RESEARCH ARTICLE

IMPACT OF INTEGRATED NUTRIENT MANAGEMENT ON QUALITY SEEDLING PRODUCTION IN *FLEMINGIA SEMIALATA* ROXB

Kameshwar Kumar Rajak*, Ravi Hunje and Krishna A.

Department of Forest Biology and Tree Improvement, College of Forestry,Sirsi-581401, University of Agricultural Science, Dharwad-580005, Karnataka, India
Email: kumar.kameshwar1207@gmail.com

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Abstract: In this experiment thirteen treatments involving different organic, inorganic, bio-fertilizer and their combinations were assessed on seedling growth. Application of Arbuscular mycorrhiza (AM) (10 g) + Phosphate solubilising bacteria (PSB) (5 g) + NPK (Sampurna 19:19:19- 2g/seedling) (T13) to soil media containing red soil, sand and FYM in 2:1:1 ratio increased the plant growth attributes viz., plant height, collar diameter and number of branches and number of leaves by 41.62, 44.09, 44.23 and 39.17 per cent respectively after 150 days of transplanting compared to control. The extent of increase in seedling height due to treatment (T13) in *F. Semialata* was found to be 51.13, 68.14, 78.13, 83.79 and 87.26 per cent over initial plant height at 30, 60, 90, 120 and 150 days after transplanting respectively. The increase in collar diameter due to treatment (T13) in *F. Semialata* was found to be 58.47, 73.36, 80.63, 83.38 and 85.65 per cent over initial collar diameter at 30, 60, 90, 120 and 150 days after transplanting respectively. Higher number of number of leaves per plant noticed in treatment (T13) was 50.98, 60.38, 68.54, 69.40 and 69.62 per cent over initial number of leaves per plant at 30, 60, 90, 120 and 150 days after transplanting respectively. Significantly higher fresh weight and dry weight were obtained in *Flemingia semialata* by application of (T13) AM (10 g) + PSB (5 g) + NPK (Sampurna 19:19:19- 2g/seedling). Overall, the treatment (T13) constituting AM (10 g) + PSB (5 g) + NPK (19:19:19- 2 g/seedling) gave highest growth parameters as compared to other treatments. So it can be recommended as best treatment for integrated nutrient management for quality seedling production.

Keywords: Organic, Inorganic, Biofertilizer, Plant height, Weight

INTRODUCTION

Flemingia semialata is commonly called as "Winged-Stalk Flemingia" and in Hindi it is known as "Bara Solpan" and "Ban Chola". It is perennial, erect, quick growing and put responsive lac host, grows up to height of about 2.5-3.5 m depending upon plant management. It has well-developed root system which comprises taproots and nodulation on the root hairs. Leaves are digitately trifoliate, with 2.5-7.5 cm long narrowly winged stalk (Anon., 2013). Leaflets are up to 15.0 cm long and 5 cm broad, broadly lance shaped, long pointed and minutely gland dotted below the lateral leaflets oblique. Stalks of the leaflets are 5 mm long. Stipules are 1.2 cm long, stem clasping. Flowering starts during August – September. Flowers are borne in often branched racemes, equal to or longer than the leaf stalk, at the end of branches on leaf axils. Bracts are ovate, falling off. Sepal cup is 6-6.5 mm long, densely silky, teeth much longer than the tube. Flowers are purple in colour, 6-6.5 mm long, shaped like pea-flowers. Fruits are 1.2-1.3 cm long, velvety, 2 seeded. Seeds ripen during the months of November-December. The pods are oblong green, tomentose, swollen, sac like structure bearing two seeds. Seeds are round, black with sporadic white spots on the outer skin. One kg seed contains approximately 27,000-30,000 seeds (Kumar and Kumar, 2014). One plant produces approximately 15-20 g of seeds. It has capacity to fix atmospheric nitrogen, there by enriching soil fertility. In view of being responsive to high coppicing, manageable stature, this plant species is gaining popularity for production of superior quality winter season kusmi lac under rain fed condition to match pace with growing global demand of lac.

