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Effects of organic manures and biofertilisers on herbage yield and bacoside content of *Bacopa monnieri*

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ABSTRACT

A field experiment was conducted for two years to find out optimum doses of organic manures and biofertilizers for higher yield and enhanced quality of Bacopa monnieri under an All India Co-ordinated Research Project on Medicinal and Aromatic Plants at Kerala Agricultural University, Vellanikkara, Kerala. Nine treatment combinations of organic manures [farm yard manure (FYM), vermicompost and coirpith compost] along with biofertilisers (Azospirillum and phosphorus solubilising bacteria [PSB]) with appropriate control were employed. Pooled results over two years indicated that performance of the crop was significantly higher under combined application of organic manures with biofertilisers compared to their individual application. Application of coirpith compost produced higher herbage yield and bacoside content among the individual application of organic manures tried. Application of coirpith compost along with Azospirillumand phosphorus solubilising bacteria registered higher yield and bacoside content. The combination of coirpith compost @ 5t/ha with Azospirillum and PSB each @1 kg/ ha was found to be the best in terms of higher herbage yield and bacosdie content for this medicinal herb.

INTRODUCTION

Bacopa monnieri (L.) Pennell belonging to the family of Scrophulariaceae, is a creeping annual plant found throughout the Indian subcontinent in wet, damp and marshy areas. This medicinal plant is locally known as Brahmi. The earliest chronicled mention of brahmi is in several ancient Ayurvedic treatises including the *Charaka Samhita* (6th century A.D.), in which it is recommended in formulations for the management of a range of mental conditions including anxiety, poor cognition and lack of concentration, and the *Bravprakash Var-Prakarana* (16th century A.D.). The main active chemical constituents of brahmi are triterpenoid saponins [13]. The saponins consist of numerous subtypes designated as bacosides, bacopasides and bacopasaponins [3]. Bacoside-A is considered the major active component, first identified by [1] with bacoside-B being an optical isomer of bacoside-A [15]. The total saponin content in the samples of plant materials and extracts varied from 5.1 to 22.17 per cent and 1.47 to 66.03 mg/capsule or tablet in the commercial formulations [10]. Brahmi is currently recognized as being effective in the treatment of mental illness and epilepsy. The

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content of the pharmacologically active components in medicinal species is influenced by both genetic and environments factors. Nutrient management can be optimized to maximize synthesis of pharmacologically active constituents [5]. Domestication and commercialization of cultivation is one of the area to secure the medicinal plant supply having the required quantity to the pharmaceutical companies. Due to high demand of the crop in ayurvedic industry, cultivation has to be encouraged to encash the demand. It is a recommended crop for wetlands and marshy lands of Kerala.

MATERIALS AND METHODS

A field experiment was conducted for two years under the All India Co-ordinated Research Project on Medicinal and Aromatic Plants at Kerala Agricultural University, Vellanikkara, Kerala under rain fed condition . The soil of the experimental field was sandy clay loam laterite with pH of 5.78 and EC of 0.41 dSm^{-1}. The nutrient status of the soil

Table 1: Effect of organic manures and biofertilisers on vine length and number of leaves in *B. monnieri*

Treatments	Vine length(cm)			Number of leaves		
	1st year	2nd year	pooled	1st year	2nd year	pooled
FYM	121.08	119.10	120.09	1091.73	1092.50	1092.11
FYM+Azo	100.77	117.10	108.93	877.86	591.77	734.81
FYM+Azo+PSB	113.86	125.10	119.48	1325.66	611.00	968.33
VC	112.26	104.00	108.13	821.93	593.60	707.76
VC+Azo	112.40	98.10	105.25	722.00	502.50	612.25
VC+Azo+PSB	103.70	119.80	111.75	1023.20	890.50	956.85
CC	71.98	124.90	98.44	727.60	765.00	746.3
CC +Azo	116.13	113.10	114.61	991.16	883.00	937.08
CC + Azo + PSB	128.24	128.10	128.17	859.20	1313.67	1086.43
Control	65.89	94.80	80.34	712.31	656.00	684.15
CD(0.05)	NS	19.35	10.14	NS	547.6	512.03

