) followed by Bradyrhizobacterium and Urea (38.27 cm) and lowest shoot length was observed in sole Bradyrhizobacterium (22.53 cm). Maximum root length was found in combinations of PSB and Urea (29.10 cm) followed by Bradyrhizobacterium and Karanj cake (27.30 cm) and lowest root length was recorded in Sole PSB (16.74 cm). Maximum collar diameter was found in combinations of PSB and Karanj cake (5.07 mm) followed by sole Karanj cake (4.97 mm) and BRJ and Urea (4.72mm) respectively and lowest collar diameter was found in sole BRJ (4.00 mm). Root-shoot ratio of *Albizzia lebbeck* seedlings under influence of applied treatment combinations showed that maximum root-shoot ratio was in sole Urea (1.29) followed by sole BRJ(1.24) and the lowest root-shoot ratio was observed in control (1.03). Vigour index (V.I) of *Albizzia lebbeck* seedlings under influence of applied treatment combinations showed that maximum (V.I) was found in combinations of PSB and Urea (6486.65) followed by Bradyrhizobacterium and Urea (5868.77) and lowest was observed in control(3482.94).Sturdiness quotient (S.Q) of *Albizzia lebbeck* seedlings under influence of applied treatment combinations showed that maximum (S.Q) was found in PSB and Urea(8.95) followed by Bradyrhizobacterium and Karanj cake (8.66) and lowest (S.Q) was observed in sole BRJ (5.65).Dickson quality index (Q.I) of *Albizzia lebbeck* seedlings under influence of applied treatment combinations showed that maximum (Q.I) was in Bradyrhizobacterium and Urea(1.92) followed by PSB and Urea (1.91) and BRJ and Karanj cake (1.91) respectively and lowest (Q.I) was recorded in control(0.90) table-1. The early biomass production of seedlings was attributed by the effect of the fertilizers and it was reflected on the growth parameters of the seedlings. The shoot length was found to be 28.49 cm under the influence of N- fertilizer (Urea) and *Brady rhizobium japonicum* which was found to be more in comparison to the 25.92 cm shown by kolhey *et al.* (2014). The dual inoculation of bio- fertilizers had a positive impact on the growth of seedlings. The shoot length was found be significantly more than control. The shoot length in T_{10} where combinations of bio-fertilizers (PSB+ BRJ) along with 25 kg N ha^{-1} and Karanj cake 25 kg N ha^{-1} showed 37.63 cm which was significantly more than 26.27 cm in T_0 (control). Initial higher growth due to biofertilizers application as compared to uninoculated control has been reported in *Azadirachta indica* Kalavathi *et al.* (2000). The root length was found to be less in comparison to results obtained by kolhey *et al.* (2014) which was 46.23 cm. Findings of Singh 2012 showed that inoculation of Rhizobium in *Albizia lebbeck* produced root length of 35.3 cm which is also more in comparison to the above findings. Krishan *et al.* (2000) also observed increased root length in individual and dually inoculated plants in *Albizzia lebbeck*. Increased root length has been reported due to single inoculation of Rhizobium as reported by Kumar *et al.* (2013) [13] in *Dalbergia sissoo*. Chauhan and Pokhriyal (2002) reported that the *Albizzia lebbeck* seedlings were treated with both nitrogen and Rhizobium performed better than those which received either one of them or none (control).