Flemingia semialata has emerged recently as one of the most suitable lac host plant which is bushy in nature and quick growing, and more importantly lac cultivation can be started from second year. The practice of lac cultivation on *Flemingia semialata* has been standardized (Jaiswal and Singh 2012) and it has shown potential for intensive lac cultivation in short time and provides very attractive returns. This plant can also be integrated in agriculture, horticulture and forest ecosystems for enhanced income (Singhal *et al.* 2014). Due to good returns through lac as compared to the agricultural crops, introduction of bushy lac host *Flemingia Semialata* in the farmers' field can improve overall returns. Thus the cultivation of winter season *kusmi* lac on *Flemingia semialata* with improved technologies will bring better economic empowerment to farmers.

The problem associated with *Flemingia semialata* is hard coat of seed due to which germination gets affected. Use of treatments which are designed to soften the hard coat of seeds has been found to be very effective. The seed treatments have a profound influence in growth aspects of seedlings, as the early germinated seeds show significant growth when compared to other seedling. Treated seeds often showed better growth in terms of height, collar girth, number of branches and number of leaves (Asare and Otsyina, 1980).

*Corresponding Author

Potting media can influence the quality of seedling to a great extent. Seedling raised in good medium can ensure better establishment and growth when planted out in the main field and show very good succulence to lac host insect. So, production of lac increased in large scale, which is the only resin of animal. The information on the effect of media on growth of seedlings is absolutely essential for large-scale production of healthy seedlings in the nursery (Baiyari., 2003).

MATERIALS AND METHODS

A comprehensive laboratory study entitled "***Impact of integrated nutrient management on quality seedling production in Flemingia semialata* Roxb .** was undertaken at Department of Forest Biology and Tree Improvement, College of Forestry, University of Agriculture Sciences, Dharwad during 2014-16. The fresh seeds of *Flemingia semialata* were obtained from the Indian Institute of Natural Resin and Gums (IINRG) Namkum, Ranchi, Jharkhand. To study the nutrient responses on seedling growth and establishment, uniform sized normal healthy seedlings were transplanted in thirteen different nutrient media as per the treatments. The potting mixture which contains two portion of red soil, one portion of sand and one portion of FYM is treated as control. Nutrient treatment combinations are added to the standard potting mixture and other natural practices were carried out. The experiment was laid out at poly house of COF, Sirsi in Complete Randomized Design (CRD) with three replications. After 15 days of transplanting of the seedlings to polybags the nutrient management treatments were imposed as per the treatments. The cultural operations and aftercare like watering and weeding was done regularly as and when required throughout the experimental period the details of the treatments are as under:

Treatment details:

T1: Control [Red soil: Sand: FYM (2:1:1)]

T2: Red soil: Sand: FYM (2:1:1) + Vermicompost (10 g.)

T3: Red soil: Sand: FYM (2:1:1) + Poultry manure (10 g.)

T4: Red soil: sand: FYM (2:1:1) + Arbuscular Mycorrhiza (AM) 10 g.

T5: Red soil: sand: FYM (2:1:1) + Phosphate Solubilizing Bacteria (PSB) (5 g.)

T6: Red soil: Sand: FYM (2:1:1) + 19:19:19 (NPK) 1 g.

T7: Red soil: Sand: FYM (2:1:1) + 19:19:19 (NPK) 2 g.

T8: Red soil: sand: FYM (2:1:1) + AM + 19:19:19 (NPK) 1g.

T9: Red soil: sand: FYM (2:1:1) + AM + 19:19:19 (NPK) 2 g.

T10: Red soil: sand: FYM (2:1:1) + PSB + 19:19:19 (NPK) 1 g.

T11: Red soil: sand: FYM (2:1:1) + PSB + 19:19:19 (NPK) 2 g.

T12: Red soil: sand: FYM (2:1:1) + AM + PSB +19:19:19 (NPK) 1 g.