Table 2: Effect of organic manures and biofertilisers on biomass production and dry matter accumulation in *B. monnieri*

Treatments	Biomass production(g/pl)			Dry matter production(g/pl)		
	1st year	2nd year	pooled	1st year	2nd year	pooled
FYM	14.92	18.70	16.81	6.61	8.40	7.50
FYM+Azo	20.23	26.30	23.26	9.81	12.80	11.40
FYM+Azo+PSB	23.99	23.10	23.54	10.40	10.43	10.41
VC	9.70	21.30	15.5	4.12	9.36	6.74
VC+Azo	10.28	16.00	13.14	4.33	7.46	5.89
VC+Azo+PSB	31.22	26.53	28.87	18.21	13.40	15.81
CC	29.92	34.10	27.01	13.25	15.73	14.49
CC +Azo	25.48	20.30	22.89	12.17	9.20	10.68
CC + Azo + PSB	31.65	35.43	33.54	18.71	19.65	19.18
Control	9.00	16.60	12.80	4.60	8.90	6.75
CD(0.05)	8.56	9.57	4.59	2.39	1.581	2.08

was 1.24% organic carbon, 25.92 kg/ha of available P_2O_5 and 440.50 kg/ha of available K_2O. The climate of the experimental site was humid tropical and the crop was grown under rainfed situation. The experiment was laid out in randomized block design with three replications. There were nine treatment combinations of organic manures (farm yard manure[FYM], vermicompost and coirpith compost) and biofertilisers (*Azospirillum* and Phosphorus solubilising bacteria [PSB]) and control. Quantity of FYM (mean nutrient content of 0.55%N, 0.42%P and 0.32% K) vermicompost (mean nutrient content of 0.92%N, 0.62%P and 0.49% K) and coirpith compost (mean nutrient content of 1.24%N, 0.06%P and 1.20 %K) required was fixed based on nitrogen equivalent of FYM and commercial inoculum of *Azospirillum* and PSB @ 1kg/ha were applied along with organic manures prior to planting. One month old rooted cuttings of brahmi were planted in plots of 5x2 m^2. All other management practices were carried out following the recommended package of practices recommendations [7]. The crop was harvested at five months after planting. The data on growth parameters viz. vine length, number of leaves biomass production and dry matter production were recorded from five randomly selected plants. The yield was recorded on net plot basis at harvest and expressed as tonnes /ha. The soil and plant samples were collected for nutrient content analysis following standard procedures [6] and nutrient uptake was computed. The bacoside content was estimated using HPTLC [14]. The statistical analysis of data was done by adopting the standard procedures of [18].

RESULTS AND DISCUSSION

The pooled data on growth characters revealed variation in growth characters due to application of organic manures alone and in combination with biofertilisers. Among the different organic manures tried, farmyard manure (FYM) had profound influence on the vine length of brahmi followed by vermicompost compared to coirpith compost. The variation in number of leaves was significant for application of FarmYard Manure(FYM) alone compared to vermicmpost or coirpith compost. This trend was noticed in both the years. Coir pith compost was found to be more efficient for biomass and dry matter production in Bacopa compared to other organic manures viz, FYM and vermicompost tried. The combined application of organic manures with biofertilisers registered higher biomass and dry matter production compared to their individual application. The pooled analysis of biomass production showed that the biomass production was the highest for the combined application of coirpith compost with Azospirillum and PSB which was 236% increase over control. The results are in conformity with findings [2, 4, 9].This may explain the efficiency of coir pith compost to hold nutrients and water for

Table 3: Effect of organic manures and biofertilisers on yield and quality of *B. monnieri.*

