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EFFECT OF INM PRACTICES IN *Rauwolfia tetraphylla* IN ASSAM CONDITION

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ABSTRACT : An experiment was carried out in the medicinal and aromatic plant block of Experimental Farm (Horticulture), Department of Horticulture, College of Agriculture, Assam Agricultural University, Jorhat during 2010-2011 and 2011-12. The experiment was laid out in Randomized Block Design with seven treatments *viz,* T_0 = control, T_1 = 100% RF + FYM 5t/ha (RF: reference dose of fertilizer @ 10 : 60 : 30 kg/ha N, P_2O_5 and K_2O, T_2 = 75% RF + *Azotobacter* @20 g per plant + PSB @20 g per plant + FYM 5t/ha, T_3 = 50% RF+ *Azotobacter* @20 g per plant + PSB @20 g per plant + FYM 5t/ha,T_4 = 25% RF+ *Azotobacter* @20 g per plant + PSB @20 g per plant + FYM 5t/ha, T_5 = 50% RF + FYM 5t/ha + Vermicompost 1t/ha, T_6 = 50% RF + FYM 5t/ha + Enrich compost @2t/ha (AAU made) and three replications for two years to determine the biometric and yield performance of *Rauwolfia tetraphylla* under different nutrient sources. The soil of the experimental plot was sandy loam having pH of 4.8, organic carbon (10.05 %), available N (243.32 kg/ha), available P_2O_5 (24.98 kg/ha) and available K_2O (94.75 kg/ha). The maximum value of plant height (89.15 cm), leaf number (374.70), leaf area index (2.62), branches (19.09), flowers (372.54) and fruits per plant (295.09), seed and root yield (8.94kg/ha and 2809.64kg/ha) were recorded under treatment T_2. The highest value of total alkaloid (1.28mg/100g dry weight), Phenol(1.69mg/100g dry weight), Tannin (0.45mg/100g dry weight) and Flavonoids (1.70mg/100g dry weight) were recorded by the treatment receiving vermicompost in combination with 50% RF dose of fertilizer and organic manures (T_5).

Keywords : *Rauwolfia, medicinal property, INM, Azotobacter, yield.*

The North-Eastern Region, due to its unique varieties of geographical and climatic factors, has a rich diversity of medicinal plant. The various species of *Rauwolfia* (Apocynaceae) are widely distributed in this part of the country. Several *Rauwolfia* species in India are known to possess ethno medicinal properties and folklore claims among which *Rauwolfia serpentina* and *R. tetraphylla* are very important due to their traditional medicinal use such as insanity, edema, rheumatic pain, epilepsy, snake and scorpio bite, purgative, sedative, anthemilatic, relief from cough, anti-diarrhoea and some intestinal disease due to the presence of *reserpine* (Sahu, 7). Further, due to its high demand in the world market the genuine plant (*i.e., R. serpentina* and *R. tetraphylla*) is almost on the track of extinction and in future can be categorized as an endangered species. So, it is necessary to cultivate both the species on commercial basis so as to ensure its constant supply in future. Therefore, the present study was attempted to cultivate *R. tetraphylla* on experiment basis to determine its yield potential in clay loam soils of Jorhat, Assam. The research work aimed for the isolation of valuable components from it and to minimize the commercial exploitations and thereby extinction of plant *R. serpentina*.

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MATERIALS AND METHEDS

An experiment was carried out in the medicinal and aromatic plant block at Experimental Farm (Horticulture), Department of Horticulture, College of Agriculture, Assam Agricultural University, Jorhat during the years 2012-2013 and 2013-14. The experiment was laid out in Randomized Block Design with seven treatments viz,T_0 = control, T_1 = 100% RF + FYM 5t/ha,T_2 = 75%RF + *Azotobacter* @20 g per plant+ PSB @20 g per plant + FYM 5t/ha, T_3 = 50% RF+ *Azotobacter* @20 g per plant+ PSB @20 g per plant + FYM 5t/ha,T_4 = 25% RF+ *Azotobacter* @20 g per plant+ PSB @20 g per plant + FYM 5t/ha, T_5 = 50% RF + FYM 5t/ha + Vermicompost 1t/ha, T_6 = 50% RF + FYM 5t/ha + Enrich compost @2t/ha (AAU made) and three replications for two years to determine the biometric and yield performance of *R. tetraphylla* under different nutrient sources. The soil of the experimental plot was sandy loam having pH of 4.8, organic carbon (10.05 %), available N (243.32 kg/ha), available P_2O_5 (24.98 kg/ha) and available K_2O (94.75 kg/ha). The gross and net plot size was 338 m^2 and 189 m^2, respectively.