T13: Red soil: sand: FYM (2:1:1) + AM +PSB + 19:19:19 (NPK) 2 g.

Observation on above ground growth parameters were recorded for six months at monthly interval. Whereas, seedling fresh weight and seedling dry weight were estimated at the end of the experiment

RESULTS AND DISCUSSION

Integrated Nutrient Management is a practice where all sources of nutrients namely organic, inorganic (chemical fertilizer) and bio-fertilizers can be combined and applied to soils so that plant growth is enhanced. It integrates the objectives of seedling production with least expensive and without harming environment, *ie.* optimum crop nutrition, optimum functioning of soil health and minimum nutrient losses. Integrated Nutrient Management practices are adopted to ensure sustainable productivity, to enhance soil productivity, to prevent degradation of the environment and to reduce expenditure on the cost of chemical fertilizers.

Growth of seedling on virtuous media with optimum quantity of nutrients is essential for production of healthy seedlings and for development of sturdy root system. Inexpensive and nutrient rich medium that produce healthy and vigorous seedlings which ensure early establishment are required in raising plantation where, after care of seedlings are comparatively less. It also reduces the time the seedling should be kept in nursery which intern reduces the cost of production per seedlings. Hence, an experiment with integrated approach for application of manures was tried to find out best combination suitable to obtain high seedling growth. The nutrient combinations significantly influenced all the seedling parameters during all the growth stages.

The significantly higher seedling height 15 cm, 23.01 cm, 34.13 cm, 45.23 cm and 57.57 cm (depicted in Table 5. and Fig. 5) and collar diameter 2.36 mm, 3.68 mm, 5.06 mm, 5.90 mm and 6.83 mm (depicted in Table 6.) was obtained with application Arbuscular Mycorrhiza (AM) (10 g) + Phosphate solubilizing bacteria (PSB) (5 g) +NPK 2 g/plant (T13) at 30 DAT, 60 DAT, 90 DAT, 120 DAT and 150 days after storage respectively (Table- 1 and Fig-1). This was followed by treatment T12 constituting AM (10 g) + PSB (5 g) + NPK 1 g/plant. This may be due to inorganic fertilizers which lead to increase uptake of essential nutrients which in turn enhances the seedling height. Nitrogen plays important role in increasing the plant height as it plays direct role in protein formation while this was supported by mycorrhizae by helping in synthesizing nutrients and making them available in later stages of growth and phosphobacteria has ability to solubilize the bonded phosphate in the soil by secreting organic acid like formic, acetic, lactic and succinic acids that lower the soil pH and bring about the dissolution of bounded form of phosphate. Phosphorous might have contributed in increasing height by increasing photosynthesis, cell division and cell enlargement in which phosphorus role is well established. The results are in conformation with result obtained by Navale and Channabasappa (2011), revealed that, the use of chemical fertilizer along with the bio-fertilizer significantly influenced the seedling parameters like higher collar diameter (5.64 mm) and higher seedling height (41.53 cm) were obtained at 180 days after transplanting compared to control in *Hydnocarpus pentandra* seedlings.

The increased in plant height *Flemingia semialata* may be due to application of optimum quality of fertilizers and it might have influenced the chlorophyll formation in the plant, which lead to improve photosynthetic activity ultimately resulted in vigorous vegetative growth and development of plant. These results are in line with studies conducted with *Melia azaderachta* where in, maximum seedling height (127.5 cm), collar diameter (7.41 mm) were recorded with 1.0 g NPK at 180 DAP compared to 0.5 g NPK/seedling (Sujatha, 2014). Chaya (2014) reported that, among the inorganic fertilizers, maximum seedling height (85.49 cm), collar diameter (11.20 mm) were recorded with PSB (10 g) + Mycorrhizae (10 g) + NPK 1g/plant in *Lagerstroemia lanceolata* seedlings.