Table 1: Growth and quality parameters of *Albizzia lebbeck* seedlings (180 DAS)

Treatments	Shoot length (cm)	Root length (cm)	Collar diameter (mm)	V.I	S. Q	D.Q. I	Root/Shoot Ratio
T_0	26.27	18.87	4.65	3482.94	5.75	0.90	1.03
T_1	28.53	18.67	4.73	3819.78	6.39	0.97	1.29
T_2	30.53	18.80	4.97	3742.11	6.17	1.12	1.21
T_3	28.49	16.74	4.19	3645.27	6.92	1.35	1.19
T_4	22.53	20.47	4.00	3494.84	5.65	1.69	1.24
T_5	31.20	17.70	4.37	3964.48	6.89	1.83	1.16
T_6	35.80	24.10	5.07	5415.62	7.07	1.79	1.16
T_7	38.30	27.30	4.42	5634.37	8.66	1.91	1.18
T_8	40.73	29.10	4.59	6486.65	8.95	1.91	1.16
T_9	38.27	25.80	4.72	5868.77	8.17	1.92	1.17
T_{10}	37.63	25.77	4.54	4906.04	8.37	1.76	1.13

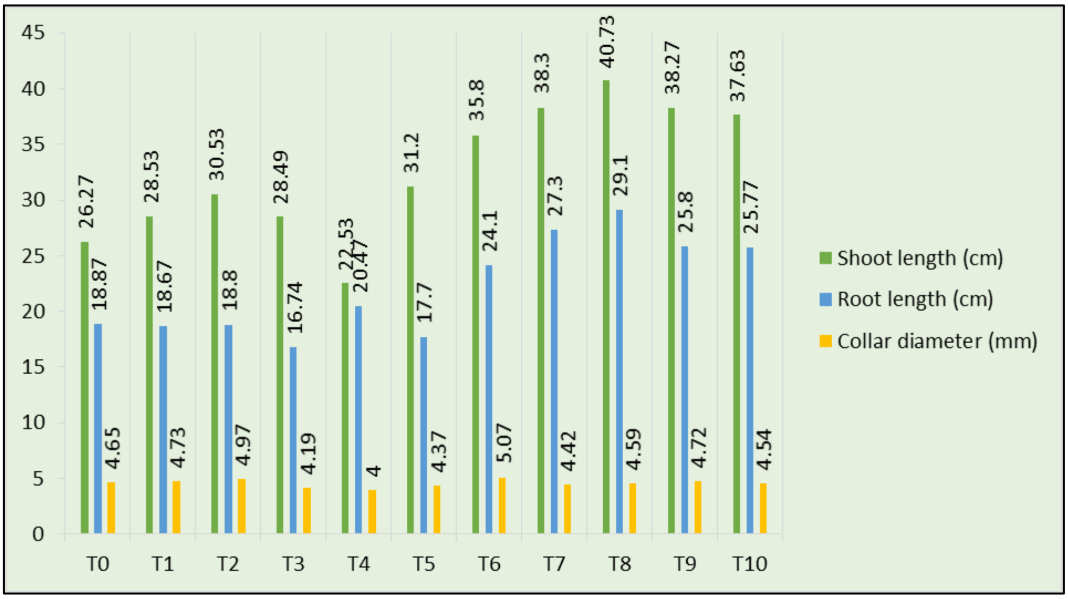

Fig 1: comparative assessment of growth parameters

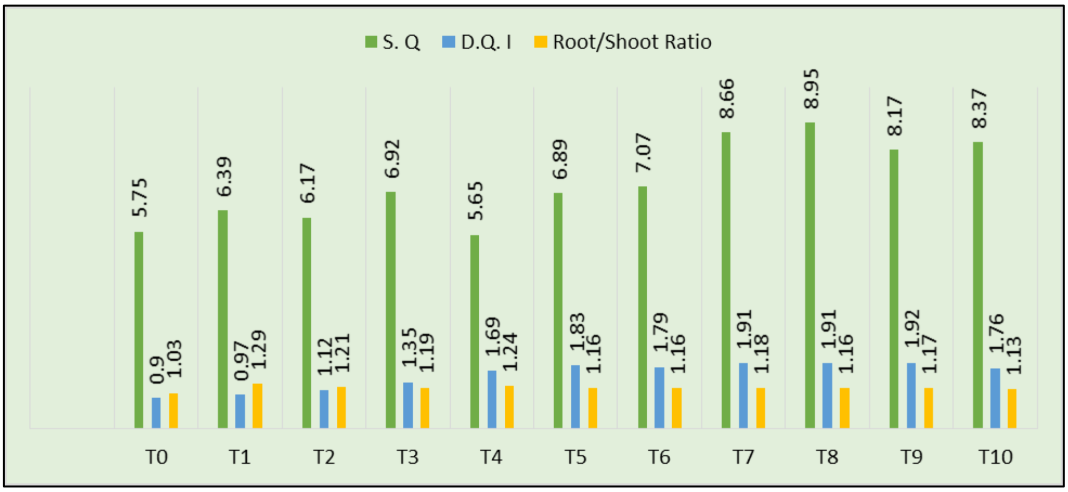

Fig 2: Comparative assessment of quality parameters

Growth parameter i.e. plant height, collar diameter and root length were observed to follow an increasing pattern with growth irrespective of the nature of treatment. Root: shoot biomass partitioning is one of the mechanisms by which plants cope with limitations imposed by growth constraining resources in the environment (Bloom, 2011; Bonifas & Lindquist, 1990) and may ultimately influence the rate of plant growth (Poorter, 1989).The root-shoot ratio was significantly different in treatment combinations. It was influenced by application of N-fertilizer (Urea), Organic fertilizer (Karanj cake) and Bio-fertilizers as well their combinations at different levels. The higher root-shoot ratio was in T_1 (1.29) which was quite high in comparison to the findings of Kumar *et al.* (2013) [13] which was recorded as (0.84) in T_5 (inoculated + N_2). Reddy (2018) reported that the influence of inoculations of rhizobial isolates on growth of *Pongamia pinnata* in nursery condition RZVVPP-4 isolate enhanced high percentage of seed germination (92 percent), seedling length (88 mm) and vigour index (8360) followed by isolate RZALPP-25 with seed germination (90 percent), seedling length (81 mm) and vigour index (7290). Jaishankar *et al.