Effect of Plant Growth Regulators and Time of Application on Growth and Tuber Yield of *Coleus forskohlii* Briq.

T. Susila and G. Satyanarayana Reddy

Medicinal and Aromatic Plants Research Station, Dr YSR Horticultural University, Rajendranagar, Hyderabad – 500030, Andhra Pradesh, India

Abstract

A field experiment was conducted to study the effect of plant growth regulators and time of application on growth and tuber yield of *Coleus forskohlii.* The experiment consists of five levels of growth regulator concentration and four times of application treatments. The experiment was arranged in Randomized Block Design with factorial concept and replicated three times. The results showed that application of cycocel significantly suppressed the vegetative growth. Cycocel 250 ppm and 500 ppm produced significantly highest number of branches per plant. Highest number of tubers per plant, length of tubers and fresh weight of tubers were significantly influenced by application of Cycocel 500 ppm. The highest fresh tuber yield per hectare (70.14 q/ha) were obtained with application of Cycocel 500 ppm and it was on par with Cycocel 250 ppm.

Keywords: *Coleus forskohlii, Growth regulators, Cycocel, Tuber yield*

INTRODUCTION

India is one of the twelve mega diversity hot spot regions of the world and one fifth of all plants found in India are used for medicinal purpose (Schippmann *et al.*, 2002). Nearly 25000 effective plant based formulations are used in folk medicine by rural communities in India (Ramakrishnappa, 2002). In spite of modern development of sophisticated pharmaceutical chemicals to treat different diseases medicinal plants remain an important tool for treating illness. In many developed nations traditional herbal remedies are making a comeback as alternatives to modern medicine. Medicinal plants are important for pharmacological research and drug development, not only when constituents are used directly as therapeutic agents, but also as starting materials for the synthesis of drugs or as models for pharmacologically active compounds (Mukherjee, 2003).

Among the various commercially important medicinal plants *Coleus forskohlii* assumes greater importance in the Indian drug industry. Traditionally the roots have been used in preparation of pickles and also for medicinal purposes (Ammon and Muller, 1985). The tuberous roots are known to be rich source of 'forskolin' – a diterpenoid, which is being used to develop drugs to treat hypertension, glaucoma, asthma, congestive heart failure and certain types of cancers (De Souza, 1986). Because of its therapeutic potentials and uniqueness of this species to contain forskolin, it evoked interest among user industries and entrepreneurs to promote the cultivation of coleus as a commercial medicinal crop and has now attained a status of international importance. In India the crop is cultivated in parts of Gujarath, Maharashtra, Rajasthan, Karnataka, Tamilnadu and Andhrapradesh. However, much studies have not been carried out to increase the productivity through application of growth regulators. Growth promoters and inhibitors control the plant growth, tuberization *etc.* (Bodlaender and Algra, 1966). The changes in the content of gibberellins like substances in relation to tuberization mechanism has been reported by Racca and Tizzio (1968); Kumar and Wareign (1974). The present study was carried out on influence of growth regulators on growth and tuber yield of *Coleus forskohlii.*

MATERIALS AND METHOD

The experiment was conducted at Medicinal and Aromatic Plants Research Station, Rajendranagar, Hyderabad, India, during 2012-13. The experimental site is situated at an altitude of 542.3 m above mean sea level with a geographical bearing of 17^0 19' latitude and 79^0 23' East longitude. Hyderabad falls under subtropical zone with an annual average rainfall of 800 mm. The mean maximum temperature is 30.75°C and minimum temperature is 20.32°C. The soil of experimental site was red sandy loam with pH 7.0, 0.57% organic carbon, 192 kg available nitrogen, 11.8 kg available P and 30.8 kg available K. The experiment consists of five levels of growth regulator concentration GA3 50 ppm (G1), GA_3 100 ppm (G2), Cycocel -250 ppm (G3), Cycocel 500 ppm (G4), Control (water spray) (G5) and four time of application treatments *viz.* root dip at the time of planting (T1), Foliar spray at 30 DAP (T2), Foliar spray at 45 DAP (T3), Foliar spray at 60 DAP (T4). The experiment was arranged in Randomized Block Design with factorial concept and replicated three times. The rooted cuttings were transplanted in the main field on ridges with a spacing of 45 cm x 45 cm between rows and plants. A combination of 40 kg N, 60 kg P_2O_5 and 50 kg K_20 per hectare were applied. Fifty percent of N was applied as basal along with entire dose of P and K. Remaining dose of N was applied one month after planting. All the Growth regulators were applied as foliar spray. Uniform cultural operations were followed for all the treatments. Data were recorded on plant height, plant spread, number of branches, number of tubers per plant, tuber length, and fresh tuber yield per plant on randomly selected five plants.