Table 1. Effect of integrated nutrient management on seedling height of *Flemingia semialata*

Treatments	**Height (cm)**					
	Initial	**30DAT**	**60DAT**	**90DAT**	**120DAT**	**150DAT**
T1 Control [Red soil: Sand: FYM (2:1:1)]	7.29	9.99	16.82	24.16	31.89	40.65
T2 Vermicompost (10 g.)	7.09	12.70	20.29	30.25	40.94	52.06
T3 Poultry manure (10 g.)	7.42	12.09	19.73	29.83	40.17	51.35
T4 Arbuscular Mycorrhiza (10 g.)	7.21	12.50	20.13	30.05	40.50	51.83
T5 PSB (5 g.)	7.20	11.77	19.55	27.47	39.84	51.07
T6 NP K (19:19:19) 1g/plant	7.58	13.04	20.36	30.62	41.24	52.28
T7 NP K (19:19:19) 2g/plant	7.72	13.21	20.52	30.89	41.64	52.73
T8 AM + NP K (19:19:19) 1g/plant	7.06	14.12	21.83	32.53	43.29	55.36
T9 AM + NP K (19:19:19) 2g/plant	7.81	14.28	22.20	32.77	43.92	55.63
T10 PSB + NP K (19:19:19) 1g/plant	7.24	13.73	21.03	31.53	42.12	53.89
T11 PSB + NP K (19:19:19) 2g/plant	7.33	14.00	21.39	32.09	42.52	54.52
T12 AM+PSB + NP K (19:19:19) 1g/plant	7.94	14.54	22.48	33.32	45.06	56.87
T13 AM +PSB+ NP K (19:19:19) 2g/plant	7.33	15.00	23.01	34.13	45.23	57.57
Mean	7.40	13.15	20.71	30.81	41.41	52.75
SEm±	**0.30**	**0.28**	**0.26**	**0.39**	**0.34**	**0.30**
CD@1%	**NS**	**0.62**	**0.77**	**0.86**	**1.00**	**0.87**

Table 2. Effect of integrated nutrient management on collar diameter of *Flemingia semialata*

Treatments	**Collar diameter (mm)**					
	Initial	**30DAT**	**60DAT**	**90DAT**	**120DAT**	**150DAT**
T1 Control [Red soil: Sand: FYM (2:1:1)]	0.96	1.27	1.92	2.95	3.86	4.74
T2 Vermicompost (10 g.)	0.99	1.54	2.57	3.76	4.84	5.28
T3 Poultry manure (10 g.)	0.98	1.54	2.57	3.76	4.84	5.10
T4 Arbuscular Mycorrhiza (10 g.)	0.92	1.48	2.52	3.67	4.76	5.20
T5 PSB (5 g.)	0.95	1.32	2.28	3.34	4.43	5.02
T6 NP K (19:19:19) 1g/plant	0.85	1.60	2.64	3.82	4.92	5.31
T7 NP K (19:19:19) 2g/plant	0.92	1.63	2.73	4.06	5.15	5.44
T8 AM + NP K (19:19:19) 1g/plant	0.99	1.90	2.97	4.48	5.36	6.28
T9 AM + NP K (19:19:19) 2g/plant	0.96	2.07	3.14	4.70	5.60	6.42
T10 PSB + NP K (19:19:19) 1g/plant	0.84	1.79	2.85	4.27	5.12	5.76
T11 PSB + NP K (19:19:19) 2g/plant	0.95	1.87	2.90	4.38	5.32	6.06
T12 AM+PSB + NP K	0.96	2.15	3.31	4.902	5.67	6.74

(19:19:19) 1g/plant						
T13 AM +PSB+ NP K (19:19:19) 2g/plant	0.98	2.36	3.68	5.06	5.90	6.83
Mean	094	1.72	2.76	4.06	4.97	5.70
SEm±	**0.03**	**0.07**	**0.29**	**0.07**	**0.10**	**0.02**
CD@1%	**NS**	**0.22**	**0.60**	**0.22**	**0.29**	**0.30**