* (2013) [13] found S.Q. (9.60). The S.Q was found quite high in *Dalbergia sissoo* under the influence of (VAM + Azospirillum + N: P: K- fertilizers) and high in comparison to the S.Q found in seedlings growing in combination treatments of PSB + BRJ + Urea + Karanj cake. The Dickson quality index (QI) integrates the aspects of total plant mass, the Sturdiness quotient and (RL/SH) ratio. The QI explains plant potential for survival and growth in the field. High index values are better (Olivo and Buduba 2006). Higher the value of index the better will be the seedling. The highest Q.I was found in T_9 (1.92) which was high in comparison to (0.475) reported in inoculated + N_1 by Kumar *et al.* (2013) [13]. Jaishankar *et al.* (2012) [111] reported that the combinations of VAM + Azospirillum + N: P: K fertilizer showed Q.I value 3.76 which was quite high in comparison to Q.I value (1.72) in combination treatments of PSB + BRJ + Urea + Karanj cake.

Table 2: Soil nutrient status in respective treatment combinations

Treatment combinations	**EC (dSM^{-1})**		**pH**		**Organic carbon (%)**		**Available Nitrogen (Kgha^{-1})**		**Available phosphorous (Kgha^{-1})**		**Available potassium (Kgha^{-1})**	
	In	**Fn**	**In**	**Fn**	**In**	**Fn**	**In**	**Fn**	**In**	**Fn**	**In**	**Fn**
$T_{0(control)}$		.33		7.21		0.43		342.4		28.30		161.00
$T_{1(urea)}$		.25		7.70		0.47		332.7		28.97		152.00
$T_{2(Karanj)}$		.28		7.51		0.52		341.2		31.83		162.33
$T_{3(PSB)}$		.36		7.17		0.42		352.6		34.40		151.00
$T_{4(BRJ)}$		.29		7.10		0.47		363.9		27.52		157.00
$T_{5(Urea+Karanj)}$	.28	.32	6.25	7.36	0.32	0.41	319.87	362.1	26.2	33.63	159	153.33
$T_{6(PSB+Karanj)}$		.28		7.25		0.45		368.9		36.50		155.33
$T_{7(BRJ+Karanj)}$		.35		7.73		0.47		371.2		35.73		151.67
$T_{8(PSB+Urea)}$		.32		7.37		0.42		348.1		37.83		163.33
$T_{9(BRJ+Urea)}$		.31		7.64		0.41		344.2		29.73		152.00
$T_{10(comb-4)}$		.31		7.20		0.42		350.6		34.17		160.67
SEm+	-		-		0.042		12.7		1.16		2.51	
CD 5%	-		-		N/A		24.2		3.43		N/A	
C.V %	-		-		16.44		6.2		6.34		5.89	

