Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2582-2845.8002

ISSN: 2582 – 2845

Ind. J. Pure App. Biosci. (2020) *8*(1), 344-350

Research Article

Indian Journal of Pure & Applied Biosciences

Peer-Reviewed, Refereed, Open Access Journal

Influence of Planting Techniques, Type of Cuttings, PGRs and Seasons on Quality in Medicinal Coleus (*Plectranthus forskohlii* Willd.)

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Received: 27.12.2019 | Revised: 30.01.2020 | Accepted: 7.02.2020

ABSTRACT

An experiment was conducted to study the influence of planting techniques, type of cuttings, PGRs and seasons on growth, tuber yield and quality in medicinal coleus (Plectranthus forskohlii Willd.) under northern dry zone of Karnataka. The experiment was conducted in split-split plot design with main plot: four treatments, sub plot 1: nine treatments and sub plot 2: two treatments. The interaction effect of planting techniques with the type of cuttings, PGRs and seasons (AXBXS) recorded that, $A_2B_6S_1$ - Un rooted cuttings in ridge and furrow with the spray of CCC 750 ppm in the Kharif has obtained maximum forskolin yield (44.33 kg/ha). Hence to obtain maximum forskolin in medicinal coleus, planting of un rooted cuttings in ridge and furrow method of planting along with CCC-750 ppm (Sprayed at 60 & 90 DAT) in Kharif can be suggested to farmers to cultivate medicinal coleus crop under Northern dry zone of Karnataka.

Keywords: *Medicinal coleus, Forskolin yield, Seasons*

INTRODUCTION

The plant *Plectranthus forskohlii* Willd. (Medicinal coleus, 2n=30) belongs to the family *Lamiaceae*, is a perennial aromatic herb with annual stems and perennial roots (Shah, 1996). Though, there are about 300 species of *coleus* but, only the species *Plectranthus forskohlii* contains the diterpene, forskohlin (Mariya et al., 2013). Because of its therapeutic uses the demand for its dry tuberous roots increased in recent times. This compelled some farmers to go for the cultivation of this crop. User industries are also promoting organized cultivation of coleus.

Cite this article: Sakhubai, H.T., Kattimani, K.N., Veerendra, P.S., Vishwanath, Y.C., Shankar, M., & Mallikarjun, G.A. (2020). Influence of Planting Techniques, Type of Cuttings, PGRs and Seasons on Quality in Medicinal Coleus (*Plectranthus forskohlii* Willd.), *Ind. J. Pure App. Biosci. 8*(1), 344-350. doi: http://dx.doi.org/10.18782/2582-2845.8002

The tuberous roots of medicinal coleus contains '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). It's used as an ancient root drug recorded in ayurvedic De materia medica under the Sanskrit name 'Makandi' or 'Mayini' (Shah, 1996).

There are several ethno medicinal uses of tubers and leaves of coleus for human as well as veterinary ailments throughout the world. In India, the roots are traditionally used in the preparation of pickles in households and by industries in the states of Gujarat, Maharashtra, Karnataka and Tamil Nadu.

The growth of a plant is the net result of diverse metabolic activities taking place in different parts of the plant during its growth and development in accordance with supply of growth factors *viz.*, water, light, temperature and nutrient from the environment. The basic biological principle that the quantity and quality of growth of a plant are controlled by its genetic potential and environment acting through its physiological, biochemical processes and conditions. The synthesis, accumulation and translocation of the metabolites to the economic parts of the plant are mainly influenced by the genetic makeup of variety, planting methods, type of cutting, use of growth regulators, environmental conditions and others.

The medicinal coleus can be propagated both from seeds and stem cuttings. Raising seedlings from seeds is a difficult process, as the viability of seeds is poor (8-10%). This method should be adopted only for breeding new varieties. For mass propagation of the plant, stem cuttings are found to be ideal. It was necessary to understand whether to plant the rooted cuttings or direct planting of the cuttings (Farooqi & Sreeramu, 2004).