Table 3. Effect of integrated nutrient management on no. of leaves of *Flemingia semialata*

Treatments	**No. of leaves/ plant**					
	Initial	**30DAT**	**60DAT**	**90DAT**	**120DAT**	**150DAT**
T1 Control [Red soil: Sand: FYM (2:1:1)]	8.00	10.80	14.37	18.40	19.00	19.40
T2 Vermicompost (10 g.)	7.80	12.40	16.90	20.50	20.80	21.13
T3 Poultry manure (10 g.)	7.90	11.40	15.00	20.00	20.20	20.50
T4 Arbuscular Mycorrhiza (10 g.)	8.13	12.00	16.80	20.40	20.60	20.93
T5 PSB (5 g.)	7.90	11.80	14.83	19.00	19.20	19.60
T6 NP K (19:19:19) 1g/plant	7.00	13.00	17.60	20.83	21.60	22.00
T7 NP K (19:19:19) 2g/plant	7.60	13.40	17.80	21.13	21.93	22.20
T8 AM + NP K (19:19:19) 1g/plant	7.80	13.97	19.20	22.10	22.80	23.23
T9 AM + NP K (19:19:19) 2g/plant	8.26	14.00	19.37	22.40	23.30	23.90
T10 PSB + NP K (19:19:19) 1g/plant	7.60	13.60	18.40	21.40	22.10	22.50
T11 PSB + NP K (19:19:19) 2g/plant	7.80	13.77	18.80	21.85	23.10	22.80
T12 AM+PSB + NP K (19:19:19) 1g/plant	7.60	14.63	19.80	24.13	22.43	25.37
T13 AM +PSB+ NP K (19:19:19) 2g/plant	8.20	16.73	20.70	26.07	24.90	27.10
Mean	7.81	13.13	17.65	21.33	26.80	22.35
SEm±	**0.36**	**0.46**	**0.42**	**0.44**	**21.97**	**0.34**
CD@1%	**NS**	**1.36**	**1.22**	**1.26**	**0.43**	**1.02**

Table 4. Fresh weight and dry weight (g) of *Flemingia semialata* at 150 DAT after treating with fertilizers

Treatments	**Fresh weight (g)**	**Dry weight (g)**
T1 Control [Red soil: Sand:FYM (2:1:1)]	56.18	15.83
T2 Vermicompost (10 g.)	80.23	**27.12**
T3 Poultry manure (10 g.)	70.14	22.44
T4 Arbuscular Mycorrhiza (10 g.)	77.07	24.26
T5 PSB (5 g.)	65.20	20.63
T6 NP K (19:19:19) 1g/plant	84.23	29.57
T7 NP K (19:19:19) 2g/plant	87.54	30.44
T8 AM + NP K (19:19:19) 1g/plant	104.36	36.45
T9 AM + NP K (19:19:19) 2g/plant	109.14	38.24
T10 PSB + NP K (19:19:19) 1g/plant	89.42	32.06
T11 PSB + NP K (19:19:19) 2g/plant	96.31	33.32
T12 AM+PSB + NP K (19:19:19) 1g/plant	119.58	41.82
T13 AM +PSB+ NP K (19:19:19) 2g/plant	125.97	46.31
Mean	**89.64**	**30.65**
SEm±	0.92	0.63
CD@1%	2.77	1.90

Plate 1. Effect of INM on seedling height of *Flemingia semialata* Roxb.