Statistical Analysis

The data recorded were subjected to appropriate statistical tools by analysis of variance. The significance was tested by F test. The Standard error mean and critical difference at 5 % probability levels were worked out. The data were analyzed using computer software programme AGRISTAT.

RESULTS AND DISCUSSION

Plant height: The data showed that (Table 1) during early stages of plant growth, no significant influence of concentration of growth regulators were observed. At 90 days after planting (DAP) maximum plant height was recorded in gibberellic acid treatments (G1 and G2). The influence of cycocel on suppression of vegetative growth was clearly evident from 90 days after planting. The data shows that cycocel at both the concentrations (G3 and G4) significantly suppressed the vegetative growth over control. This trend was continued at 120 days after planting. The mechanism of reduction in plant height appears to be due to reduction in cell division and cell elongation because of inhibitory action of growth retardants in the biosynthetic pathway of gibberellins (Moore, 1980). Pandita and Hooda (1979) observed reduced plant height in potato due to reduction in the growth of important sinks (all auxillary buds), which in turn might change the distribution pattern of assimilates. Time of application of growth regulator did not have any influence on plant height.

Number of Branches per plant: The data indicated that no significant influences of concentration of growth regulators were observed up to 90 days after planting (Table 1). At 120 days after planting Cycocel 250 ppm (G3) and 500 ppm (G4) produced significantly highest number of branches per plant (34.33 and 34.89). The increase in number of branches could be due to suppression of apical dominance as a result of increase in the auxin activity due to application of growth retardants there by diverting the polar transport of auxin towards the basal buds leads to increased branching. Madalgeri and Ganiger (1993) and Gasti (1994) reported that application of Cycocel 750 ppm and mepiquat chloride 150 ppm increased the number of tillers per plant in potato. Time of application of growth regulators did not influence the production of number of branches up to 90 days after planting. At 120 days after planting significantly highest number of branches were produced when the growth regulators were applied at 60 days after planting (T4).

Plant Spread: During the initial stages of plant growth, influence of growth regulators were not observed (Table 2). Significant difference in plant spread was observed from 60 days after

planting. There was decrease in plant spread in both directions due to application of Cycocel. Minimum plant spread in both the directions was recorded with application of Cycocel 500 ppm (G4). Control recorded maximum plant spread. Time of application of growth regulators did not show any influence on plant spread.

Number of tubers per plant: Number of tubers per plant is an important yield contributing factor and it was significantly increased by application of Cycocel (Table 2). Highest number of tubers per plant were produced with application of Cycocel 500 ppm (G4) (18.60) and it was on par with GA 100 ppm (G2) and Cycocel 250 ppm (G3). Control recorded lowest number of tubers per plant (14.70). Among the different time of application, application of growth regulators at 30 days after planting recorded significantly highest number of tubers per plant (17.71).

Length of longest tuber: Application of cycocel at 500 ppm (G4) resulted in significantly maximum length of tubers (34.08 cm) compared to other treatments (Table 2). Similar increase in tuber length due to application of Cycocel 1000 ppm in coleus was also reported by Sunilkumar (2005). No significant influence of time of application of growth regulators were observed.

Yield per plant: Application of Cycocel 500 ppm (G4) produced significantly highest fresh tuber yield per plant (251g) and on par with Cycocel 250 ppm (G3) (Table 2). Application of Cycocel might have increased the translocation of more carbohydrates to the developing sink and contributed for higher tuber yield (Rajangam *et al.*, 2010). Increase in yield and yield components in potato due to growth retardant treatments was reported by Madalageri, (1996). Time of application did not have any influence on tuber yield/plant.

