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Studies on the Effect of Plant Density, Type of Cutting and Method of Planting on Root Yield of Medicinal Coleus [*Coleus forskohlii* (willd) Briq.]

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ABSTRACT

The results revealed that closer spacing (60cm x 20cm) recorded maximum root yield, rooted cutting plants yielded higher, ridge and furrow method recorded higher yields and K-8 variety yielded more. Higher yields in closer spacing could be due to more population resulted in higher cumulative yields. Higher yields with rooted cuttings could be due to more age and established root system. With Ridge and furrow method, yields are higher could be due to more tuberous roots. K-8 variety yielded higher might be due to genetical control of dry matter partitioning and more leaf area.

Key words: *Plant density, Medicinal coleus, Yield.*

Coleus forskohill (Willd) Briq. (Synonym *C.barbatus* (Andr.) Benth) belongs to the family Labiatae (Lamiaceae) is an ancient and important root drug claimed to improve appetite, increase vitality and useful by curing the ailments like inflammation, flatulence, dropsy etc. It occurs in sub-tropical Himalayan regions from kumaon to Nepal, Bihar and Deccan plateau of southern India. It is cultivated in the parts of Rajasthan, Maharashtra, Gujarat, Karnataka, Tamil Nadu and Andhra Pradesh. Forskolin, an active diterpenoid in roots, possess multifaceted biological activities such as positive inotropic, anti-hypertensive, anti-glaucoma (Rupp et. al., 1986). The novel feature of forskolin in its roots having unique mechanism of generating cyclic adenosine monophosphate in the cells through direct activation of the catalytic unit of adenylate cyclaze enzyme (Metzer and Lindner, 1981; Seaman and Daly, 1981a).

For commercial cultivation of this crop optimization of plant population per unit area, method of planting and type of cutting are the prime factors in terms of root yield of medicinal coleus. The major problem confronting the commercial growers of coleus is optimum plant density, appropriate type of cutting, method of planting and suitable cultivar. Most of the morphological characters governed by these factors are crucial, as they ultimately accounts for bulking of tubers through affecting photosynthetic surface area and quantum of photosynthates production and their translocation. Keeping these in view, the present investigation was undertaken.

MATERIAL AND METHODS

The field experiment was laid out in a Factorial Randomized Block Design (FRBD) with two replications at Herbal Gardens, Acharya NG Ranga Agricultural University, Hyderabad on red sandy loam soil. The studies were carried out in two cultivars of medicinal coleus with 24 treatments as below

The varieties used for this present experiment were of Chintapalli local and K-8 variety, is a selection from Karnataka, which is under commercial cultivation in Andhra Pradesh. The terminal cuttings of 10-15 cm long with 3-4 pairs of leaves were planted after attaining 7-8 pairs of leaves were transplanted to main field. Ridge and furrow method and flat bed method are used to study the effect of method of planting in the main field. Three different spacings between plant to plant *viz.,* 20 cm, 30 cm and 45 cm taken for study. Root yield was recorded at harvest by weighing the dried tubers (Excluding non tuberous) and computed per acre and expressed in tonnes.

RESULTS AND DISCUSSION

Effect of plant density and type of cutting on root dry yield of medicinal Coleus revealed that, plant density differed significantly with respect to root yield per acre (on dry weight basis) at harvest.

In 60 x 20 cm spacing recorded maximum dry root yield per acre (2.26 t) and significantly differed with 60 x 30 cm (1.75) and 60 x 45 cm (1.68 t). Type of cutting also varied for dry root yield. The rooted cuttings recorded maximum yield (2.06 t acre) and significantly differed with unrooted cuttings (1.73) (Table 2). Interaction between plant density and type of cutting was significant. Observations revealed that, rooted cuttings planed with a spacing of 60 x 20 cm recorded highest root yield (2.29) followed by unrooted cuttings planted with 60 x 20 cm spacing (2.23) which were at par.

Similarly, method of planting also differed significantly on dry root yield per acre. Observations disclosed that, ridge and furrow method of planting recorded highest root yield per acre (2.04) over flatbed method (1.76). Data on interaction between plant density and method of planting was significant. Cuttings planted in 60 x 20 cm spacing on ridge and furrow method of planting observed highest root yield per acre (2.55) followed compared to planting in flat method of planting and 60 x 20 spacing (1.98) (Table 3).

Results on effect of coleus lines on dry root yield per acre were statistically significant. K-8 variety recorded highest dry root yield (2.17) followed by chintapalli local (1.62). There was significant influence on root yield per acre due to interaction effects between plant density and coleus lines. K-8 variety planted with a spacing of 60 x 20 cm recorded maximum root yield (2.43) followed by K-8 variety planted with a spacing of 60 x 45 cm (2.14) (Table 4).

