Biotechnical Approaches to Enhance the Growth and Biomass of *Sapindus Trifoliatus* Seedlings

Archana Sharma

Scientist-E, MP State Forest Research Institute, Jabalpur, Madhya Pradesh, India
Email: *archanasfri[at]gmail.com*

Abstract: ***Biofertilizers play a significant and complex role in plant growth of forestry species, which have been proved in the present study. In the present investigation various biofertilizers were applied alone and in combination. The growth and biomass response of S. trifoliatus were enhanced due to application of biofertilizers. The study was conducted in green house of the institute. 06 months old seedlings of Sapindus trifoliatus were selected for study. Total 28 treatments were tried using biofertilizers alone and in combination. Vermicompost was found the most efficient in improving the plant growth, biomass and survival of seedlings followed by Azotobacter application. Vermicompost and azotobacter was found most efficient in improving organic matter and total nitrogen accumulation through nitrogen fixation. It secretes growth promoting hormones like Auxin, Gibbrellins, Cytokinins, Indole Acitic Acid as well as antibiotics, which suppress and control plant pathogens, which has resulted in increasing the growth of seedlings.***

Keywords: Seedling growth, biomass, survival, growth increment.

1. Introduction

Biofertilizers refer to micro-organisms consisting of bacteria, fungi, algae etc., which fix the atmospheric nitrogen and enhance the solubility and availability of soil nutrients. Thease individually, or in combination, are known for increasing plant growth by way of inducing various biochemical activities in the soil. Their significance lies in their ability to supplement and immobilize soil nutrients with minimum use of non-renewable resources. Biofertilizers develop symbiotic association with plants that supply protected niche to the microbes for growth and in return, the plants receive continueous supply of reduced nitrogen. Biofertilizers help in the growth of plants and in increasing productivity by nitrogen fixation, phosphorous utilization, preventing attack of root pathogen and enhancement of tolerance to moisture stress condition in the plants in the most natural way. There are mainly two groups of biofertilizers i.e. symbiotic and non symbiotic. The symbiotic group comprises of Rizobium, Frankia (nitrogen fixing organisum) and Mycorrhizae (especially for phosphorous) and covers most of the terrestrial and aquatic plant community, while non symbiotic group includes Azotobacter, Azospirllum, Pseudomonas, *etc.*, living in the environment. The role of microorganisms is very specific and plants interect with this micro-organisms to fulfil their requirements for various minerals. The function and potentialities of various beneficial micro organisims have been documented by different scientific experiments (Bagyaraj *et. al.,* 1996, Chandra *et. al.,* 1999). The application of biofertilizers in agriculture sector as well as recognized world wide through comprehensive studies on agriculture crops (Harley and Smith, 1983; Powell and Bagyraj, 1984; Sieverding and Toro, 1998; Subha Rao, 1984 and Raj *et. al.,* 1981) but very little information on their effects on forestry species is available in literature.

Moreover, the dosage of bio fertilizers for *Sapindus trifoliatus* has not been standardized so far. The present paper deals undertaken to compare the effect of various biofertilizers on growth and biomass production in *S. trifoliatus* seedlings.

2. Materials and Methods

The study was conducted in the green net house of State Forest Research Institute, Jabalpur (MP). 06 months old seedling of *Sapindus trifoliatus* were taken for study and the potting mixture comprised of soil, sand, vermicompost with different ratio and soil, sand, FYM alone and with different dosage of Azotobacter, PSB, Rizobium and neem cake. The potting mixture was analyzed for its physico chemical properties prior to experimental use. Total 28 treatments were tried using various combinations of biofertilizers. Details are as under:

T. No.	Treatments Name	T.No.	Treatment Name
T0	Control (only Soil)	T15	T0 + 100gm Azotobacter
T1	Soil + Sand + FYM (1:1:1)	T16	T0 + 2Ogm PSB
T2	Soil + Sand + FYM (2:1:1)	T17	T0 + 4Ogm PSB
T3	Soil + Sand + FYM (1:2:1)	T18	T0 + 6Ogm PSB
T4	Soil + Sand + FYM (1:1:2)	T19	T0 + 8Ogm PSB
T5	Soil + Sand + FYM (2:2:1)	T20	T0 + 1OOgm PSB
T6	Soil + Sand + Vermi (1:1:1)	T21	T0 + 2Ogm Rizobium
T7	Soil + Sand + Vermi (2:1:1)	T22	T0 + 4Ogm Rizobium
T8	Soil + Sand + Vermi (1:2:1)	T23	T0 + 6Ogm Rizobium
T9	Soil + Sand + Vermi (1:1:2)	T24	T0 + 8Ogm Rizobium
T10	Soil + Sand + Vermi (2:2:1)	T25	T0 + 1OOgm Rizobium
T11	T0 + 20gm Azotobacter	T26	T0 + 2Ogm Neem cake
T12	T0 + 40gm Azotobacter	T27	T0 + 5Ogm Neem cake
T13	T0 + 60gm Azotobacter	T28	T0 + 1OOgm Neem cake
T14	T0 + 80gm Azotobacter		