Plate 2. Seedling growth (whole plant) under integrated nutrient management

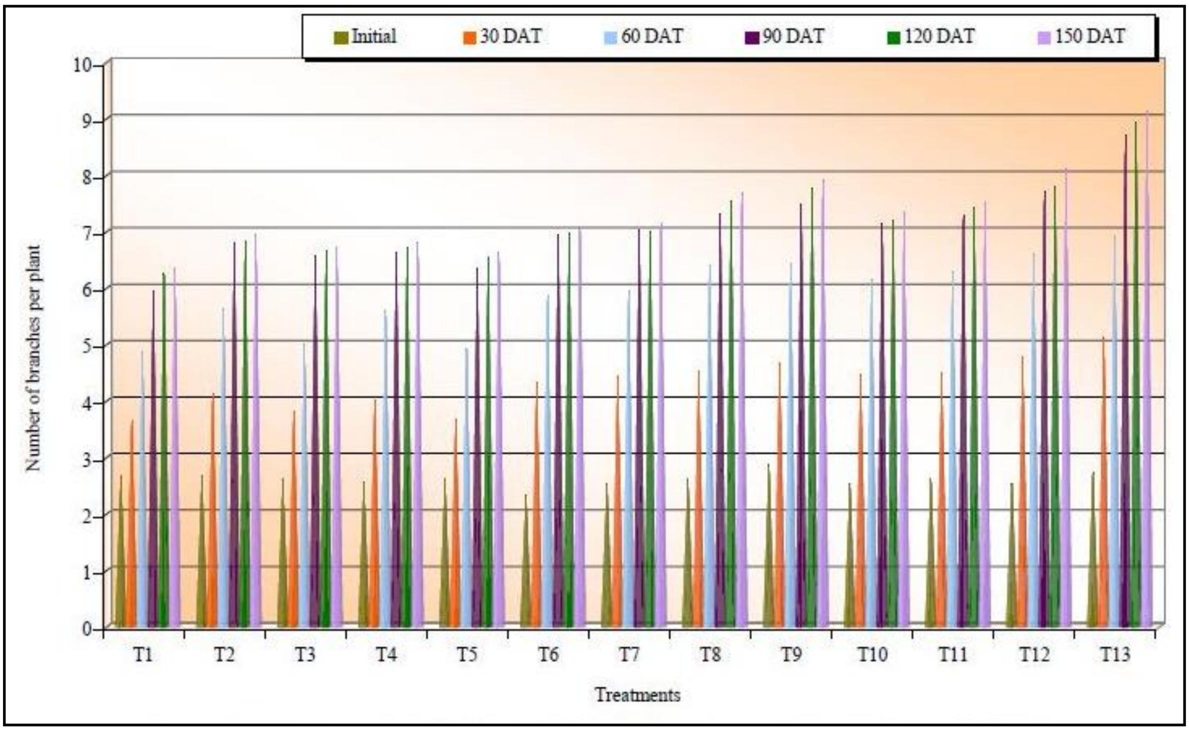

Fig. 1. Effect of integrated nutrient management on number of branches per plant of *Flemingia semialata*

