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RESEARCH PAPER

Influence of organic and inorganic fertilizers on growth and tuber yield of coleus (*Coleus forskohlii* Briq.) under northern dry zone of Karnataka

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Abstract : Coleus (*Coleus forskohlii* Briq.) belonging to the family Lamiaceae is an Indian medicinal plant grown for its tuberous roots. It is used against hypertension, glaucoma and congestive cardiomyopathy. It needs to be cultivated in large scale. A field experiment was conducted on sandy loam soil under irrigated conditions at the Kittur Rani Channamma College of Horticulture, Arabhavi, Karnataka, India, to study the effect of organic and inorganic fertilizers on growth and yield of coleus. The results of the experiment revealed that application of 75 Per cent RDF (Recommended dose of fertilizer) + 10 t FYM + vermicompost 5 t per hectare produced increased plant height (66.49cm), number of branches per plant (85.95), leaf area index (7.49) at harvest, absolute growth rate (3.394g/plant/day), crop growth rate (0.943g/m^2/day) and relative growth rate (0.0460g/g/week) were recorded at 120-160 days after planting. The maximum fresh tuber yield 225.47 and 250.52 g/plant and q/ha, respectively and dry tuber yield 29.53 and 32.81 g/plant and q/ha, respectively.

Key Words : *Coleus forskohlii*, Forskolin, Nutrients, Dry matter accumulation, Tuber yield

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INTRODUCTION

Coleus (Coleus forskohlii Briq.) belonging to the family Lamiaceae is an Indian medicinal herb (Valdes *et al.*, 1987). It is the most important species of genus *Coleus* popularly known as 'garmar' in Maharastra and 'makandiberu' in Karnataka. It is cultivated to a limited extent in Maharastra, Tamil Nadu, Gujarat and Karnataka, for the tuberous roots which are pickled and eaten (Anonymous, 1950), this is also used for the medicinal purposes mentioned in the Hindu and Ayurvedic schools of medicines (Ammon and Muller, 1985). *C. forskohlii* is the only known source of forskolin (De Souza and Shah, 1988). Though almost all parts of the plant are found to have traces of forskolin, the roots are the main source, containing 0.1 to 0.5 per cent and are commercially preferred for its extraction (Valdes *et al.*, 1987). The tuber attachment region contains maximum (1.3 times higher) forskolin (Yanagihara, 1995). The forskolin is used in the treatment of congestive cardiomyopathy, hypertension and glaucoma (Seamon, 1984). Being the only source of the forskolin to this species, the indiscriminate collection of *C. forskohlii* from the wild has made the species vulnerable and it has been included in the list of endangered species (Vishwakarma *et al.*, 1988). To protect these herbal medicinal plants in their habitat, systematic agro techniques need to be developed for such economically important medicinal crops. The cultural practices have not so far been standardized for commercial cultivation of *C. forskohlii*.

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Among the various cultural practices conducive for enhancing the growth and obtain maximum tuber yield, the nutrient management also plays an important role in enhancing the yield per unit area. In the present situation, there is a need to give more emphasis on integrated nutrient management in *C. forskohlii* to get quality tubers. But in south India, not much work has been done on integrated nutrient management. Hence, the present investigation was carried out under Ghataprabha Left Bank command area of north Karnataka, to study the effect of organics and inorganic fertilizers on growth and yield of *C. forskohlii*.

MATERIAL AND METHODS

A field experiment was conducted during the *Kharif* season at Department of Medicinal and Aromatic Plants in Kittur Rani Channamma College of Horticulture, Arabhavi, Karnataka, on sandy loam soil having pH of 8.46. The treatment were $T_{1:}$ 100 per cent RDF *viz*., 40:60:50 kg NPK /hectare (ha) + 10 t FYM per ha (control), T_2: 75 per cent RDF + 10 t FYM + vermicompost 2.5 t/ha, T_3: 75 per cent RDF + 10 t FYM + vermicompost 5.0 t/ha, T_4: 50 per cent RDF + 10 t FYM + vermicompost 2.5 t/ha, T_5 : 50 per cent RDF + 10 t FYM + vermicompost 5.0 t/ha, T_6: 25 per cent RDF + 10 t FYM + vermicompost 2.5 t/ha, T_7: 25per cent RDF + 10 t FYM + vermicompost 5.0 t/ha, T_8 : 10 t FYM + vermicompost 2.5 t/ha, T_9 : 10 t FYM + vermicompost 5.0 t/ ha. The cuttings were planted at 60x15cm spacing during *Kharif* season. The observations were recorded at 40 days intervals on five plants on randomly from the three replications in each treatment. The design adopted was Randomized Block Design with three replications. The crop was harvested at 160 days after planting (DAP). FYM and vermicompost were applied to the plots well before planting based on the treatment.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Growth :

The plant height, number of branches per plant and leaf area index (LAI) increased with increase in the advancement of crop age in all the treatments (Table 1).