Experimental Design
Experimental design was RBD (Random Block Design). Three replicates each of 15 seedlings were taken for each treatment. Total 435 seedlings were taken for this study. Different dosage of biofertilizers was applied at the time of transplantation of seedlings into polypots. Normal watering was done after application. After one year of the experiment following observations were taken to assess the response of seedlings with various potting mixture.

3. Observations

- Survival percentage of seedlings.
- Growth performance (root, shoot length).
- Seedling biomass in terms of root & shoot biomass (dry biomass).

Measurement of Growth and Biomass of Seedlings

Nine plants from each treatment (3 from each replicate) were taken for measuring growth performance. The length of seedling was measured by scale. The dry biomass was estimated after keeping plant material in oven at 70˚C for 3 days.

Effect of various biofertilizers on seedling growth and biomass of *Sapindus trifoliatus* under nursery stage in polypots.

T. No.	Treatment	Before Treatment			After Treatment			% Growth Increment	Growth Increment against control	BM gm/ plant	Survival %
		Root	Shoot	TSL	Root	Shoot	TSL				
T0	Control (only Soil)	19.00	23.50	42.50	34.50	42.00	76.50	80.00	0.00	54.08	55.33
T1	Soil + Sand + FYM (1:1:1)	19.00	24.00	43.00	42.50	54.50	97.00	125.58	45.58	58.62	77.67
T2	Soil + Sand + FYM (2:1:1)	18.50	23.00	41.50	41.50	57.00	98.50	137.35	57.35	62.28	89.00
T3	Soil + Sand + FYM (1:2:1)	19.50	23.00	42.50	43.00	51.50	94.50	122.35	42.35	57.39	89.00
T4	Soil + Sand + FYM (1:1:2)	19.00	23.50	42.50	46.50	61.00	107.50	152.94	72.94	64.09	100.00
T5	Soil + Sand + FYM (2:2:1)	18.70	24.00	42.70	39.50	52.50	92.00	115.46	35.46	55.92	89.00
T6	Soil + Sand + Vermi (1:1:1)	18.00	24.00	42.00	40.00	67.00	107.00	154.76	74.76	65.33	100.00
T7	Soil + Sand + Vermi (2:1:1)	19.00	23.50	42.50	40.00	59.00	99.00	132.94	52.94	60.85	89.00
T8	Soil + Sand + Vermi (1:2:1)	19.50	23.00	42.50	38.00	65.00	103.00	142.35	62.35	62.90	100.00
T9	Soil + Sand + Vermi (1:1:2)	19.40	23.00	42.40	47.50	75.50	123.00	190.09	110.09	74.18	100.00
T10	Soil + Sand + Vermi (2:2:1)	19.00	23.50	42.50	46.00	54.20	100.20	135.76	55.76	62.23	89.00
T11	T0 + 20gm Azotobacter	19.50	23.00	42.50	49.00	67.00	116.00	172.94	92.94	71.82	100.00
T12	T0 + 40gm Azotobacter	20.00	22.50	42.50	47.50	64.00	111.50	162.35	82.35	69.19	100.00
T13	T0 + 60gm Azotobacter	19.50	23.20	42.70	50.50	51.50	102.00	138.88	58.88	62.90	89.00
T14	T0 + 80gm Azotobacter	19.00	23.00	42.00	43.00	50.50	93.50	122.62	42.62	58.01	89.00
T15	T0 + 100gm Azotobacter	18.50	24.00	42.50	45.50	58.50	104.00	144.71	64.71	63.05	100.00
T16	T0 + 2Ogm PSB	19.00	23.00	42.00	47.50	50.50	98.00	133.33	53.33	62.05	89.00
T17	T0 + 4Ogm PSB	19.20	22.80	42.00	46.00	54.00	100.00	138.10	58.10	62.50	100.00
T18	T0 + 6Ogm PSB	20.00	22.50	42.50	52.50	55.00	107.50	152.94	72.94	65.00	100.00
T19	T0 + 8Ogm PSB	19.70	23.00	42.70	39.50	53.50	93.00	117.80	37.80	57.15	77.67
T20	T0 + 1OOgm PSB	18.50	23.50	42.00	38.00	53.00	91.00	116.67	36.67	56.95	77.76
T21	T0 + 2Ogm Rizobium	19.00	22.50	41.50	40.00	52.50	92.50	122.89	42.89	58.37	89.00
T22	T0 + 4Ogm Rizobium	19.00	23.50	42.50	42.60	47.41	90.01	111.79	31.79	55.87	77.67
T23	T0 + 6Ogm Rizobium	20.00	22.00	42.00	45.00	62.50	107.50	155.95	75.95	65.55	100.00
T24	T0 + 8Ogm Rizobium	19.50	22.50	42.00	44.00	52.00	96.00	128.57	48.57	60.31	89.00
T25	T0 + 1OOgm Rizobium	19.00	23.00	42.00	43.00	63.00	106.00	152.38	72.38	63.85	100.00
T26	T0 + 2Ogm Neem cake	18.50	23.50	42.00	41.00	62.00	103.00	145.24	65.24	63.32	100.00
T27	T0 + 5Ogm Neem cake	19.00	23.50	42.50	42.00	67.50	109.50	157.65	77.65	66.42	100.00
T28	T0 + 1OOgm Neem cake	18.50	23.00	41.50	40.50	63.00	103.50	149.40	69.40	63.34	100.00