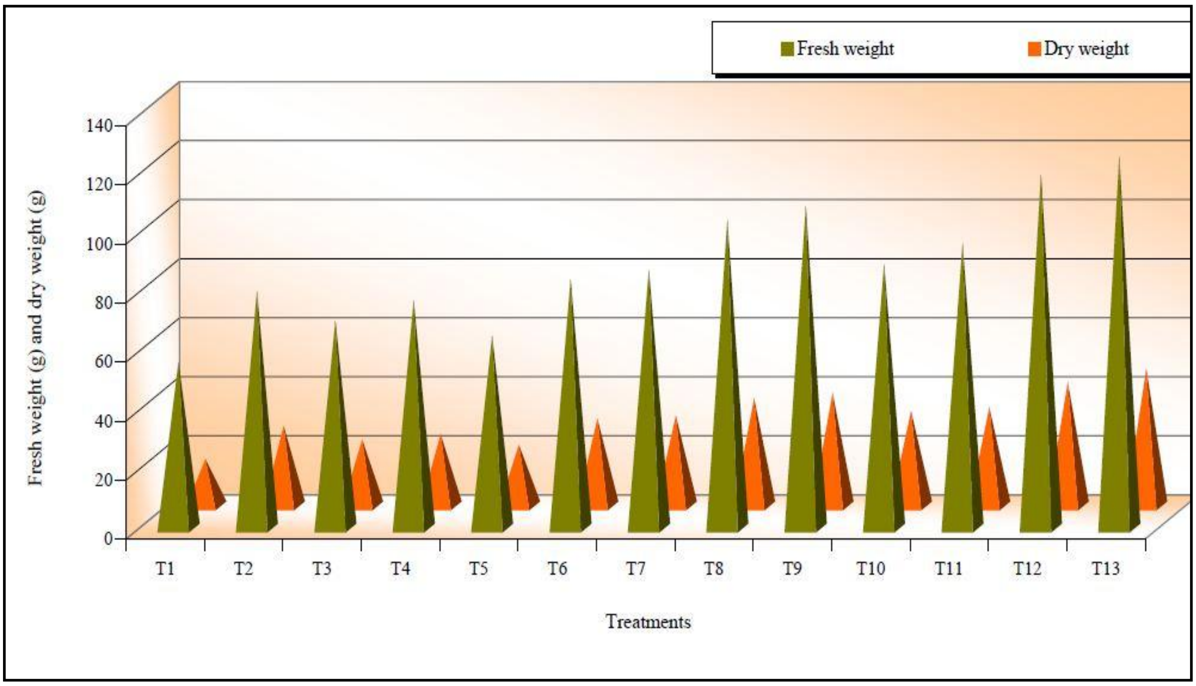

Fig. 2. Fresh weight (g) and dry weight (g) of *Flemingia semialata* at 150 days after transplanting after application of treatments

There was significant increase in number of branches 5.10, 6.90, 8.70, 8.93 and 9.13 (depicted in Table 7. and Fig. 6.) and number of leaves 16.73, 20.70, 26.07, 26.80 and 27.10 (depicted in Table 8.) with application of AM (10 g) + PSB (5 g) +NPK 2 g/plant at 30 DAT, 60 DAT, 90 DAT, 120 DAT and 150 days after storage respectively followed by application of AM (10 g) + PSB (5 g) + NPK 1 g/plant. This may be due to application of optimum quantity of nitrogen in applied fertilizers might have increased the chlorophyll content in the plants, it also enhanced the photosynthetic activity which resulted in increased synthesis of carbohydrates by the action of bio-fertilizers resulting in vigorous vegetative growth and development of seedling. Banerjee (1973) reported that increased number of branches can be attributed to increased availability of nutrients which might have resulted in increased production of photosynthates and their translocation into branches and leaves. These results are in conformation with Chaya (2014) who revealed that, among different manures and fertilizers, application of PSB (10 g) + Mycorrihizae (10 g) + NPK (1 g) has significantly increased seedling growth attributed *viz.*, number of branches and number of leaves respectively over control. Lebba (2011) studied the nutrient response of *Melia dubia* and reported that, application of complex fertilizers at 1.0 g/seedling significantly increased the seedling growth attributes *viz.*, number of branches and number of leaves as compared to control(Table- 2,3 and Fig-2).

All the biomass accumulation parameters such as fresh weight and dry weight of seedlings differed significantly after 150 days after transplanting. Maximum fresh weight of seedling (125.97 g) and dry weight of seedling (46.3 g) was recorded in treatment with application of AM (10 g) + PSB (5 g) +NPK 2 g/plant followed by treatment AM (10 g) + PSB (5 g) + NPK 1 g/plant (Table- 4). This may be due to well established fact that Arbuscular mycorrhizae can markedly improve the efficiency of nutrient absorption in plants by increasing the surface area, mobilizing sparingly available nutrient sources and phospobacteria can solubilizes the available source of phosphate in the soil and make it available to the plant these by enhancing the growth of the plant. These results are in lines with Thriveni *et al*. (2010) and Krishnan *et al*. (2004) and they reported that, vigorous seedlings of *Nothapodytes nimmoniana* and *Simarouba glauca* could be grown economically by applying complex fertilizers at the rate of 0.25 g per plant and phosphobacteria @ 5 g per plant at monthly interval with increased seedling growth and dry biomass when compared to other treatments.

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