The data on growth parameters are presented in Table 1. The results revealed significant difference with respect to growth parameters in coleus, when the crop was supplied with organic sources of nutrients and inorganic. Plant height, number of branches per plant and leaf area index (LAI) increased with increase in the advancement of crop age in all the treatments. The maximum plant height, number of branches per plant and LAI was recorded in crop supplied with 75 per cent RDF + 10 t FYM + vermicompost 5 t per hectare at all the stages of the crop growth. At harvest (160 DAP), maximum plant height (66.49cm), number of branches per plant (85.95) and higher leaf area index (LAI) (7.49) were recorded with the application of 75per cent RDF + 10 t FYM + vermicompost 5 t per hectare followed by application of 75per cent RDF + 10 t FYM + vermicompost 2.5 t per hectare (plant height of 60.86cm), number of branches per plant of 80.09 and LAI of 6.80 at harvest. The lowest plant height (51.84cm), number of branches per plant (64.21) and LAI (5.74) were recorded with application of 10 t FYM + vermicompost 2.5 t per ha. The increased growth in coleus (T_3) might be due to macro and micronutrients available in sufficient quantity in FYM and vermicompost and when

Table 1: Plant height (cm), number of branches per plant and leaf area index (LAI) at different stages of crop growth as influenced by organic manures and inorganic fertilizer in *Coleus forskohlii*

Treatments	Plant height (cm)			No. of branches per plant			Leaf area index		
	80 *DAP	120 DAP	160 DAP	80 DAP	120 DAP	160 DAP	80 DAP	120 DAP	160 DAP
T_1 : 100 per cent RDF + 10 t FYM / ha (control)	30.83	41.58	55.09	24.05	48.27	67.81	2.26	5.12	6.40
T_2 : 75 per cent RDF + 10 t FYM + vermicompost 2.5 t /ha	32.80	42.97	60.86	28.50	52.33	80.09	2.70	5.89	6.80
T_3 : 75 per cent RDF + 10 t FYM + vermicompost 5.0 t / ha	37.02	48.41	66.49	32.97	60.84	85.95	3.00	6.47	7.49
T_4 : 50 per cent RDF + 10 t FYM + vermicompost 2.5 t /ha	32.70	44.27	57.52	25.93	47.24	73.56	2.24	5.87	6.40
T_5 : 50 per cent RDF + 10 t FYM +vermicompost 5.0 t / ha	33.94	45.02	58.95	27.01	48.87	74.89	2.44	5.94	6.45
T_6 : 25 per cent RDF + 10 t FYM +vermicompost 2.5 t /ha	28.86	38.36	55.88	23.18	45.90	70.16	2.04	5.51	6.17
T_7 : 25per cent RDF + 10 t FYM +vermicompost 5.0 t / ha	30.36	40.25	56.95	23.66	46.96	71.61	2.15	5.77	6.27
T_8 : 10 t FYM + vermicompost 2.5 t / ha	23.32	37.91	51.84	21.54	42.33	64.21	1.68	4.99	5.74
T_9 : 10 t FYM + vermicompost 5.0 t / ha	25.76	38.41	52.55	23.04	43.85	68.10	1.82	5.20	6.21
Mean	30.62	41.90	57.34	25.54	48.50	72.93	2.26	5.64	6.44
S..E. ±	1.939	0.799	1.099	0.368	0.696	1.718	0.040	0.100	0.115
C.D. (P=0.05)	5.814	2.396	3.295	1.103	2.086	5.152	0.120	0.299	0.323

* DAP: Days after planting

applied with major nutrients might have helped in better growth of the crop. Similar findings were made by Somanath (2002) in coleus and Vastrad (1999) in ginger.

Total dry matter accumulation (g/plant):

The data on total dry matter accumulation at different stages of crop growth as influenced by organic manures and inorganic fertilizers in *C. forskohlii* are presented in Table 2.

Total dry matter accumulation differed significantly among the different treatments at all the stages of crop growth. At 40 DAP, significantly maximum total dry matter accumulation (32.72 g/plant) was recorded in T_3 (75% RDF + 10 t FYM + vermicompost 5.0 t/ha) followed by T_2 (75% RDF + 10 t FYM + vermicompost 2.5 t/ha) (29.46 g/plant) and T_5 (50% RDF + 10 t FYM + vermicompost 5.0 t/ha) (25.90 g/plant). The minimum total dry matter accumulation of 15.99 g plant^{-1} was recorded in T_8 (10 t FYM + vermicompost 2.5 t/ha). The similar trend was recorded at 80 DAP, 120 DAP and at harvest.