Treatments	Fresh yield(t/ha)			Dry yield(t/ha)			Bacoside content(%)		
	2010	2011	pooled	2010	2011	pooled	2010	2011	pooled
FYM	25.61	24.65	25.13	12.10	11.42	11.76	5.32	5.16	5.24
FYM+Azo	23.54	25.62	24.58	10.32	11.36	10.84	5.41	5.54	5.47
FYM+Azo+PSB	27.25	30.88	29.06	15.20	17.21	16.20	5.62	5.78	5.70
VC	22.31	24.15	23.23	9.65	11.65	10.65	4.21	4.42	4.31
VC+Azo	15.98	14.73	15.35	8.01	7.65	7.83	4.31	4.76	4.53
VC+Azo+PSB	25.12	24.60	24.86	12.64	11.64	12.14	5.20	5.54	5.37
CC	26.35	25.87	26.11	12.89	12.05	12.47	5.62	5.62	5.62
CC +Azo	28.65	26.98	27.81	13.58	12.98	13.28	5.73	5.78	5.75
CC + Azo + PSB	35.64	39.04	37.34	17.58	18.25	17.91	6.23	6.04	6.13
Control	19.54	18.25	18.89	9.25	8.87	9.06	5.12	4.85	4.98
CD(0.05)	3.452	2.98	3.021	1.015	1.25	1.08	0.98	0.65	0.71

Table 4: Effect of organic manures and biofertilisers on nutrient uptake in *B. monnieri.*

Treatments	N uptake(g/pl)			P uptake(g/pl)			K uptake(g/pl)		
	1st year	2nd year	pooled	1st year	2nd year	pooled	1st year	2nd year	pooled
FYM	7.25	8.12	7.68	0.728	0.745	0.736	1.85	1.58	1.71
FYM+Azo	7.40	8.05	7.72	0.764	0.854	0.809	1.81	1.98	1.89
FYM+Azo+PSB	10.55	10.98	10.76	1.078	1.652	1.365	2.91	3.02	2.96
VC	5.04	5.23	5.15	0.457	0.421	0.439	1.23	1.58	1.40
VC+Azo	5.24	5.62	5.43	0.498	0.487	0.492	1.35	1.65	1.50
VC+Azo+PSB	5.64	5.98	5.81	0.557	0.568	0.562	1.57	1.98	1.77
CC	5.94	6.25	6.09	0.754	0.789	0.771	1.54	1.98	1.76
CC +Azo	13.62	14.98	14.30	1.258	1.452	1.35	3.46	3.25	3.35
CC + Azo + PSB	15.62	16.54	16.08	1.987	1.894	1.940	3.98	4.05	4.01
Control	6.58	6.95	6.72	0.587	0.487	0.537	1.25	1.02	1.13
CD(0.05)	1.25	1.12	1.054	0.183	0.757	0.812	0.481	0.458	0.51

Table.5. Effect of organic manures and biofertilisers on soil nutrient status in *B. monnieri* field.

Treatments	Soil N (Kg/ha)			Soil P (Kg/ha)			Soil K (Kg/ha)		
	1st year	2nd year	pooled	1st year	2nd year	pooled	1st year	2nd year	pooled
FYM	250.77	257.98	254.37	8.72	9.12	8.92	13.54	12.34	12.94
FYM+Azo	247.98	245.98	246.98	9.26	9.87	9.56	16.25	13.02	14.63
FYM+Azo+PSB	298.25	256.58	277.41	9.25	10.28	9.76	5.36	6.02	5.69
VC	314.04	328.98	321.51	3.78	3.98	3.88	6.58	6.35	6.465
VC+Azo	310.54	325.21	317.87	4.23	4.21	4.22	8.97	7.25	8.11
VC+Azo+PSB	321.98	365.21	343.59	4.65	5.21	4.93	12.01	13.2	12.60
CC	362.15	378.65	370.4	5.98	6.25	6.11	10.2	11.2	10.7
CC +Azo	398.54	405.62	402.08	8.97	8.97	8.97	13.65	12.95	13.3
CC + Azo + PSB	458.87	487.69	473.28	10.25	11.29	10.77	15.98	16.54	16.26
Control	162.35	198.35	180.35	2.65	3.01	2.83	5.25	5.14	5.19
CD(0.05)	21.02	25.98	29.87	1.65	1.35	1.98	2.01	2.35	3.21