According to the earlier studies, planting method is a soil management tool which affects plant growth and yield. Method of planting is an important factor for higher production and gives equal opportunity to the plants for their survival and best use of other inputs. Understanding the proper planting method is very important to increase yield and to decrease interference with weeds. A certain methods of planting like flat bed method or ridge and furrow method for a specific root crop may provide an optimum space to maximize vegetative parts, which subsequently receives higher solar energy and results in maximum yield. Plant spacing is an important factor for tuber production as it influences interplant competition (Shahidul et al., 2002).

In addition, plant growth regulation is one of the important factor which controls growth and development of various characters and use of a suitable plant growth regulator will help in obtaining higher yields. Among the various plant growth regulators that influence higher production, type of plant growth regulator and its concentration are the most important (Nichols et al., 2003).

Further, it is also known that climatic conditions can change the vegetal secondary metabolism and consequently, alter the composition of essential oils throughout the seasons of the year. The variation in chemical composition of the essential oils is known to vary with the seasonal variation (Senthilkumar & Venkatesalu, 2010). Hence it was very necessary to find out the suitable season for the higher yields.

Keeping this in view, an investigation was initiated to study the influence of planting techniques, type of cuttings, PGRs and seasons on growth, tuber yield and quality in medicinal coleus (*Plectranthus forskohlii* Willd.) with the objective to identify the suitable season for cultivation of coleus under northern dry zone of Karnataka.

MATERIALS AND METHODS

The present investigation was carried out during *Kharif* and *Rabi* seasons of 2018-19 at Haveli farm, which comes under College of Horticultural Sciences, Bagalkot, University of Horticultural Sciences, Bagalkot, Karnataka. The experiment was laid out in split - split plot

design with planting techniques with the type of cuttings as main plot and Growth Regulators as sub plot 1 and seasons as sub plot 2.

Treatments comprised of four main plots and subplot 1: Nine, subplot 2: Two Main plot comprised of planting techniques with the type of cuttings (A) and subplots included growth regulators (B). Further, to identify the best season among *Kharif* and *Rabi*, Season was taken as one more factor as sub plot 2 and analysed under Split-Split plot design.

The treatment details are as follows-

Main plot: Planting techniques with the type of cuttings (A)

1. A_1- Rooted cuttings in ridge and furrow, **2.** A_2 - Un rooted cuttings in ridge and furrow, **3**. A_3 - Rooted cuttings in flat bed , **4**. A_4 – Un rooted cuttings in flat bed

Sub plot 1: Growth Regulators (B) (Sprayed at 60 and 90 DAT)

1. B_1- Gibberlic Acid (GA_3) -100 ppm**,** **2.** B_2- Gibberlic Acid ($GA_{3)}$ - 150 ppm**, 3.** B_3- Napthalene Acetic Acid (NAA) - 20 ppm**, 4.** B_4- Napthalene Acetic Acid (NAA) - 30 ppm**, 5.** B_5- Cycocel (CCC) - 500 ppm**, 6.** B_6- Cycocel (CCC) -750 ppm, **7.** B_7- Mepiquat Chloride (MC) - 500 ppm**, 8.** B_8- Mepiquat Chloride (MC) -750 ppm**, 9.** B_9- Control – Water spray

Sub plot 2: Seasons (*Kharif* and *Rabi*)

The experiment was conducted in the two seasons of *Kharif* and *Rabi* and observation recorded during the experiment was the forskohlin yield. The data on quality component was subjected to Fisher's method of analysis of variance (ANOVA) as outlined by Sundararaj et al. (1972).

RESULT AND DISCUSSION

Influence of seasons (*Kharif* and *Rabi*) on quality of medicinal coleus

Influence of planting techniques with the type of cuttings, PGRs and seasons on forskolin yield (kg/ha) in medicinal coleus

Influence of planting techniques with the type of cuttings, PGRs, seasons and their interactions on forskolin yield (kg/ha) in medicinal coleus is depicted in Table 1and Fig. 1a, 1b and 1c.

Plant diversity has a considerable importance as a source of pharmaceutically active substances. Environmental conditions affect not only plant growth but also influences secondary metabolites. The medicinal plants show a marked variation in active ingredients during different seasons; as these have been widely attributed to variations in environmental variables such as temperature and rainfall.