Yield per hectare: The highest tuber yield per hectare (70.143 q) were obtained with application of Cycocel 500 ppm (G4) and it was on par with application of Cycocel 250 ppm (G3) (Table 2). The increase in tuber yield could be attributed to enhanced photosynthetic activity, improved translocation of photosynthates to the developing roots, higher number of tubers per plant. The growth retardants are capable of redistribution of dry matter in the plant parts thereby bringing about improvement in yield (Reddy and Patil, 1981; Chetti, 1991 and Chandrababu *et al.*, 1995). Crop yield depends not only on the accumulation of photosynthates during the crop growth and development, but also on the partitioning of photosynthates between the desired plant organs. These in turn are influenced by the efficiency of metabolic processes within the plant. No significant influence of time of application of growth regulations were observed on tuber yield.

CONCLUSION

Application of cycocel 500 ppm to coleus significantly increased the number of tubers per plant, length of the tuber and fresh tuber yield. No significant influence of time of application of growth regulators were observed on tuber yield.

REFERENCES

Ammon HPT and Muller AB (1985) Forskolin: from an ayurvedic remedy to a modern agent. Planta Med. 46: 473-477.

Bodlaender KBA and Algras (1966) Influence of the growth retardant B_{995}on growth and yield of potatoes. European Potato Journal. 9: 242-258.

Chetti MB (1991) Evaluation of chamatkar on groundnut. *Pestology*, 15 (8): 43-50.

Chandrababu R, Manian K, Nagarajan M and Ramachandran TK (1995) Effect of Mepiquat chloride on growth and yield of groundnut. Madras Agricultural Journal, 82 (3): 229-230.

De Souza NJ, Dohandwalla AN and Rupp RH (1986) Forskolin: its Chemical, Biological and Medical potential. Hoechst India Limited: 77.

Gasti VD (1994) Response of commercial vegetables to growth retardants. M. Sc. (Agri.) Thesis, University of Agricultural Sciences, Dharwad.

Kumar D and Wareing PF (1974) Studies on tuberization in Potato (*Solanum andigena*) II. Growth hormones and tuberization. New Phytol. 73: 833-840.

Madalageri BB and Ganiger VM (1993) Mepiquat chloride increases potato yield. Journal of Indian Potato Association, 20 (3-4): 45.

Madalageri MB (1996) Investigations on the True Potato Seed (TPS) transplants for potato production in rainfed vertisols. Ph. D. Thesis, University of Agricultural Sciences, Dharwad.

Moore TC (1980) Biochemistry and Physiology of Plant Hormones. Naroja Publishing House, New Delhi, pp. 107-131.

Mukherjee PK (2003) GMP for Indian systems of medicines. In: GMP for Botanicals: Regulatory and Quality Issues on phytomedicines (P.K.Mukherjee and R.Verpoorte.eds.). Business Horizons. New Delhi: 99-112.

Panditha ML and Hooda RS (1979) Effect of cycocel on growth, yield and quality of potato (*Solanum tuberosum* L.) cultivar Kufri Candramukhi. Haryana Journal of Horticultural Sciences, 8(3-4): 139-142.

Racca RW and Tizio R (1968) A preliminary study of changes in the content of gibberellins like substances in the potato plant in relation to tuberization mechanism. European Potato Journal. 11: 213-220.

Rajangam J, Natarajan S, Rajamani K, Subbiah A, Rajadurai KR and Ponnuswami V (2010) Studies on the effect of planting methods.and growth regulators on yield and yield components of Coleus (*Coleus forskohlii Briq.*). South Indian Horticulture 58: 55-58.

Ramakrishnappa K (2002) Impact of cultivation and gathering of medicinal plants on biodiversity: Case studies from India. In: Biodiversity and the Ecosystems Approach in Agriculture, Forestry and Fisharies, FAO, 2002. http://www.fao. org/BOCREP /005/AAO21E eoo.htm.

Reddy SC and Patil SV (1981) Effect of growth retardants on yield and yield attributes of groundnut. Mysore Journal of Agricultural Sciences, 15 : 238-243.

Sunilkumar GS (2005) Influence of organic manures and growth regulators on growth and yield of Coleus (*Coleus forskohlii* Briq.) M.Sc thesis submitted to University of Agricultural Sciences, Dharwad.

Schippmann U, Leaman DJ and Cunningham AB (2002) Impact of cultivation and gathering of medicinal plants on biodiversity: Global trends and Issues. In: biodiversity and Ecosystem Approach in Agriculture, Forestry and Fisharies. 1-121.