In: initial reading Fn: final reading

The EC of the experimental soil was recorded before putting up the experiment and it was recorded 0.31dSM^{-1}. The EC was recorded after harvesting of the crop and it was observed that the highest EC was in T3 (0.36dSM^{-1}) while the lowest was observed in T_1 (0.25 dSM^{-1}). The EC of the soil changes according to the nutrient status of the soil. The acidity and alkalinity of the soil carries a major role in EC of the soil. The EC was found nonsignificant in polybag because of buffering action of FYM, biofertilizers and Karanj cake. The pH of the soil was recorded before putting up the experiment and it was recorded as 6.25. The pH was recorded after harvesting of crops and it was observed that the highest value was in T_9 (7.64) while the lowest was seen in T_4 (7.10). The pH was nearly equal to the neutral because due effect of growing crop which stabilized the soil pH. The OC of the experimental soil was recorded before the start of the experiment and it was recorded as 0.32%. The OC was recorded after the harvest of the crops and it was observed that the highest OC was in T_2 while lowest OC was in T_5 and $T_{9.}$ The available nitrogen of the soil was recorded at initial stage of the experiment and it was recorded as 319.87 Kgha^{-1}. The available nitrogen after the harvest of the crops and observed that the highest available nitrogen was T_7 (371.2 Kgha^{-1}), while the lowest value was in T_1 (332.7 Kgha$^{-1)}$. There was significant change in available nitrogen in the soil due to leguminous properties of the *Albizia lebbeck*. The nitrogen fixing ability of the species increased the nitrogen status of the soil while biofertilizer *Brady rhizobium japonicum* which is a rhizobium species also contributed and augmented the soil nitrogen status. The available phosphorous of the soil was recorded before the experiment and it was recorded as 26.2 Kgha^{-1}. The available phosphorous was recorded after the harvest of the crops and it was highest in T_8 (37.83 Kgha^{-1}) while the lowest was recorded in T_0 (28.30 Kgha^{-1}). There was significant change or increase in available phosphorous after the harvest of the soil in treatments containing PSB. The PSB helped in solublizing the insoluble phosphorous into soluble form which was taken by the plants. Available potassium of the experimental soil was recorded before the start of experiment and it was recorded as 159 Kgha^{-1}. The available potassium was recorded after the harvest of the crops and it was found highest in T_8 (163 Kgha^{-1}) while T_3 (151 Kgha^{-1}) had lowest value. There was no significant change in available potassium in the treatments

Conclusion

This study indicated that the inorganic fertilizer increase or boost the early growth parameters such as root length or shoot length but biofertilizer along with combination of inorganic and organic fertilizers have increased the overall quality of the planting stock. The augmentation provided by the biofertilizers is not only seen in the seedlings but they have also increased the soil nutrient status. The toxicity that we often face by using extensive inorganic fertilizer will be decreased to many extent if we combine both inorganic and biofertilizers because the doses required by the plant can be supplemented by biofertilizers along with less use of inorganic fertilizers. The early environmental stress conditions to seedlings can be mitigated by using biofertilizers as they showed very exceptional results during this study.

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