supply to plants for longer time. The superior performance of growth parameters under coir pith compost + *Azospirillum* + PSB could be attributed to higher availability of N, P and K in the soil due to the combined application. Biofertilisers are microbial inoculants and were found to have not only the improvement of the availability of nutrients but also the ability to release phytohormones which could stimulate photosynthesis and biomass accumulation [8]. In *Bacopa* the biomass production being the economic yield, the increased biomass production resulted in increased yield. Coir pith compost was more effective for higher yield compared to FYM or vermicompost. The biofertliser application also produced significant variation in fresh yield of Bacopa. The yield response due to *Azospirillum* and PSB was more pronounced in combination with coir pith compost than with FYM or vermicompost. The increase in the yield may be explained by the increased population of soil microorganisms in combination with organic source and increased intensity of the processes in which they are involved which in turn preconditions better plant nutrition [20].

Coir pith compost was found to be a better source of organic manure for increased bacoside content compared to vermicompost and FYM. The combined application of coirpith compost with *Azospirillum* and PSB recorded the highest bacoside content. Similar findings of higher quality attributes due to combined application of organic manures and biofertilisers were reported in coriander [2, 9]. The quality of medicinal plants is a function of secondary metabolite and the secondary metabolite production is associated with the steady supply of balance nutrients which was achieved from the combination of coirpith compost and biofertilisers leading to enhanced quality.

Significantly higher uptake of N, P and K were noticed due to the application of coir pith compost compared to FYM or vermicompost. The nutrient uptake is generally considered as a function of dry matter production. Hence combined application of Azospirillum and PSB with coirpith compost resulted in higher N, P and K uptake due to higher dry matter production in the treatment. Azosiripllum helped in building up of N through biological nitrogen fixation [16] and PSB have the ability to solubilise native as well as applied phosphorus [17]. The increased uptake may be due to the interaction effect of organic manures with biofertlisers through release of macro and micro nutrients by the breakdown of organic source and mobilization of the nutrients in the composted materials. This synergetic effect contributed to higher availability and absorption of nutrients resulting in higher nutrient uptake, biomass and dry matter production and ultimately the yield in Bacopa. Increased uptake due to combined application of organic manures with biofertilisers was reported by Sreekala and Jayachandran [19].

The different organic manures behaved differently in maintaining the fertility status of soil. The combined application of organic manures and biofertilisers had a positive influence on the nutrient status of soil. Inoculation of *Azospirillum* and PSB with coir pith compost have resulted in enhanced assimilation of nutrients N,P and K due to the synergetic relationship between them. The increased release of nutrients in soil enhanced the uptake thereby yield of Bacopa. The results are in conformity with findings reported by Priya and Elakkiya [11] in *Eclipta alba* and Nejad and Moghaddam [12] in cumin.

CONCLUSION

In the present study higher nutrient uptake, economic yield and bacoside content were noticed when organic manures were applied along with biofertlisers. The treatment combination of Coirpith compost @ 5t/ha with Azospirillum and PSB each @1 kg/ha was found to be better in terms of higher herbage yield and bacosdie content in *Bacopa monnieri.*