Tables

Table 1: Effect of Gibberellic acid and Cycocel on plant height and number of branches of *Coleus forskohlii*

Treatment	Plant Height (cm)				No. of Branches/plant			
	30 DAP	60 DAP	90 DAP	120 DAP	30 DAP	60 DAP	90 DAP	120 DAP
Concentration of Growth regulator (C)								
G1 –GA_3 -50 ppm	27.875	38.108	46.678	48.85	11.7	24.133	26.867	29.900
G2- GA_3 -100 ppm	23.417	40.050	46.158	50.650	12.033	25.200	27.767	31.739
G3 – CCC- 250 ppm	22.025	36.550	40.708	43.567	10.917	26.067	26.000	34.333
G4 – CCC – 500 ppm	22.492	36.300	40.550	43.233	12.133	24.700	26.467	34.889
G5- Water spray (Control)	21.167	36.717	42.733	47.717	10.80	23.417	26.933	30.683
SEm ±	0.70	1.34	1.12	1.33	0.064	0.72	0.74	0.89
CD at(0.05)	NS	NS	3.101	3.679	NS	NS	NS	2.468
Time of application (T)								
T1 – Root dip at planting	22.78	37.25	43.21	46.29	11.97	25.09	27.47	32.32
T2 – Spraying at 30 DAP	22.87	38.24	43.85	46.44	11.75	24.09	26.11	30.04
T3 – Spraying at 45 DAP	21.31	36.83	42.29	46.55	10.97	24.20	25.77	32.76
T4 – Spraying at 60 DAP	21.83	37.87	44.11	47.93	11.37	25.43	27.88	34.11
SEm ±	0.63	1.20	1.00	1.19	0.57	0.65	0.66	0.8
CD at(0.05)	NS	NS	NS	NS	NS	NS	NS	2.208
Interaction (C x T)								
SEm ±	1.40	2.67	2.24	2.65	1.28	1.44	1.49	1.78
CD at(0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Table 2: Effect of Gibberellic acid and Cycocel on plant spread, tuber characteristics and yield of *Coleus forskohlii*

Treatment	Plant Spread/plant (cm)								No.of tubers per plant	Length of the longest tuber	Yield per plant (g)	Fresh tuber Yield q/ha
	30 DAP		60 DAP		90 DAP		120 DAP					
	EW	NS	EW	NS	EW	NS	EW	NS				
Concentration of Growth regulator (C)												
G1 –GA_3 -50 ppm	25.967	26.808	49.200	48.717	55.10	56.250	58.767	58.767	16.217	30.29	194.268	55.031
G2- GA_3 -100 ppm	26.000	26.333	47.367	47.533	54.933	55.450	59.950	59.950	17.600	29.36	189.820	56.579
G3 – CCC- 250 ppm	27.400	25.983	48.650	49.433	52.333	53.517	55.367	55.367	16.650	28.67	227.448	61.436
G4 – CCC – 500 ppm	28.442	28.150	49.767	47.300	53.783	54.450	54.100	54.100	18.600	34.08	251.000	70.143
G5- Water spray (Control)	27.567	27.750	53.700	53.300	59.617	59.400	61.433	61.433	14.700	28.92	194.187	59.410
SEm ±	1.08	1.10	1.32	1.13	1.20	1.29	1.84	1.42	00.74	0.81	14.6	3.46
CD at(0.05)	NS	NS	3.659	3.146	3.334	3.582	5.105	3.934	02.060	2.25	40.419	9.039
Time of application (T)												
T1 – Root dip at planting	26.22	25.51	50.88	48.75	55.47	55.04	60.04	57.93	16.71	30.11	207.2	57.82
T2 – Spraying at 30 DAP	27.25	28.14	47.77	48.32	55.05	55.29	57.40	57.71	17.71	30.92	221.0	64.71
T3 – Spraying at 45 DAP	27.07	26.61	49.09	48.32	54.79	56.67	56.60	56.03	16.25	30.77	211.0	58.61
T4 – Spraying at 60 DAP	27.77	27.75	51.20	50.84	55.31	56.25	57.65	57.22	16.88	29.28	206.3	58.95
SEm ±	0.96	0.99	1.13	1.02	1.08	1.16	1.65	1.27	0.66	0.73	13.0	3.09
CD at(0.05)	NS	NS	NS	NS	NS	NS	NS	NS	0.94	NS	NS	NS
Interaction (C x T)												
SEm ±	2.15	2.21	2.64	2.27	2.41	2.58	2.58	2.84	1.49	1.63	29.2	6.52
CD at(0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS