



Effect of Integrated Use of Organic Manures, Bio-fertilizers with Inorganic Nitrogenous Fertilizer on Growth and Yield of Medicinal Coleus (*Coleus forskohlii* Briq.)

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ABSTRACT

A field experiment was conducted on medicinal coleus (*Coleus forskohlii* Briq.) (K-8) at Herbal Garden, Rajendranagar, Hyderabad on a fine loamy, mixed hyperthermic, Typic Haplustept soil during *Kharif* 2005-06 to study the effect of organic manures (different doses of castor cake, FYM), bio-fertilizers (*Azospirillum*, *Phosphorous Solubilizing Bacteria*) and inorganic nitrogenous fertilizer (different levels). Conjunctive use of 50% RDN (20 kg N ha⁻¹) with organic manures (FYM@2.5 t ha⁻¹ + Castor Cake @ 0.25 t ha⁻¹) and bio-fertilizers (T₁₂) has resulted in the highest fresh tuber yield (121.91 t ha⁻¹), dry tuber yield (21.59 q ha⁻¹) at harvest and dry matter production at different growth stages and at harvest.

Key words : Azospirillum, Castor Cake, FYM, Phosphorous Solubilizing Bacteria

Coleus forskohlii Briq. (Synonym *Coleus barbatus* Benth.) belonging to the family Lamiaceae is one of the most significant potential medicinal crops. The tuberous roots contain active diterpenoid (C₂₂H₃₄O₇), forskohlin that is used as a drug against hypertension, glaucoma, asthma, congestive heart failures and certain types of cancer (Shah, 1989). The drug is claimed to improve appetite, facilitate digestion and is useful for anemia, fever with rigors, dysentery and chronic abdominal problems. Application of organic manures viz., animal manures, urban compost, FYM, vermicompost and green manures in conjunction with chemical fertilizers not only improve soil health but also maintain soil fertility and increase crop yields (Glenn, 1976). Hence an experiment was conducted to study the influence of nutrient management strategies in medicinal coleus.

MATERIAL AND METHODS

A field experiment was carried out at Herbal Garden, College of Agriculture, Acharya N.G Ranga Agricultural University, Rajendranagar, Hyderabad in a fine loamy, mixed hyperthermic, typic Haplustept soil during the *Kharif* 2005. The treatments were 12 viz., control (T₁-No manures, no bio-fertilizers (BF) and no inorganic nitrogen), 50 per cent of recommended dose of N (RDN)(20 kg N ha⁻¹- T₂), 100% RDN(40kg N ha⁻¹- T₃), FYM @ 10 t ha⁻¹- T₄, FYM @ 10 t ha⁻¹ + BF (T₅), 50% RDN + FYM @ 5 t ha⁻¹ + BF (T₆) Castor cake @ 1.0 t ha⁻¹ (T₇), Castor cake @ 1.0 t ha⁻¹ + BF (T₈), 50% RDN +

Castor cake @ 0.5 t ha⁻¹ + BF (T₉), FYM @ 5 t ha⁻¹ + Castor cake @ 0.5 t ha⁻¹ (T₁₀), FYM @ 5 t ha⁻¹ + Castor cake @ 0.5 t ha⁻¹ + BF (T₁₁) and 50% RDN FYM @ 2.5 t ha⁻¹ + Castor cake @ 0.25 t ha⁻¹ + BF (T₁₂) arranged in randomized block design with three replications. The control plot received no organic manures, bio-fertilizers or inorganic N fertilizers. Nitrogen was applied through urea in two equal splits at basal and 30 days after planting (DAP) as per the treatments. All the plots including control received uniform doses of 60 kg P₂O₅ and 50 kg K₂O ha⁻¹ through single super phosphate (SSP) and muriate of potash (MOP), respectively. Castor cake and FYM were applied as per the treatments. The coleus cuttings were dipped for half an hour in bio-fertilizers (*Azospirillum* + *Phosphorus Solubilising Bacteria*) solution @ 1 kg each in 10 liters of water before planting. The N content of FYM and castor cake was analyzed and found to be 0.35 and 4.40 per cent, respectively. The initial soil samples were analyzed by following standard methods (Tandon, 1973) and the initial physico-chemical properties of the experimental site are presented in Table 1.

For plant analysis at a time three plant samples from each treatmental plot were collected randomly at harvest (150 DAP) in each treatment and separated into different parts viz., leaves, stems and roots. The plant parts were dried in oven at 65°C and dry weights of the tubers were recorded immediately after harvest and after drying in oven, respectively and expressed as q ha⁻¹.

