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Effect of Soil Amendments and Bio-Inoculants on Growth Performance of *Flemingia semialata* under Field Conditions

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Abstract A field experiment was laid with *Flemingia semialata* Roxb. Consisting of 14 treatments namely, T_1=Control, T_2=FYM, T_3=FYM + *Rhizobium*, T_4=FYM + $N_1P_1K_1$ + *Rhizobium*, T_5=FYM + $N_2P_2K_2$ + *Rhizobium*, T_6=FYM + $N_3P_3K_3$ + *Rhizobium*, T_7=FYM + Mycorrhizae, T_8=FYM + $N_1P_1K_1$ + Mycorrhizae, T_9= FYM + $N_2P_2K_2$ + Mycorrhizao, T_{10}= FYM + $N_3P_3K_3$ + Mycorrhizae, T_{11}= FYM + Mycorrhizae + *Rhizobium*, T_{12}=FYM + $N_1P_1K_1$ + *Rhizobium* + Mycorrhizae, T_{13}=FYM + $N_2P_2K_2$ + *Rhizobium* + Mycorrhizae and T_{14}= FYM + $N_3P_3K_3$ + *Rhizobium* + Mycorrhizae in RBD having 3 replications to study their effect on plant growth performance under field conditions. T_{14} recorded maximum number of branches (31), petiole length (9.1 cm), branch diameter (2.36 cm) and leaf width (5.3 cm), T_{13} recorded maximum plant height (2.38 m), shoot spread (2.21 m), T_{12} recorded highest branch length (85.3 m), number of leaves (158), collar diameter (3.68 cm) and T_3 maximum angle of branch emergence (82°). It infers that both bioinoculants and NPK application on *Flemingia* affects more the vertical growth that the horizontal growth.

Keywords *Rhizobium*, Mycorrhizae, Amendments, Lac, *Flemingia semialata*.

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Introduction

Lac is the protective covering and resin secreted by lac insects namely *Kerria lacca* and has possessed commercial value providing the subsidiary source of income mainly for tribals over a large of India. The conventional hosts followed are kusum (*Schleichera oleosa*), palas (*Butea monosperma*), ber (*Zizyphus mauritiana*),Flemingia semialata Roxb. called winged-stalk flemingia belongs to family fabaceae, available in North Eastern part, Uttaranchal and Andaman in India and in Pakistan, Myanamar and China [1]. It has been potentially exploited due to nutritive fodder, deep rooting, nitrogen fixing and drought with standing ability. This species of late became exploited by farm-

ers as best lac insect shrub host, due to its insect compatibility, short gestation, strong coppicing ability and acclimatization in wastelands to farmlands which could safe guard big trees in natural forests [2]. Apart from lac production, it has gained popularity in view of its medicinal, nutritive, good calorific value, brows ability, deep rooting, soil binding, nitrogen fixing, drought bearing, fertilizer and bio-inoculations responding tendencies. For which it has been grown in block plantations or introduced in crop lands to design various agroforestry models. Besides, *Flemingia semialata* has been used in soil and water conservation works. For both the purposes application of less expensive bio-inoculants is very much vital to increase productivity without affecting system sustainability.

Flemingia being a nitrogen fixing one, artificial inoculation of Rhizobia can boost nodulation potential under nursery and plantations. Mycorrhizae is an integral part of both forest and agro-ecosystems as it absorbs minerals N, P, K, ca, S, Zn, Cu, Sr from soil and simultaneously produce enzymes, hormones, vitamins apart from translocation of water during scarcity in plants. Endomycorrhizae or Vescicular Arbuscular Mycorrhizae (VAM) through astro-metrical mycelium infect root system of hosts [3]. Thus, there is urgent need to integrate chemical, organic and biofertilizers in order to enhance productivity and safeguard environment which can provide balanced nutrient management for growth of *Flemingia semialata*.

Since, research in this direction of *Flemingia semialata* is meager, thus present investigations have been designed to study effect of bionoculants (Mycorrhizae and *Rhizobium*) with soil amendments (nitrogen, phosphorus and potassium based fertilizers) on plant growth characters of *Flemingia semialata* under plantation in Mizoram University campus, Aizawl.

Materials and Methods

The study has been carried out in a 1.5 year old established plantation in the instructional farm of Department of Forestry, School Earth Sciences and Natural Resources Management, Mizoram University, Tanhril, Aizawl, Mizoram during year 2014 to 2016. The experimental site has latitude 23°43´37´´ N and longitude 92°40´23´´ E and altitude 780 m above mean sea level, temperature range 13° C to 30°C, rainfall 1820 mm and soil clay loam. The plantation was established in August, 2014 using 4 months old seedlings which had been raised using seeds brought from Indian Institute of Natural Resin and Gum (IINRG). Namkum, Ranchi, Jharkhand.