REFERENCE

1. Chatterji N, Rastorgi RP, Dhar, ML. 1963. Chemical examination of *Bacopa monnieri* Wettst. Part I: isolation of chemical constituents. *Ind J Chemistry* **1** : 206–212.
2. Darzi TM, Shirkhodaei M , Hadi MHS. 2013. Effects of vermicompost and azotobacter and azospirillum bacteria on quantity and quality of essential oil of coriander (*Coriandrum sativumL.*) *Int J Fmg Allied Sci* **2**:1277-1283.
3. Deepak M, Amit A. 2004. The need for establishing identities of 'Bacoside-A and B', the putative major bioactive saponins of Indian medicinal plant *Bacopa monnieri*. *Phytomed* **11** : 264–268.
4. Fraihat, AH, Al-dalain YA, Al-Rawashdeh Z B, Abu-Darwish SM , Al-Tabbal, JA. 2011. Effect of organic and biofertilisers on growth, herb yield and volatile oil of marjoram plant grown in Ajioun region. *J Med Pl Res* **5**:2822-2833.
5. Griffe P, Metha S , Shankar D.2003. Organic production of medicinal, aromatic and dye yielding plants. *Bull Faculty Agri* **51**: 151-174.
6. Jackson ML. 1973. *Soil Chemical Analysis*. Prentice Hall of India Private Ltd., New Delhi
7. KAU 2007. Package of Practices Recom-mendations-2007. Directorate of Extension, Kerala Agricultural University, Thrissur.

8. Mahfouz S and Eldin MAS. 2007. Effect of mineral vs. biofertiliser on growth, yield and essential oil content of fennel (*Foeniculum vulgareMill.*) *Int Agrophysics* **21**:361-366.

9. Moradi R, Rezvani MP, Nasiri MM, Lakzian A. 2010. Effect of application of organic and biological fertilizers on yield, yield components and essential oil of *Foeniculum vulgare*. *Iran J Agron Res* **7**: 625-635

10. Murthy PBS, Raju VR, Ramakrisana T, Chakravarthy MS, Kumar KV, Kannababu, S, Subraraj GV. 2006. Estimation of twelve bacopa saponins in *Bacopa monnieri* Extracts and formulations by high-performance liquid chromatography. *Chemi. Pharmaceutical Bull* **54** : 907-911.

11. Nejad SAH, Moghaddam RP. 2010. Evaluation biofertiliser and chemical fertilizer application on morphological traits, yield and yield components and essential oil percent in cumin (*Cuminum cyminum*). *J Hortic Sci* **24**: 38-44.

12. Priya S, Elakkiya R. 2012. Effect of organic manure and biofertilisers on growth and yield of Eclipta alba. *Int J Pharmatech Res*. **14**:1703-1706.

13. Saraswati G, Shashi B, Mahato KO, Kazuo Y. 1996. Dammarane-type triterpenoid saponins from *Bacopa monnieri*. *Phyto-chem* **42**: 815-820

14. Shrikumar S, Sandeep S, Ravi TK, Umamaheswari M. 2004. HPTLC determination and finger printing of bacoside A in *Bacopa monnieri* and its formulation. *Ind J Pharm Sci* **66**: 132 - 135

15. Singh HK, Rastogi RP, Srimal RC, Dhawan BN. 1998. Effect of bacosides A and B on avoidance responses in rats *Phytotherapy Res* **2** : 70–74.

16. Singh K, Singh PP, Beg SU, Kumar D, Patra, D.D. 2004. Effect of harvesting time and nitrogen application on essential oil yield and quality of methyl rich cultivar of Indian basil (*Ocimum basilium*). *J Med Arom Pl Sci* **26**: 293-296

17. Smith SE, Read DJ. 1997. *Mycorrhizal symbiosis 2nd Edn*. Academic Press, San Diego. 126p.

18. Sukhatme PV, Amble VN. 1985. *Statistical Methods for Agricultural Workers* (Rev. Edn.) ICAR, New Delhi.

19. Sreekala GS, Jayachandran BK (2006). Effect of organic manures and microbial inoculants on nutrient uptake, yield and nutrient status of soil in ginger intercropped coconut garden. *J Plantn Crops* **34**: 25-31.

20. Tringoveska I, Kanazirska V. 2003. Use of biohumus in greenhouse vegetable production. IVth Scientific and Practical Conf. Ecological problems of agriculture AgroecoXLVII, Bulgaria,19 May, 2003: 317-322.