At harvest (160 DAP), the maximum total dry matter accumulation (370.24 g/plant) was recorded in T_3 followed by T_2 (339.23 g/plant) and T_5 (312.20 g/plant). The minimum total dry matter accumulation (220.64 g/plant) was recorded in T_8. The total dry matter accumulation is a result of dry matter accumulation in individual plant parts *viz.*, leaves, stem and roots. This might be due to application of inorganic fertilizers combined with organics helped in the uptake of macro and micro nutrients essential for plant growth which in turn resulted in increase in plant height, number of branches and more number of leaves per plant. These were potential sources of photosynthates and helped in maximum

Table 2 : Total dry matter accumulation (g/plant) at different stages of the crop growth as influenced by organic manures and inorganic fertilizers in *C. forskohlii*

Treatments	Days after planting			
	40	80	120	160
T_1 : 100 per cent RDF + 10 t FYM / ha (control)	21.57	87.25	168.48	286.96
T_2 : 75 per cent RDF + 10 t FYM + vermicompost 2.5 t /ha	29.46	99.45	218.55	339.23
T_3 : 75 per cent RDF + 10 t FYM + vermicompost 5.0 t / ha	32.72	107.25	234.50	370.24
T_4 : 50 per cent RDF + 10 t FYM + vermicompost 2.5 t /ha	23.35	92.83	198.24	302.50
T_5 : 50 per cent RDF + 10 t FYM + vermicompost 5.0 t / ha	25.90	95.24	202.36	312.20
T_6 : 25 per cent RDF + 10 t FYM + vermicompost 2.5 t /ha	18.97	87.04	185.50	281.49
T_7 : 25per cent RDF + 10 t FYM + vermicompost 5.0 t / ha	19.47	89.09	196.64	298.50
T_8 : 10 t FYM + vermicompost 2.5 t / ha	15.99	77.87	130.43	220.64
T_9 : 10 t FYM + vermicompost 5.0 t / ha	17.68	85.72	154.62	248.95
Mean	22.79	91.30	187.70	295.63
S.E. ±	0.400	1.622	3.360	5.249
C.D. (P=0.05)	1.200	4.864	10.074	15.736

Table 3 : Absolute growth rate, crop growth rate and relative growth rate at different stages of the crop growth as influenced by organic and inorganic fertilizers in *Coleus forskohlii*

Treatments	Absolute growth rate (g/plant/day)		Crop growth rate (g/m^2/day)		Relative growth rate (g/g/week)	
	80-120 *DAP	120-160 DAP	80-120 DAP	120-160 DAP	80-120 DAP	120-160 DAP
T_1 : 100 per cent RDF + 10 t FYM / ha (control)	2.031	2.962	0.564	0.823	0.0501	0.0366
T_2 : 75 per cent RDF + 10 t FYM + vermicompost 2.5 t /ha	2.978	3.017	0.287	0.838	0.0595	0.0389
T_3 : 75 per cent RDF + 10 t FYM +Vermicompost 5.0 t / ha	3.181	3.394	0.884	0.943	0.0822	0.0460
T_4 : 50 per cent RDF + 10 t FYM +Vermicompost 2.5 t /ha	2.635	2.606	0.732	0.724	0.0578	0.0320
T_5 : 50 per cent RDF + 10 t FYM + Vermicompost 5.0 t / ha	2.678	2.746	0.744	0.763	0.0574	0.0373
T_6 : 25 per cent RDF + 10 t FYM +Vermicompost 2.5 t /ha	2.461	2.400	0.684	0.667	0.0576	0.0334
T_7 : 25per cent RDF + 10 t FYM +Vermicompost 5.0 t / ha	2.569	2.546	0.747	0.707	0.0602	0.0317
T_8 : 10 t FYM + vermicompost 2.5 t/ha	1.314	2.255	0.365	0.626	0.0392	0.0235
T_9 : 10 t FYM + vermicompost 5.0 t/ ha	1.723	2.358	0.479	0.655	0.0448	0.0362
Mean	2.410	2.298	0.669	0.750	0.0565	0.0351
S.E.±	0.044	0.047	0.012	0.013	0.0010	0.0006
C.D. (P=0.05)	0.132	0.142	0.037	0.040	0.0030	0.0019

*DAP: Days after planting

Table 4 : Fresh and dry tuber yield as influenced by organic manures and inorganic fertilizers in *C. Forskohlii*