The novel feature of medicinal coleus is the forskolin which has got many advantages and it is used in the ethno medicinal uses, used to develop drugs to treat hypertension, glaucoma, asthma, congestive heart failure and certain types of cancers. The levels of secondary metabolites produced in plants can be environmentally as well as genetically controlled (Singh et al., 2003). These biochemical variations among plant families and genera can be attributed in part to phylogenetic and ecological influences. The development of these different combinations of secondary metabolites in plants has allowed adaptation to and in the environment (Wink, 2003). Weather in agriculture, it is essential to analyze and characterize the weather resources like rainfall, temperature, solar radiation *etc*., for identifying the appropriate crops and cropping systems for different agro-eco regions not only to take advantage of potential weather resources but also to avoid the risks of abnormal weather conditions. Such a scientific approach based on appropriate understanding of weather resources and application of this knowledge for efficient crop management can help in achieving higher production and productivity of crops and cropping systems adopted in various agro-eco regions of the country.

Table 1: Influence of planting techniques with the type of cuttings, PGRs, seasons and their interactions on forskolin yield (kg/ha) in medicinal coleus

Treatments	A_1		Mean of A_1xB	A_2		Mean of A_2xB	A_3		Mean of A_3xB	A_4		Mean of A_4xB	Mean of B	Mean of BxS	
	S_1	S_2		S_1	S_2		S_1	S_2		S_1	S_2			S_1	S_2
B_1	19.79	21.29	**20.54**	31.06	28.80	**29.93**	14.38	10.14	**12.26**	11.00	14.53	**12.77**	**18.87**	**19.06**	**18.69**
B_2	22.10	19.53	**20.82**	18.81	38.00	**28.41**	15.22	13.42	**14.32**	12.45	15.85	**14.15**	**19.42**	**17.15**	**21.70**
B_3	20.79	19.85	**20.32**	22.39	23.61	**23.00**	13.72	15.43	**14.58**	11.72	7.50	**9.61**	**16.88**	**17.16**	**16.60**
B_4	22.12	21.25	**21.69**	20.82	29.22	**25.02**	13.15	13.42	**13.29**	12.12	7.02	**9.57**	**17.39**	**17.05**	**17.73**
B_5	24.97	15.79	**20.38**	24.38	16.31	**20.35**	19.65	11.85	**15.75**	17.51	7.72	**12.62**	**17.27**	**21.63**	**12.92**
B_6	33.38	21.71	**27.55**	44.33	21.40	**32.87**	21.64	12.38	**17.01**	23.34	4.83	**14.09**	**22.88**	**30.67**	**15.08**
B_7	26.36	16.58	**21.47**	31.59	11.66	**21.63**	18.82	11.96	**15.39**	16.58	7.67	**12.13**	**17.65**	**22.33**	**11.97**
B_8	28.95	17.02	**22.99**	38.62	17.04	**27.83**	20.79	13.47	**17.13**	19.59	5.34	**12.47**	**20.10**	**26.99**	**13.22**
B_9	16.20	14.74	**15.47**	14.49	16.90	**15.70**	8.54	10.51	**9.53**	5.93	11.22	**8.58**	**12.32**	**11.29**	**13.34**
Mean of AxS	**23.85**	**18.49**		**27.39**	**22.55**		**16.21**	**12.51**		**14.47**	**9.07**				
Mean of A/S			**21.25**			**24.97**			**14.36**			**11.77**		**20.37**	**15.69**
	A		**B**		**S**		**AxB**		**AxS**		**BxS**		**AxBxS**		
SEm±	1.85		1.34		0.63		2.69		1.90		1.27		1.89		
C.D	4.52		2.66		NS		5.33		NS		3.77		5.53		

Legend:

Main plot: Planting techniques with the type of cuttings (A)

1 A_1 - Rooted cuttings in ridge and furrow
2 A_2 - Un rooted cuttings in ridge and furrow
3 A_3- Rooted cuttings in flat bed
4 A_4 - Un rooted cuttings in flat bed