Table 1. Initial soil properties of experimental site

Property	
Physical properties	
i) Sand(%)	71.90
ii) Silt (%)	7.80
iii) Clay (%)	18.50
Textural class	Sandy loam
Bulk density (g cm ⁻³)	1.70
Physico-chemical properties	
pH (1:2)	7.70
EC (1:2) (dS m ⁻¹)	0.37
Organic Carbon (g kg ⁻¹)	5.90
Chemical properties	
Available nitrogen (kg ha ⁻¹)	201.00
Available P (kg ha ⁻¹)	17.92
Available K (kg ha ⁻¹)	338.00
Available S (mg kg ⁻¹)	24.00
Available DTPA extractable micronutrients(mg kg⁻¹)	
Iron	7.42
Manganese	22.10
Copper	2.16
Zinc	1.36

RESULTS AND DISCUSSION

Tuber Yield

Application of 50% RDN + FYM @ 2.5 t ha⁻¹ + castor cake @ 0.25 t ha⁻¹ + bio-fertilizers (T₁₂) has recorded the highest fresh and dry tuber yields (121.91 q ha⁻¹ and 21.59 q ha⁻¹, respectively) which was on par with only inorganic 100% RDN (T₃-115.54 q ha⁻¹ and 19.61 q ha⁻¹ respectively) (Table 2). The lowest fresh and dry tuber yields were observed under control (T₁- 91.79 q ha⁻¹ and 12.31 q ha⁻¹, respectively). With increase in N levels from 50 to 100 per cent RDN there was increase in fresh and dry tuber yields. Among organic manures, castor cake @ 1.0 t ha⁻¹ (T₇) has recorded higher yield (8.62 and 19.08 per cent higher fresh and dry tuber yield, respectively) over FYM @ 10 t ha⁻¹ (T₄). It is interesting to note that both of these treatments were on par with 50% RDN which indicates that these organic manures were able to substitute nearly 50% of N requirement of crop. Significant difference was not observed when bio-fertilizers were integrated with FYM or castor cake or FYM + castor cake. Response of coleus up to 40 kg N ha⁻¹ was also reported by Sailaja (2004), Seemanthini Ramadass and Mohammed Yassin (1989) and Virbala Shah (1986), whereas response up to 60 kg N ha⁻¹ was reported by Geetha and Madhavan Nair (1993).

The higher yield due to integration of organic manures could be due to their effect on higher supply of nutrients, favorable physical and biological environment in the soil leading to better root activity and nutrient absorption (Mazumdar *et al.*, 2002). As coleus is a rhizomatous crop, improvement of soil physical environment might have helped in better development of tubers. Higher yields in castor cake applied plots when compared to FYM might be due to higher N supply through castor cake. The C:N ratio of castor cake is lower (8-10) than FYM (10-20) (Parr *et al.*, 1986) indicating rapid mineralization of N from castor cake when compared to FYM.

Dry Matter Production

Dry Matter production was significantly influenced by different treatments. It increased as the age of crop advanced. Data on dry matter production by coleus leaves, stem, roots and total dry matter production at 90, 120 DAP and at harvest are presented in Table 3.

Contribution by leaves, stems and root in total drymatter production varied between the treatments at different growth stages. During the early crop growth period i.e., at 90 DAP stems followed by leaves contributed more than roots in all the treatments except in control (T₁) where roots contributed more than leaves. Where as at 120 DAP stems followed by roots contributed more than leaves in treatments 50% RDN + FYM @ 2.5 t ha⁻¹ + CC @ 0.25 t ha⁻¹ + BF (12), 100% RDN (T₃), CC @ 1.0 t ha⁻¹ + BF (T₈) and CC @ 1.0 t ha⁻¹ (T₇) indicating the development of roots by the crop and in rest of the treatments leaves contributed more than roots. Similarly, at harvest stems followed by roots contributed more than leaves in all the treatments except in control (T₃) where leaves contributed more than roots due to poor root development (Table 3).

Among the N levels (T₁ to T₃) significant increase in dry matter production was observed with increase in N dose from control to 100% RDN. At 90, 120 DAP and at harvest application of 100% RDN was found to be 1.63, 1.35 and 1.43 times higher over 50% RDN (T₂) and 3.27, 2.10 and 2.05 time higher over control (T₁). Similarly, application of 50% RDN (T₂) has recorded 2.00, 1.55 and 1.44 time higher than control (T₁) at all the growth stages.