The inoculums (broth) of *Rhizobium* were prepared using pink and healthy root nodules after separating these from the root systems of seedlings of same species in nursery which passed through standard inoculum procedures. Inoculation made through dipping root systems of seedlings in broth prior bare root planting. Endomycorrhizae (*Glomus fasciculatum*) were brought from Division of Micribiology, Indian Agricultural Research Institute, New Delhi of spore form which had been developed using activated charcoal. VAM inoculums of 10 g per pit were applied after mixing these thoroughly with soil at the time of planting. The spacing maintained for plantation was 1 m × 2 m and pit size was 1 ft × 1 ft × 1 ft. Design followed was RBD with 3 replications. Besides normal fertilizer doses, fertilizer applied at the age of 1 year of planting as per treatment schedule. Treatment details were T_1=Control virgin soil, T_2=FYM, T_3=FYM + *Rhizobium*, T_4=FYM + $N_1P_1K_1$ + *Rhizobium*, T_5=FYM + $N_2P_2K_2$ + *Rhizobium*, T_6=FYM + $N_3P_3K_3$ + *Rhizobium*, T_7=FYM + Mycorrhizae, T_8=FYM + $N_1P_1K_1$ + Mycorrhizae, T_9=FYM + $N_2P_2K_2$ + Mycorrhizae, T_{10}=FYM + $N_3P_3K_3$ + Mycorrhizae, T_{11}=FYM + Mycorrhizae + *Rhizobium*, T_{12}= FYM + $N_1P_1K_1$ + Mycorrhizae + *Rhizobium*, T_{13}=FYM + $N_2P_2K_2$ + Mycorrhizae + *Rhizobium* and T_{14}=FYM + $N_3P_3K_3$ + Mycorrhizae + *Rhizobium* where $N_1P_1K_1$ means 10 g N_2, 10 g P_2O_5 and 25 g K_2O, $N_2P_2K_2$ means 20 g N_2, 20 g P_2O_5 and 50 g K_2O and $N_3P_3K_3$ means 30 g N_2, 30 g P_2O_5 and 75 g K_2O. Various parameters namely plant height, shot spread number of branches, branch angle, number of leaves, petiole length, leaf width, leaf area, collar diameter and average branch diameter were recorded and compared. For variance ratio comparison in ANOVA *F* test and treatment means comparison *t* rest and Duncan's Multiple Range Test ($p < 0.05$) were followed.

Table 1. Development of aerial parts of *Flemingia semialata* after 1.5 years of plantation. The figures in the parentheses are standard deviation from mean. Means with the same letter are not significantly different of Duncan test ($p \leq 0.05$).

Treatments	Angle of emergence (deg)	Average branch diameter (cm)	Branch length (cm)	Collar diameter (cm)	Leaf width (cm)
T_1	81 (±4.68)^{ab}	1.12 (±0.07)^{e}	61.4 (±1.33a)^{i}	2.72 (±0.17)^{d}	3.0 (±0.18)^{e}
T_2	74 (±3.22)^{d}	1.18 (±0.04)^{e}	63.8 (±1.12)^{h}	2.84 (±0.11)^{cd}	3.42 (±0.09)^{d}
T_3	82 (±4.79)^{a}	1.21 (±0.12)^{e}	66.8 (±0.99)^{g}	3.29 (±0.10)^{abcd}	3.52 (±0.14)^{d}
T_4	78 (±2.46)^{bc}	1.25 (±0.02)^{de}	67.9 (±1.15)^{g}	3.53 (±0.14)^{ab}	3.45 (±0.12)^{d}
T_5	78 (±2.10)^{bc}	1.4 (±0.10)^{cde}	72.5 (±1.33)^{f}	3.04 (±0.11)^{bcd}	3.31 (±0.10)^{d}
T_6	71 (±1.86)^{ef}	1.24 (±0.04)^{de}	73.6 (±1.11)^{f}	2.93 (±0.13)^{bcd}	3.41 (±0.15)^{d}
T_7	75 (±2.35)^{cd}	1.26 (±0.05)^{de}	78.2 (±1.44)^{d}	2.84 (±0.85)^{cd}	3.75 (±0.07)^{cd}
T_8	81 (±2.48)^{ab}	1.52 (±0.10)^{bcd}	75.9 (±1.14)^{e}	3.01 (±0.08)^{bcd}	4.01 (±0.16)^{bc}
T_9	68 (±3.19)^{g}	1.61 (±0.10)^{bc}	80.6 (±1.48)^{c}	3.08 (±0.0.09)^{abcd}	4.23 (±0.14)^{ab}
T_{10}	73 (±2.01)^{de}	1.31 (±0.10)^{de}	81.6 (±1.26)^{abc}	3.26 (±0.08)^{abcd}	4.35 (±0.13)^{ab}
T_{11}	69 (±3.05)^{fg}	1.18 (±0.04)^{e}	83.2 (±1.31)^{a}	3.41 (±0.10)^{abc}	4.41 (±0.11)^{ab}
T_{12}	75 (±3.35)^{cd}	1.26 (±0.05)^{de}	85.3 (±1.31)	3.68 (±0.07)^{a}	4.53 (±0.08)^{a}
T_{13}	81 (±2.91)^{ab}	1.76 (±0.08)^{b}	82.6 (±1.40)^{ab}	3.32 (±0.13)^{abcd}	4.62 (±0.11)^{a}
T_{14}	68 (±3.10)^{g}	2.36 (±0.10)^{a}	81.2 (±1.26)^{bc}	3.12 (±0.36)^{abcd}	5.3 (±0.31)
SEm	1.28	0.12	1.28	0.25	1.28
CD 0.05	2.63	0.24	2.63	0.52	0.38
CD 0.01	3.56	0.33	3.56	0.71	0.51

Results and Discussion

Angle of branch emergence

Maximum angle of branch spread was observed in T_3 (82°) followed by T_1 (81°) and T_8 (81°), T_4 (78°) and T_5 (78°), T_7 (75°) and T_{12} (75°), T_2 (74°), T_{10} (73°), T_6 (71°), T_{11} (69°) and least with T_9 (68°) and T_{14} (68°) (Table 1). There was significant difference among the treatments observed except at par relations among few treatments. Relation was at par among the treatment combinations namely, T_3 and T_{13}, among T_1, T_8, T_{13}, T_4 and T_5, among T_4, T_5, T_7 and T_{12}, among T_7, T_{12}, T_2 and T_{10} and between T_{10} and T_6, between T_6 and T_{11} and among T_{11}, T_9 and T_{14}.

Average branch diameter

Average branch diameter was observed to be significant among the treatments with maximum value T_{14} (2.36 cm) followed by T_{13} (1.76 cm) then T_9 (1.61 cm), T_8 (1.52 cm), T_5 (1.40 cm), T_{10} (1.31 cm), T_7 (1.26 cm) and T_{12} (1.26 cm), T_4 (1.25 cm), T_6 (1.24 cm), T_3 (1.21 cm), T_2 (1.18 cm) and T_{11} (1.18 cm) and least with T_1 (1.12 cm) (Table 2). Among few treatment combinations at par relations were observed namely, T_{13}, T_9 and T_8, among T_9, T_8 and T_5, among T_8, T_5, T_{10}, T_7, T_{12}, T_4 and T_6 and among T_5, T_{10}, T_7, T_{12}, T_4, T_6, T_3, T_2, T_{11} and T_1.

Branch length

Maximum branch length was observed with T_{12} (85.3 cm) followed by T_{11} (83.2 cm), then T_{13} (82.6 cm), T_{10} (81.6 cm), T_{14} (81.2 cm), T_9 (80.6 cm), T_7 (78.2 cm), T_8 (75.9 cm), T_6 (73.6 cm), T_5 (72.5 cm), T_4 (67.9 cm), T_3 (66.8 cm), T_2 (63.8 cm), T_1 (61.4 cm). However, the at par relations were observed among the treatments as T_{11}, T_{13} and T_{10}; among T_{13}, T_{10} and T_{14}, among T_{10}, T_{14} and T_9, between T_6 and T_5 and between T_4 and T_8.

Collar diameter

Among the treatments significant difference was observed with maximum collar diameter in treatment T_{12} (3.68 cm) followed by T_4 (3.53 cm), then T_{11} (3.41 cm), T_{13} (3.32 cm), T_3 (3.29 cm), T_{10} (3.26 cm), T_{14} (3.12 cm), T_9 (3.08 cm), T_5 (3.08 cm), T_8 (3.01 cm), T_6 (2.93 cm), T_2 (2.84 cm) and T_7 (2.84 cm) and the least collar diameter with T_1 (2.72 cm). At par relation was observed

Table 2. Height, spread, branches and leaves of *Flemingia semialata* of 1.5 years planting. The figures in the parentheses are standard deviation from mean. Means with the same letter are not significantly different of Duncan test ($p \leq 0.05$).

Treatments	Number of branches	Number of leaves	Petiole length (cm)	Plant height (m)	Shoot spread (m)
T_1	20 (±0.89)	94 (±1.49)	7.2 (±0.46)^{f}	1.54 (±0.07)^{g}	1.31 (±0.51)^{d}
T_2	21 (±0.79)^{h}	97 (±1.89)^{j}	7.6 (±0.40)^{def}	1.78 (±0.03)^{f}	1.4 (±0.44)^{d}
T_3	22 (±0.79)^{gh}	112 (±1.76)^{i}	7.4 (±0.27)^{ef}	1.81(±0.25)^{f}	1.42 (±0.32)^{d}
T_4	23 (±1.00)^{gh}	119 (±2.30)^{h}	7.4 (±0.32)^{ef}	1.89 (±0.07)^{f}	1.36 (±0.35)^{d}
T_5	24 (±1.97)^{fg}	125 (±2.36)^{g}	8.1 (±0.28)^{cde}	2.18 (±0.08)^{de}	1.52 (±0.34)^{cd}
T_6	24 (±0.85)^{fg}	117 (±2.00)^{h}	8.8 (±0.25)^{abc}	2.11 (±0.06)^{e}	1.38 (±0.32)^{d}
T_7	26 (±2.91)^{def}	132 (±2.29)^{f}	7.6 (±0.18)^{def}	2.14 (±0.06)^{e}	1.78 (±0.25)^{b}
T_8	26 (±0.85)^{def}	117 (±1.89)^{h}	7.3 (±0.40)^{f}	2.31 (±0.08)^{bcd}	2.15 (±0.45)^{a}
T_9	27 (±0.86)^{cde}	138 (±2.32)^{e}	7.5 (±0.25)^{ef}	2.36 (±0.08)^{ab}	1.67 (±0.30)^{bc}
T_{10}	27 (±1.03)^{cde}	141 (±2.18)^{cd}	8.3 (±0.28)^{bcd}	2.22 (±0.10)^{cde}	1.68 (±0.34)^{bc}
T_{11}	28 (±1.08)^{bcd}	149 (±2.45)^{ab}	8.9 (±0.26)^{ab}	2.24 (±0.08)^{cde}	1.38 (±0.34)^{d}
T_{12}	29 (±1.53)^{abc}	158 (±2.62)	8.3 (±0.33)^{bcd}	2.35 (±0.08)^{abc}	1.78 (±0.38)^{b}
T_{13}	30 (±0.85)^{ab}	151 (±2.55)^{a}	8.4 (±0.39)^{abc}	2.38 (±0.10)^{a}	2.21 (±0.44)^{a}
T_{14}	31 (±0.86)^{a}	143 (±2.34)^{c}	9.1 (±0.39)^{a}	2.31 (±0.05)^{bcd}	2.1 (±0.44)^{a}
SEm	1.12	1.24	0.30	0.06	0.10
CD 0.05	2.31	2.55	0.62	0.12	0.20
CD 0.01	3.12	3.44	0.84	0.16	0.29

among the treatments like T_{12}, T_4, T_{11}, T_{13}, T_3, T_{10}, T_{14} and T_9; among the treatments T_4, T_{11}, T_{13}, T_3, T_{10}, T_{14}, T_9, T_5, T_8 and T_6, among the treatments T_{11}, T_{13}, T_3, T_{10}, T_{14}, T_9, T_5, T_8, T_6, T_2 and T_7 and among T_{13}, T_3, T_{10}, T_{14}, T_9, T_5, T_8, T_6, T_2, T_7 and T_1.

Leaves width

Maximum leaf width was with T_{14} (5.30 cm) followed by T_{13} (4.62 cm) then T_{12} (4.53 cm), T_{11} (4.41 cm), T_{10} (4.35 cm), T_9 (4.23 cm), T_8 (4.01 cm), T_7 (3.75 cm), T_3 (3.52 cm), T_4 (3.45 cm), T_2 (3.42 cm), T_6 (3.41 cm), T_5 (3.31 cm) and least with T_1 (3.0 cm). Significant difference was observed among the treatments except at par relations observed among the treatments T_{13}, T_{12}, T_{11}, T_{10} and T_9; among the treatments T_{11}, T_{10}, T_9 and T_8; between T_8 and T_9 and among T_7, T_3, T_4, T_2, T_6 and T_5.

Number of branches

Maximum number of branches observed with T_{14} (31) followed by T_{13} (30), T_{12} (29), T_{11} (28), T_9 (27) and T_{10} (27), T_7 (26) and T_8 (26), T_5 (24) and T_6 (24), T_4 (23), T_3 (22), T_2 (21), and least with T_1 (20). Among treatments significant relations were observed except at par relation recorded among treatments namely, T_{14}, T_{13} and T_{12}; among T_{13}, T_{12} and T_{11}; among T_{12}, T_{11}, T_9 and T_{10}; among T_{11}, T_9, T_{10}, T_7 and T_8; among T_9, T_{10}, T_7 and T_8; among T_7 and T_8, T_5 and T_6, among T_5, T_6, T_4 and T_3 and among T_4, T_3 and T_2.

Number of leaves

Maximum number of leaves were present in T_{12} (158) which was followed by T_{13} (151) then T_{11} (149), T_{14} (143), T_{10} (141), T_9 (138), T_7 (132), T_5 (125), T_4 (119), T_6 (117) and T_8 (117), T_3 (112), T_2 (97) and least with T_1 (94). Treatments were found to be significant among each other except at par relations observed between T_{13} and T_{11}, between T_{14} and T_{10} and among T_4, T_6 and T_8.

Petiole length

Maximum petiole length was observed in T_{14} (9.1 cm) which was followed by T_{11} (8.9 cm) then T_6 (8.8 cm), T_{13} (8.4 cm), T_{10} (8.3 cm), T_{12} (8.3 cm), T_5 (8.1 cm), T_2 (7.6 cm) and T_7 (7.6 cm), T_9 (7.5 cm), T_3 (7.4 cm), T_4 (7.4 cm), T_8 (7.3 cm) then lowest with T_1 (7.2 cm). Among the treatments significant relations were observed except at par relations recorded among T_1, T_2, T_3 and

T_4, among T_{11}, T_6, T_{13}, T_{10} and T_{12}; among T_6, T_{13}, T_{10}, T_{12} and T_5; among T_{10}, T_{12}, T_5, T_2 and T_7; among T_5, T_2, T_7, T_9, T_3 and T_4 and among T_2, T_7, T_9, T_3, T_4, T_8 and T_1.

Plant height

Maximum plant height was observed in T_{13} (2.38 cm), which was followed by T_9 (2.36 cm), T_{12} (2.35 cm), T_8 (2.31 cm), T_{14} (2.31 cm), T_{11} (2.24 cm), T_{10} (2.22 cm), T_5 (2.18 cm), T_7 (2.14 cm), T_6 (2.11 cm), T_4 (1.89 cm), T_3 (1.81 cm), T_2 (1.78 cm), and T_1 (1.54 cm). Significant relations were observed among the treatments except at par relations observed among the treatments namely T_{13}, T_9 and T_{12}; among T_9, T_{12}, T_8 and T_{14}; among T_{12}, T_8, T_{14}, T_{11} and T_{10}; among T_8, T_{14}, T_{11}, T_{10}, and T_5; among T_{11}, T_{10}, T_5, T_7 and T_6 and among T_4, T_3 and T_2.

Shoot spread

Among the treatments significant difference was observed with highest shoot spread with T_{13} (2.21 cm), which was followed by T_8 (2.15 cm), then T_{14} (2.10 cm), T_7 (1.78 cm), T_{12} (1.78 cm), T_{10} (1.68 cm), T_9 (1.67 cm), T_5 (1.62 cm), T_3 (1.42 cm), T_2 (1.40 cm), T_6 (1.38 cm) and T_{11} (1.38 cm), T_4 (1.36 cm) and T_1 (1.31 cm). Among the treatments at par relations were observed among T_{13}, T_8 and T_3; among T_7, T_{12}, T_{10} among T_9, among T_{10}, T_9 and T_5 and among T_5, T_3, T_2, T_6, T_{11}, T_4 and T_1.

Branch angle

Branch angle has relevance on tree longevity and intercropping. Plagiotropic branches should expaned horizontally to capture light efficiently. Branch angles were steeper in upper branches and were nearly horizontal in lower branches, irrespective of sapling height [4]. Under present condition only FYM gave highest angle i.e., branch appear to be more horizontal; whereas applying higher treatments combinations reduced the aggle i.e., breaking horizontal branching. Stable non-vertical growth of shoot and root branches is sustained by an anti-gravitropic offset mechanism [5].

Average branch diameter and collar diameter

Combined application of all the applications namely, farm yard manure, Mycorrhizae, *Rhizobium* and $N_3P_3K_3$ gave maximum branch diameter whereas control gave minimum. Fertilization has better response than bio-inoculation. Collar diameter was maximum with farm yard manure, *Rhizobium*, Mycorrhizae with $N_1P_1K_1$ resulted maximum and control resulted minimum. Bioinoculants with minute fertilizer doses responded best to collar diameter which became sensitive to further NPK doses. Nitrogen fertilization in *Quercus ilex* sp. ballota (Desf.). Samp [6] and Aleppo pine (*Pinus halepensis* Mill.) and holm oak (*Quercus ilex* L.) [7] and phosphorus fertilization in *Dalbergia sissoo* [8], Mycorrhizal inoculation *Tecomella undulata* [9] and *Rhizobium* inoculation *Acacia catechu* and *Acacia mollissimia* [10] and combined bio-fertilization in *Acacia nilotica* [11] and combination of bio-inoculation and fertilization in *Albizia procera* [12] have increased collar diameter as observed by previous workers.

Branch length and petiole length

Branch length was highest with combination of FYM, Mycorrhizae and *Rhizobium* and $N_1P_1K_1$, lowest was with control. Petiole length was maximum with FYM, Mycorrhizae and *Rhizobium* and $N_3P_3K_3$ and minimum with control. It makes it clear that branch length was best compatible with FYM, bio-inoculation and minute dise of fertilization, which became highly sensitive to further increase in doses of fertilization. On the other hand, petiole length was best compatible with FYM, Mycorrhizae and *Rhizobium* and higher doses of fertilization for which lower doses became unresponsive.

Leaf width

Maximum leaf width was observed with FYM, Mycorrhizae and *Rhizobium* and $N_3P_3K_3$ and minimum with control. It indicates that the combined effect of bio-inoculation along with highest dose of fertilization became best compatible to develop maximum leaf width. Previous workers also observed positive effect of biofertilizers on leaf width of *Spathiphyllum*

illusion [13]. In almond (*Prunus amygdalus*), biofertilizer application could bring leaf width higher in lettuce [14].

Number of branches and
number of leaves

Number of branches was maximum with FYM, Mycorrhizae and *Rhizobium* and $N_3P_3K_3$ and minimum with control. In contrary to it, number of leaves was maximum with FYM, Mycorrhizae and *Rhizobium* and $N_1P_1K_1$ and minimum with control. It indicates that number of branches well responded to bioinoculation along with increasing levels of fertilization. Number of leaves well responded to bio-inoculation and lower level of fertilization which became sensitive to higher level of fertilization. Rhizobial inoculation has been observed to have increased number of branches in *Acacia catechu* and *Acacia mollissimia* [10]. Previous workers found increase in number of leaves by combined application of phosphorus and mycorrhizal inoculation in *Prosopis juliflora* [15] and by combined application of PSB and AMF in young oil plam. [16].

Plant height and
branch spread

Plant height and branch spread well responded to bio-inoculation and fertilization peculiarly. Maximum plant height and plant spread was observed with FYM, Mycorrhizae and *Rhizobium* and $N_2P_2K_2$ and minimum with control. Height growth and plant spread well responded to FYM, bio-inoculation and moderate dose of fertilization, further increase in fertilizer dose adversely affect height. Previous workers found increased plant height by use of *Azospirillum* in Beijernick-plant [17], phosphate fertilization in *Mimosa caesalpiniaefolia* [18] and nitrogenous fertilization in exotic almonds [19] and recorded increase in height and number of leaves by application of NPK and lime in baru (*Dipteryx alata*) plants [20].

Conclusion

The branches emerging from main stem became responsive of soil applications. Under applications of FYM and *Rhizobium*, branches tend to emerge horizontally this horizontal nature decresed when soil becomes further added with Mycorrizae and NPK. All aerial growth parameters of *Flemingia semialata* responded positive to bioinoculants but behaved differently towards quantum of amendments added. Collar diameter, branch length and number of leaves responded well to lower doses, plant height and plant spread to medium doses and number and diameter of branches, petiole length and leaf width to higher doses of soil amendments. This experiment may be further multiplied to higher ages and multiple locations to prove efficacy of the results prior introducing the species under various land use systems.

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