Sub plot 1: Growth Regulators (B) – Sprayed at 60 & 90 DAT

1 B_1 - Gibberlic Acid (GA_3)- 100 ppm
2 B_2 - Gibberlic Acid (GA_3) - 150 ppm
3 B_3- Napthalene Acetic Acid (NAA) - 20 ppm
4 B_4 - Napthalene Acetic Acid (NAA) - 30 ppm
5 B_5 - Cycocel (CCC) -500 ppm
6 B_6- Cycocel (CCC) -750 ppm
7 B_7- Mepiquat Chloride (MC) - 500 ppm
8 B_8- Mepiquat Chloride (MC) -750 ppm
9 B_9- Control – Water spray

Sub plot 2: Season

S_1:*Kharif*

S_2: *Rabi*

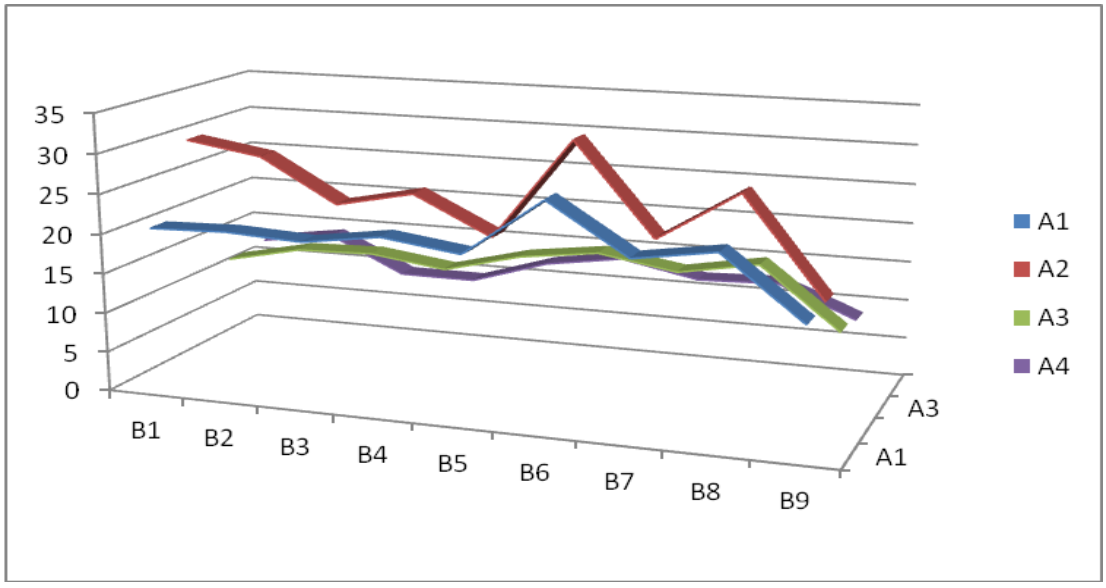

Fig. 1a. Interaction effect of planting techniques with the type of cuttings and PGRs on forskolin yield (kg/ha) (pooled)