Treatments	Fresh tuber yield		Dry tuber yield	
	g/plant	q/ha	g/plant	q/ha
T_1 : 100 per cent RDF + 10 t FYM /ha (control)	165.46	183.84	21.67	24.08
T_2 : 75 per cent RDF + 10 t FYM + vermicompost 2.5 t /ha	202.13	224.58	26.47	29.42
T_3 : 75 per cent RDF + 10 t FYM + vermicompost 5.0 t / ha	225.47	250.52	29.53	32.81
T_4 : 50 per cent RDF + 10 t FYM + vermicompost 2.5 t /ha	181.32	201.46	23.75	26.39
T_5 : 50 per cent RDF + 10 t FYM +vermicompost 5.0 t / ha	184.10	204.56	24.11	26.79
T_6 : 25 per cent RDF + 10 t FYM +vermicompost 2.5 t /ha	160.02	177.80	20.96	23.29
T_7 : 25per cent RDF + 10 t FYM + vermicompost 5.0 t / ha	162.39	180.43	21.27	23.63
T_8 : 10 t FYM + vermicompost 2.5 t /ha	153.70	170.78	20.13	22.37
T_9 : 10 t FYM + vermicompost 5.0 t /ha	160.38	178.20	21.01	23.34
Mean	177.22	196.91	23.21	25.79
S.E. ±	3.307	6.102	0.719	0.799
C.D. (P=0.05)	9.914	18.292	2.157	2.396

dry matter accumulation. Similar findings were also made by Sujatha and Krishnappa (1995), Vastrad (1999) in ginger, Rajwade *et al.* (2000) in potato and Harshavardhan *et al.* (2005) in *Melissa officinalis*.

Physiological parameters:

The data on absolute growth rate (AGR), crop growth rate (CGR) and relative growth rate (RGR) are presented in Table 3. The AGR, CGR and RGR increased with advancement of the crop age. Significantly higher AGR, CGR and RGR were recorded with application of 75 per cent RDF + 10 t FYM + vermicompost 5 t per ha at all the stages of the crop growth. At 120-160 DAP, maximum AGR (3.394 g/plant/day), CGR (0.943 g/m^2/day) and RGR (0.0460 g/g/week) were recorded with the application of 75 per cent RDF + 10 t FYM + vermicompost 5 t per ha followed by application of 75 per cent RDF + 10 t FYM + vermicompost 2.5 t per ha (AGR 3.017 g/plant/day, CGR 0.838 g/m^2/day and RGR 0.0389 g/g/week). The lowest AGR (2.255 g/plant/day), CGR (0.626 g/m^2/day) and RGR (0.0235 g/g/week) were recorded with application of 10 t FYM + vermicompost 2.5 t per ha. The increased in physiological parameters was due to increase in plant height, number of branches per plant and number of leaves leading to higher dry matter accumulation in plants and translocation of photosynthates from source to sink which might be due to sufficient availability of major and micronutrients from FYM and vermicompost used in combination with inorganic fertilizers helped in the uptake of more nutrients. These results are in line with Patel *et al.* (2000) and Rajwade *et al*. (2000) in potato.

Yield parameters:

The data on fresh and dry tuber yield is presented in Table 4. The fresh and dry tuber yield was maximum in crops treated with organics combined with chemical fertilizers than the crop treated with organics alone. Significantly higher fresh (225.47 and 250.52 g/plant and q/ha, respectively) and dry tuber yield (29.53 and 32.81 g/plant and q/ha, respectively) was recorded with the application of 75 per cent RDF + 10 t FYM + vermicompost 5 t per ha followed by application of 75per cent RDF + 10 t FYM + vermicompost 2.5 t per ha (202.13 and 224.58 g/plant and q/ha fresh and dry 26.47 and 29.42 g/plant and q/ha, respectively) and lowest fresh (153.70 and170.78 g/plant and q/ha, respectively) and dry tuber yield (20.13 and 22.37 g/plant and q/ha, respectively) was recorded in crops supplemented with 10 t FYM + vermicompost 2.5 t per ha. This increase in tuber yield might be due to the fact that vermicompost and FYM might have supplied higher amount of major and micronutrients. Application of FYM and vermicompost in combination with chemical fertilizers has resulted in higher uptake of the major nutrients. Due to the presence of humus forming microbes and growth regulators in vermicompost helped in better growth of crops (Bano *et al.*, 1987). These all reasons might have helped in increase in tuber yield. The present investigation confirms the results obtained by earlier workers *viz*., Somanath *et al*. (2005) in coleus, Vadiraj *et al.* (1992) in cardamom.

Conclusion:

From the present investigation it can be concluded that application of 75 per cent RDF + 10 t FYM + vermicompost 5 t per ha or application of 75 per cent RDF + 10 t FYM + vermicompost 2.5 t per ha had proved for the better growth of the plant, higher fresh and dry tuber yield and using the vermicompost and FYM will reduce the 25% of recommended dose of chemical lfertilizers.

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