Among the organic manures (T₄ and T₇) application of castor cake @ 1.0 t ha⁻¹ (T₇ - 17.95, 30.82 and 62.67 q ha⁻¹, respectively) has recorded significantly higher dry matter than FYM @ 10 t ha⁻¹ (T₄ - 13.51, 25.31 and 51.99 q ha⁻¹, respectively) at 90, 120 DAP and at harvest. Both

Table 2. Effect of organic manures, biofertilizers and nitrogen levels on tuber yield of *Coleus forskohlii* at harvest (150 days after planting)(q ha⁻¹).

Treatments	Tuber yield (q ha ⁻¹)	
	Fresh	Dry
T ₁ - Control	91.79	12.31
T ₂ -50% RDN*	100.86 (9.88)**	16.53 (34.28)
T ₃ -100% RDN	115.54 (25.87)	19.61 (59.30)
T ₄ -FYM @ 10 t ha ⁻¹	95.06 (3.56)	15.14 (22.98)
T ₅ -FYM @10t ha ⁻¹ BF***	99.05 (7.90)	15.44 (25.42)
T ₆ - 50% RDN+ FYM @5 t ha ⁻¹ + BF	103.04 (12.25)	16.95 (37.69)
T ₇ - CC****@ 1.0 t ha ⁻¹	103.30 (12.53)	18.03 (46.46)
T ₈ - CC @1.0 t ha ⁻¹ + BF	103.40 (12.64)	18.61 (51.17)
T ₉ - 50% RDN +CC @0.5 t ha ⁻¹ + BF	107.03 (16.60)	19.34 (57.10)
T ₁₀ - FYM @ 5 t ha ⁻¹ +CC @0.5 t ha ⁻¹	103.22 (12.45)	17.97 (45.97)
T ₁₁ - FYM @ 5 t ha ⁻¹ + CC @0.5 t ha ⁻¹ + BF	112.54 (22.60)	19.24 (56.29)
T ₁₂ - 50% RDN + FYM @2.5 t ha ⁻¹ + CC @0.25 t ha ⁻¹ + BF	121.91 (32.81)	21.59 (75.38)
S.E.m	2.56	0.70
CD (P=0.05)	7.50	2.04

* RDN - Recommended dose of nitrogen (40 kg N ha⁻¹).

** Figures in the parenthesis indicate percentage increase or decrease over control

*** BF-Bio-fertilizers (*Azospirillum*+*Phosphorous Solubilizing Bacteria*)

****CC-Castor cake

these treatments were found to be on par with 50% RDN (T₂) treatment and were significantly lower than 100% N (T₃) and higher over control (T₁).

Bio-fertilizers effect on dry matter production was found to be non- significant when it was integrated either with only FYM @ 10 t ha⁻¹ or CC @ 1.0 t ha⁻¹. However, when both were integrated with bio-fertilizers (T₁₁) there was 30.63, 22.96 and 12.58 per cent increase in dry matter production respectively, when compared to FYM @ 5 t ha⁻¹ + CC @ 0.5 t ha⁻¹ (T₁₀) at 90, 120 DAP and at harvest.

Among all the treatments, integrated use of inorganic 50% RDN with organic manures and bio-fertilizers i.e. 50% RDN + FYM @ 2.5 t ha⁻¹ + CC @ 0.25 t ha⁻¹ + BF (T₁₂) has recorded the highest dry matter production (26.01, 42.60 and 85.81 q ha⁻¹ respectively) was on par with 100% RDN T₃ (25.70, 40.00 and 83.06 q ha⁻¹ respectively) and was

significantly higher over rest of the treatments at 90, 120, DAP and at harvest. The lowest dry matter production was recorded under control (T₁-7.84, 19.04 and 40.48 q ha⁻¹ respectively at all the growth stages. The treatment 50% RDN + CC@ 0.25 t ha⁻¹ + BF (T₉) has recorded 15.53, 33.19 and 16.24 per cent higher dry matter production over 50% RDN + FYM @ 5 t ha⁻¹ + BF (T₆) and 1.43, 20.10 and 19.70 times higher over 50% N (T₂) at 90, 120 DAP and at harvest.

Higher dry matter production with FYM @ 15 t + vermicompost @ 1.0 t + neem cake @ 1.0t + BF 10 kg ha⁻¹ was reported by Sudhakar (2005) in coleus. Integrated use of inorganic fertilizers with poultry manure resulted in higher dry matter production of potato (Kirthi Singh *et al.*, 1973). Similarly, higher dry matter production of potato by integrating enmite was reported by Biswajit and

Table 3. Effect of organic manures, biofertilizers and nitrogen levels on dry matter production of *Coleus forskohlii* at 90, 120 days after planting and at harvest ($q\ ha^{-1}$).