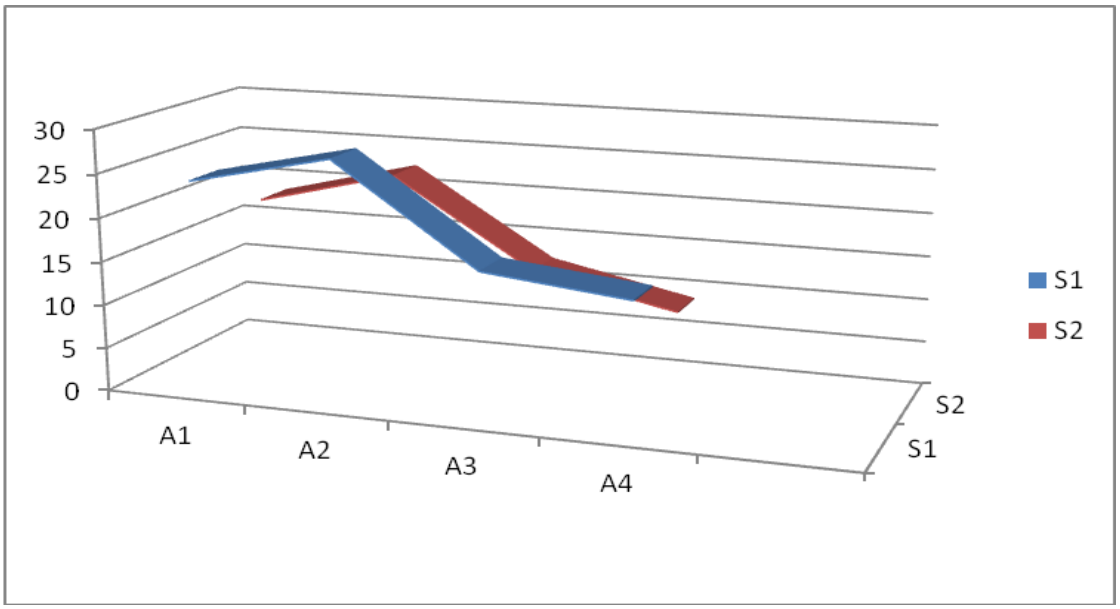

Fig. 1b. Interaction effect of planting techniques with the type of cuttings and seasons on forskolin yield (kg/ha) during *Kharif* and *Rabi* seasons, 2018-19

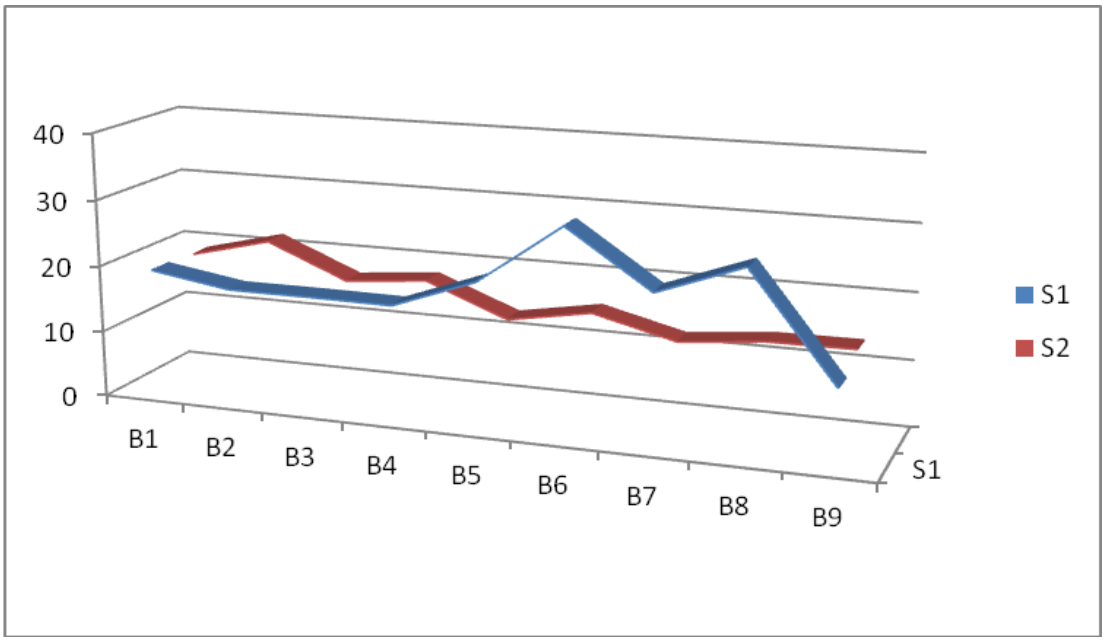

Fig. 1c. Interaction effect of growth regulators and seasons on forskolin yield (kg/ha) during *Kharif* and *Rabi* seasons, 2018-19

Here, the effect of planting techniques with the type of cuttings (A) on forskolin yield (kg/ha) in medicinal coleus (pooled) was significantly maximum in A_2– Un rooted cuttings in ridge and furrow (24.97 kg/ha) which was on par with A_1- Rooted cuttings in ridge and furrow (21.25 kg/ha) and A_3 – Rooted cuttings in flat bed (14.36 kg/ha) and the effect of PGRs on forskolin yield was significantly maximum with the spray of B_6– CCC 750 ppm (22.88 kg/ha).