The seedlings of *R. tetraphylla* are collected from Koliabor nursery, Khetri, Assam and were transplanted in the month of November 2010 at a distance of 45 cm × 30cm. Organic manures, *i.e.,* FYM, enriched

compost, vermi-compost were applied to soil 15 days before transplanting, while biofertilizers, *i.e., Azotobactor* and phosphate solubilizing bacteria wear applied around the base of plant at 2 days after transplanting. The nutrient content of different organic source are enlisted in the Table 1. Full doses of P, K and half doses of N of reference dose of fertilizer were applied as basal dose at the time of transplanting while remaining dose of N was applied at the time of top dressing *i.e.,* 45 days after transplanting. Irrigation, thinning, gap filling, weeding, earthing up and plant protection measures were followed timely. The observations on biometric and yield parameters were taken at the time of harvesting.

The biochemical analysis of the root bark was also carried out after harvest of the crop. Shade dried root bark of *R. tetraphylla* was powdered and separately extracted in a Soxhlet apparatus for 72 hrs with methanol and the liquid extracts were concentrated separately under vacuum and resulting extracts were kept in desiccators for subsequent analysis. Total alkaloid content of the sample was determined by Spectrophotometric method, phenol by colorimetric method, tannins by Folin-Denis method and flavonoids by the method outlined standard procedures.

Table 1: The nutrient content of different organic source.

Form of compost/fertilizer	Major nutrient content (%)		
	Nitrogen (Kg^{-ha})	Phosphrus (Kg^{-ha})	Potash (kg^{-ha})
FYM	0.5	0.2	0.5
Vermi-compost	2.5-3.0	1.8-2.9	1.4-2.0
Enrich compost	2.5	2.89	1.93
Urea	38-40	0	0
SSP	0	16-20	0
MOP	0	0	50-60

RESULTS AND DISCUSSION

It is evident from Table 2 that there was significant increase in plant height, leaf number, leaf area index and number of branches when organic manures are combined with biofertilizers and inorganic fertilizers. The maximum value of plant height (89.15cm), leaf number (374.70), Leaf area index (2.62) and Branches (19.09) were recorded under treatment T_2 = (75%RF + *Azotobacter* @20 g per plant+ PSB @20 g per plant + FYM 5t/ha,) at 18 months after planting which was at par with the treatment T_3 = 50% RF+ *Azotobacter* @20 g per plant + PSB @20 g per plant + FYM 5t/ha (87.58cm, 369.10, 2.48 and 18.47 respectively). The increased availability and uptake of nutrients by plants would have resulted in better growth with more number of branches in plots treated with integration of organic manures, biofertilizers and inorganic fertilizers. Asiegbu and Oikeh (2) found that NPK fertilizers were more efficient than organic manures in supply of N, P and K in short run, while the organic manures has an advantage in supply of other macro and micro nutrient elements not contained in NPK fertilizers throughout the growth period. Here dual inoculation of *Azotobacter* and PSB showed beneficial effect on plant growth and productivity indicating a positive interaction between these two groups of organisms (Alagawadi and Gaur, 1; Kumar *et al.,* 3).These two treatments were closely followed by T_5 receiving 50% RF + FYM 5t/ha + vermi-compost 1 t/ha (83.39cm, 352.64, 2.25 and 17.36, respectively). A possible explanation for this beneficial effect of vermicompost over enriched compost and FYM may be due to the fact that application of vermi-compost increases total microbial population of N-fixing bacteria, phosphobacteria and actinomycetes. This increased microbial activity improves the availability of soil phosphorus and nitrogen. Further the effect of vermicompost on soil physico-chemical properties imparts favourable soil structure for root growth which influenced better plant growth. The results are in conformity with findings of Sharma and Bhalla (8). Again Naher (5) also reported the maximum number of main stem per hill in potato with organic fertilizer management practices.

Seeds are the means of propogation in Rauwolfia. Flowers are born in clusters. The number of flowers and fruits per plant are the most important determinant of seed yield in rauwolfia, which was greatly influenced by the application of integrated nutrient sources (Table 3). The increased number of flowers and fruits per plant (372.54 and 295.09) was in the treatment combination of 75%RF + *Azotobacter* @20 g per plant + PSB@20 g per plant + FYM 5t/ha (T_2) followed by T_3 = 50% RF+ *Azotobacter* @20 g per plant + PSB @20g per plant + FYM 5t/ha (369.23 and 265.47). Similarly, vermi-compost along with 50% RF dose of fertilizers (T_4) gives statistically similar number of flowers and fruits per plant (361.49 and 260.73 respectively) as that of the above two treatments. The higher number of fruits per plant may also be due to higher percentage of productive flowers in this treatment (Rajagopal and Rao, 6).