Treatments	90 DAP**			120 DAP**			At harvest					
	Leaves	Stems	Roots	Total	Leaves	Stems	Roots	Total	Leaves	Stems	Roots	Total
T ₁ - Control	2.25	9.99	3.64	7.84	5.55	8.26	5.23	19.04	7.56	20.60	12.31	40.48
T ₂ -50% RDN*	4.84	7.25	3.64	15.73	8.95	12.52	8.12	29.59	13.80	27.84	16.53	58.17
T ₃ -100% RDN	8.29	11.25	6.16	25.70	11.66	16.45	11.89	40.00	20.37	43.08	19.61	83.06
T ₄ -FYM 10 t ha ⁻¹	4.42	6.31	2.78	13.51	7.36	10.71	7.24	25.31	11.00	25.85	15.14	51.99
T ₅ -FYM @10t ha ⁻¹ + BF ***	4.67	6.59	3.13	14.39	7.93	11.43	7.51	26.87	11.94	26.87	15.44	54.25
T ₆ - 50% RDN FYM @ 5t ha ⁻¹ + BF	5.20	7.66	3.98	16.84	9.00	12.90	8.86	30.76	14.48	28.47	16.95	59.90
T ₇ -CC****@ 1.0 t ha ⁻¹	5.34	8.40	4.21	17.95	8.36	13.52	8.94	30.82	15.36	29.28	18.03	62.67
T ₈ - CC @1.0 t ha ⁻¹ + BF	5.48	8.56	4.22	18.26	8.62	14.15	9.14	31.91	15.73	31.43	18.61	65.78
T ₉ - 50% RDN +CC @ 1.5 t ha ⁻¹ + BF	6.95	9.83	5.65	22.43	10.68	15.15	9.71	35.54	17.58	32.70	19.34	69.63
T ₁₀ - FYM @ 5 t ha ⁻¹ +CC @0.5 t ha ⁻¹	5.26	8.38	4.02	17.66	9.16	13.11	8.17	30.44	15.17	28.93	17.97	62.07
T ₁₁ - FYM @ 5 t ha ⁻¹ + CC @0.5 t ha ⁻¹ + BF	7.31	9.99	5.77	23.07	11.43	15.20	10.84	37.43	17.59	33.05	19.24	69.88
T ₁₂ - 50% RDN + FYM @ 2.5 t ha ⁻¹ + CC @ 0.25 t ha ⁻¹ + BF	8.16	11.48	6.37	26.01	12.67	16.90	13.03	42.60	20.79	43.43	21.59	85.81
S.E.m	0.50	0.55	0.40	0.87	0.56	0.48	0.55	1.00	1.05	0.95	0.70	1.45
CD (P=0.05)	1.47	1.62	1.18	2.57	1.65	1.39	1.62	2.92	3.07	2.79	2.04	4.25

* RDN - Recommended dose of nitrogen (40 kg N ha⁻¹).

** Figures in the parentheses indicate percentage increase or decrease over control

*** BF-Bio-fertilizers (*Azospirillum+Phosphorous solubilizing Bacteria*)

****CC-Castor cake

Mondal (2005). Integration of FYM +BF with NPK resulted in higher total dry matter production of potato which was also reported by *Kate et al.*, (2005). The beneficial effects of organic manures as discussed under yield also might have been responsible for higher total dry matter production of coleus. Significant positive correlation was obtained between total dry matter production and yield. Integrated use of organic manures or bio-fertilizers with inorganic fertilizers not only reduced the dosage of inorganic fertilizers but also helped in more translocation of photosynthates to the tubers due to increased dry matter production resulting in higher tuber yields.

The above results revealed that integrated use of organic manures, bio-fertilizers with 50% inorganic recommended N fertilizers has recorded the highest dry matter production, fresh and dry tuber yields at harvest (150 DAP) which was on par with 100% RDN. Among the organic manures castor cake @ 1.0 t ha⁻¹ (T₇) has recorded higher yield over FYM @ 10 t ha⁻¹ (T₄).

Taking into consideration of tuber yield and dry matter production, integrating of 50% N +FYM@ 2.5 t ha⁻¹ +CC @0.25 t ha⁻¹ + BF (T₁₂) is recommended for coleus crop grown in Typic Haplustept soils of the Southern Telangana Zone of Andhra Pradesh for achieving higher yield and maintaining the soil fertility.

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