Further, the interaction effect of (AXB), *ie*., Planting techniques with the type of cuttings (A) and Growth Regulators (B) on forskolin yield was obtained maximum in A_2B_6 - Un rooted cuttings in ridge and furrow + CCC 750 ppm (32.87 kg/ha) which was on par with A_2B_2 - Un rooted cuttings in ridge and

furrow + GA_3 150 ppm (28.41 kg/ha) and A_2B_8- Un rooted cuttings in ridge and furrow + MC 750 ppm (27.83 t/ha). In the pooled data of *Kharif* and *Rabi*, maximum forskolin yield was obtained with the spray of CCC 750 ppm and MC 750 ppm and also with the spray of growth regulator GA_3 150 ppm. It might be due to increase in the chlorophyll content and nitrate reductase activity due to growth retardants which also might have contributed for increase in yield and yield components and hence there was increase in total forskolin yield. The CCC and MC has the ability to block the biosynthesis of gibberellins thereby improved the forskolin content. A direct effect of plant growth regulators on monoterpene metabolism through increased activity of enzyme that synthesize terpenes leading to accumulation of secondary metabolites was observed in several species belonging to family Lamiaceae. The results were found in similarity with the findings of Khandelwal et al., 2003 in marigold, Garai and Datta., 2003 in green gram, Gautam et al., 2014 in garlic. Hence the study clearly explains that the application of growth retardants influence the growth and yield irrespective of type of crops. However forskolin yield was also obtained maximum in A_2B_2- Un rooted cuttings in ridge and furrow + GA_3 150 ppm as the Gibberellic acid is a natural plant hormone which is synthesized in plants and it is well known that the application of GA_3 improves quality in many other horticultural crops. In the Fig. 1a**,** the similar results has been depicted where there is more effect of growth regulators on A_2, which has obtained higher yields with the spray of B_6, B_8 and B_2. Hence, A_2B_6 - Un rooted cuttings in ridge and furrow + CCC 750 ppm , A_2B_8- Un rooted cuttings in ridge and furrow + MC 750 ppm and A_2B_2 - Un rooted cuttings in ridge and furrow + GA_3 150 ppm were found better among all other treatments to obtain high forskolin yield.

Further, the interaction effect of planting techniques with the type of cuttings and seasons (AXS) on forskolin yield was noticed to be non significant. It is confirmed that there is no seasonal effect on planting techniques with the type of cuttings.

In addition, the interaction effect of BXS *ie*., Growth Regulators (B) and Seasons on forskolin yield was observed maximum in B_6S_1 – Spray of CCC 750 ppm in *Kharif* (30.67 kg/ha). In the Fig 1b, there was no effect of seasons on the growth regulators from B_1-B_4, where as growth retardants had maximum effect of the *Kharif* season compared to *Rabi*. Maximum forskolin yield was obtained in *Kharif* season with the spray of CCC 750 ppm.

Further, the interaction effect of planting techniques with the type of cuttings, PGRs and seasons (AXBXS) on forskolin yield was noticed to be maximum in $A_2B_6S_1$ - Un rooted cuttings in ridge and furrow with the spray of CCC 750 ppm in the *Kharif* (44.33 kg/ha). Hence to obtain maximum forskolin yield, the medicinal coleus should be planted with un rooted cuttings in the raised bed in the *Kharif*. The results are in line with the findings of Yang 1995 in eucalyptus, John *et al*, 2000 in pine, Haque *et al*., 2002 in chick pea, Ramesh and Devasenapathy in pigeon pea, Singh *et al*., 2008 in chick pea, Khandelwal *et al*., 2003 in marigold, Garai and Datta., 2003 in green gram and Gautam *et al*., 2014 in garlic.

CONCLUSION

Comparing *Kharif* and *Rabi*

The interaction effect of planting techniques with the type of cuttings, PGRs and seasons (AXBXS) recorded that, $A_2B_6S_1$ - Un rooted cuttings in ridge and furrow with the spray of CCC 750 ppm in the *Kharif* has obtained maximum forskolin yield.

To obtain maximum forskolin yield in medicinal coleus, planting of un rooted cuttings in ridge and furrow method of planting along with CCC-750 ppm (Sprayed at 60 & 90 DAT) in *Kharif* can be suggested to farmers to cultivate medicinal coleus crop under Northern dry zone of Karnataka.

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