Roots were harvested 18 months after planting as the total alkaloid content was maximum at that time. A significant influence of treatments on seed and root yield per hectare was observed with a maximum of

Table 2 : Biometric parameters of *R. tetraphylla* under different treatment,

Treatments	Plant height (cm)	Branch number	Leaf number per plant	Leaf area index	Flower per plant	Fruits per plant
T_1	79.43	16.35	347.92	2.12	345.43	235.35
T_2	89.15	19.09	374.70	2.62	372.54	295.09
T_3	87.58	18.47	369.10	2.48	369.23	265.47
T_4	75.54	16.01	342.80	2.10	361.49	260.73
T_5	83.39	17.36	352.64	2.25	333.39	244.36
T_6	71.56	15.01	329.48	2.02	319.15	207.85
CD (P=0.05)	4.883	0.153	2.349	0.478	4.883	0.153

8.94 kg/ha and 2809.64 kg/ha in T_2 followed by T_3 (8.19 kg/ha and 2799.44 kg/ha) and T_4 (8.16kg/ha and 2794.26 kg/ha). However, there was no significant difference among the treatments T_3 and T_4. The higher seed yield per plant with increasing fertility status may be due to greater plant growth and increased number of branches. The higher root yield obtained with the combined use of Organic inorganic and biofertilizers was possibly due to supply of balanced nutrition, provision of congenial physical and biological environment of soil and stimulation on fixation, P solubilization and the thiosulphate oxidizing power (Tiwari *et al.,* 9). The lowest yield was obtained with T_6 (6.98 kg/ha and 2741.48 kg/ha) which would be ascribed to the failure of this treatment to supply adequate nutrients to the crop as manifested by the reduced growth in absence of biofertilizers.

Table 3 : Total yield of *R. tetraphylla* under different treatment.

Treatments	Total yield (kg/ha)	
	Seed yield	Root yield
T_1	7.12	2751.06
T_2	8.94	2809.64
T_3	8.19	2799.44
T_4	8.16	2794.26
T_5	7.21	2781.44
T_6	6.98	2741.48
CD (P=0.05)	0.063	9.769

The highest value of total alkaloid (1.28 mg/100g dry weight), Phenol (1.69 mg/100g dry weight), Tannin (0.45 mg/100g dry weight) and Flavonoids (1.70 mg/100g dry weight) were recorded by the treatment receiving vermicompost in combination with 50% RF dose of fertilizer and organic manures (T_5) which was at par T_3 = 50% RF+ *Azotobacter* @ 20g per plant+ PSB @ 20g per plant + FYM 5t/ha (1.25, 1.66, 0.42 and 1.67 mg/100g dry matter, respectively) followed by T_2 (1.18, 1.58, 0.38 and 1.62 mg/100g dry matter, respectively) and the minimum values (1.01,1.26, 0.18 and 1.39 mg/100g dry matter, respectively) were recorded in T_1 =100% RF + FYM 5t/ha treatment. The application of organic sources with inorganic fertilizers might have significantly enhanced the availability of native and applied macro and micro nutrients in the soil as consequence of which the quality would have increased (Kumar *et al.,* 4). Application of organic nutrient sources increased the quality parameters because addition of organic manures improved the physicochemical and biological properties of the soil which might have improved the root growth, higher nutrient content, increased dry matter production and nutrient uptake, finally leading to improvement in quality of Rauwolfia roots.

Table 4: Biochemical parameters (mg/100g dry weight) of *R. tetraphylla* under different treatment.

Treatments	Total alkaloids	Phenols	Tannins	Flavanoids
T_1	1.01	1.26	0.18	1.39
T_2	1.18	1.58	0.38	1.62
T_3	1.25	1.66	0.42	1.67
T_4	1.12	1.53	0.33	1.57
T_5	1.28	1.69	0.45	1.70
T_6	1.06	1.33	0.26	1.50
CD (P=0.05)	3.076	5.201	5.536	3.648

From the present study, it can be concluded that integrated use of organic manures, biofertilizers and inorganic fertilizers *i.e.,* T_2 = 75%RF + *Azotobacter* @ 20 g per plant + PSB @20g per plant + FYM 5t/ha was the most efficient treatment in terms of growth and yield of *Rauwolfia tetraphylla* followed by T_3 = 50% RF+ *Azotobacter* @ 20 g per plant+ PSB @20g per plant + FYM 5t/ha. Regarding medicinal qualities, application of vermicompost in combination with 50% RF dose of fertilizer and organic manures (T_5) gives maximum value of the parameters which was

statistically similar as that of T_3 = 50% RF+ *Azotobacter* @20 g per plant + PSB @20 g per plant. Hence, biofertilizers with 50% RF dose of fertilizer and organic manures can be considered as an effective means of improving crop yield and quality of Rauwolfia tetraphylla through better soil fertility and can replace the inorganic fertilizers on equivalent nutrient basis under Assam condition.

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