RL: Root Length, SL: Shoot Length, TSL: Total Seedling Length, BM: Biomass

One Way ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
TSL	Between Groups	6873.180	28	245.471	56.646	.000
	Within Groups	251.340	58	4.333		
	Total	7124.520	86			
% Growth Increment	Between Groups	38518.451	28	1375.659	105.225	.000
	Within Groups	758.260	58	13.073		
	Total	39276.712	86			
Biomass / Plant (gm)	Between Groups	1845.236	28	65.901	72.698	.000
	Within Groups	52.578	58	.907		
	Total	1897.813	86			

4. Results

Table-1 shows the growth performance of *Sapindus trifoliatus* seedlings in different treatment under various combination of biofertilizers, vermicompost and neem cake. The data revealed that after experiment, in control the total length of seedlings was found to be 76.50 cm. However, under different treatments and different combination of biofertilizers the dosage of soil + sand + vermicompost (1:1:2) per plant gave promising results in terms of growth performance *viz;* seedling length, biomass and growth increment. The maximum length of seedling 123 cm was recorded with treatment T9 (Soil + Sand + Vermicompost (1:1:2) followed by 116 cm with treatment T11 (T0 + 20gm Azotobacter) and 111.50 cm with treatment T12 (T0 + 40 gm Azotobacter). The observations were also recorded on seedling biomass and growth increment. The maximum biomass 74.18 gm per seedling was found to be with treatment T9 followed by 71.82 gm per seedling with treatment T11 against 54.08 gm per seedling in control.

Similarly, the highest growth increment 110.09 and survival 100% was also recorded with treatment T9 and growth

5. Discussion & Conclusion

The above account, vermicompost has positive effect on plant growth and soil structure. Vermicompost have antibiotic properties due to biochemical harmones they contain. Vermicompost application enrich the soil with micro and macro nutrients, vitamins, engymes and harmones and contribute to plant development by regulating the physicochemical properties (Makulec, 2002), (Sinha *et. al.*, 2009), (Hazra, 2016). The application of Azotobactor secrets growth promoting substances like Auxin, Gibberellins, Cytokinins, Indol acetic acid which suppress and control plant growth and stimulate nitrogen fixation, which is reflected in increase total nitrogen accumulation through nodulation, which has resulted in increasing the growth and survival of seedlings.

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Author Profile

Dr. Archana Sharma, Scientist-E and Division Head, State Forest Research Institute, Jabalpur (Madhya Pradesh), India.

Dr. Archana Sharma is working as Head of Forest Productivity Division in M.P. State Forest Research Institute, Jabalpur. She was awarded in Ph.D. degree in Seed Science in 1993 from Dr. H.S. Gaur University, Sagar, (Madhya Pradesh, India). She has to her credit more than 75 research paper published in both National and International journals and three

increment 92.94 and survival 100% with treatment T11 against survival 55.33% in control.

bulletins and fourteen brochures. She has 30 years of research experience in seed technology. She has completed more than 30 externally funded research projects in the capacity of Principal Investigator. She has organized a number of trainings and workshops at National and State levels. She has imparted trainings to field foresters, University scholars, NGOs and Rural Communities engaged in seed technology, sustainable management and harvesting of bio resources. She can be contacted at archanasfri@gmail.com