The interaction effects among plant density, type of cutting, method of planting and coleus lines were significant. Rooted cuttings of K-8 variety planted in ridge and furrow method of planting with 60 x 20 cm spacing recorded highest dry root yield per acre at harvest (3.09) followed by unrooted cuttings of Chintapalli local planted in flat bed method of planting with a spacing of 60 x 20 cm (2.93) (Table 5).

The ultimate aim in cultivation of medicinal coleus is to increase root yield. Root yield was significantly influenced due to plant density, type of cutting, method of planting and coleus lines. Dry root yield differed significantly due to plant density. Closer spacing recorded maximum dry root yield per acre (2.26) compared to 60 x 30 cm (1.75) an 60 x 45 cm (1.68) and the per plant dry root yield was maximum in wider spacing, but the cumulative yield for unit area was highest in closer spacing, due to accommodation of more number of plants per unit area. Veeraraghavathatham *et al.,* (1985) reported in *Coleus forskholi* that wider spacing increased per plant root yield, which was unable to compensate the loss due to less population compared to closer spacing. The present results are in conformity with the findings of PM Safeer *et al.,* (2013) Ramachandra *et. al.,* (2003) reported similar findings in Safed musli and Srivatsava and Pahapalkar in *Acorus calamus* were in line with the present experimental findings. Similar results were also reported by Dash *et al.,* (1995) in Vettiver that closer spacing resulted in more vegetative growth that contributes more photosynthetic area inturn higher root yield. Vadivel *et al.,* (1980) also reported that plant growth that contributes to root yield was more due to higher plant densities. The present results are in conformity with that of Sajjapongse and Roan (1981) in sweet potato. The present results are in confirmity with Suresh (2009) that closer spacing (60 X 20 cm) recorded the maximum tuber yield in coleus was due to more number of plants per unit area which increased the total yield significantly higher than other treatments (Sundharaiya *et al*., 1998). The present results shows per plant yields are higher in wider spacing due to maximum utilization of space, water and light are in conformity with Joy *et al.,* (2002) in *Alpinia galangal*. These results are also supported with the results of Patil et al. (1992), Hamid and Sasaki (2001) in Sweet Potato.

Results on the effect of type of cutting on dry root yield were significant. Rooted cuttings observed maximum dry root yield (2.06) compared to unrooted cuttings (1.73). It may be due to more age and established root system in the rooted cuttings. Since, rooted cuttings possess initially more dry matter than unrooted cuttings, resulted in continuous dominance in dry matter accumulation over unrooted cuttings. Dry matter partitioning was more and early in rooted cuttings than unrooted towards in bulking of roots. Quantum of photosynthates was also highest in rooted cuttings over unrooted cuttings as they possess maximum plant spared and leaf area (photosynthetic area).

Table 1.

Treatment	Description			
	Coleus line	Spacing	Type of cutting	Method of planting
T1	Local	60 x 20 cm	Rooted	Ridge and Furrow
T2	Local	60 x 20 cm	Rooted	Flat bed
T3	K-8	60 x 20 cm	Rooted	Ridge and Furrow
T4	K-8	60 x 20 cm	Rooted	Flat bed
T5	Local	60 x 20 cm	Un-rooted	Ridge and Furrow
T6	Local	60 x 20 cm	Un-rooted	Flat bed
T7	K-8	60 x 20 cm	Un-rooted	Ridge and Furrow
T8	K-8	60 x 20 cm	Un-rooted	Flat bed
T9	Local	60 x 30cm	Rooted	Ridge and Furrow
T10	Local	60 x 30cm	Rooted	Flat bed
T11	K-8	60 x 30cm	Rooted	Ridge and Furrow
T12	K-8	60 x 30cm	Rooted	Flat bed
T13	Local	60 x 30cm	Un-rooted	Ridge and Furrow
T14	Local	60 x 30cm	Un-rooted	Flat bed
T15	K-8	60 x 30cm	Un-rooted	Ridge and Furrow
T16	K-8	60 x 30cm	Un-rooted	Flat bed
T17	Local	60 x 45 cm	Rooted	Ridge and Furrow
T18	Local	60 x 45 cm	Rooted	Flat bed
T19	K-8	60 x 45 cm	Rooted	Ridge and Furrow
T20	K-8	60 x 45 cm	Rooted	Flat bed
T21	Local	60 x 45 cm	Un-rooted	Ridge and Furrow
T22	Local	60 x 45 cm	Un-rooted	Flat bed
T23	K-8	60 x 45 cm	Un-rooted	Ridge and Furrow
T24	K-8	60 x 45 cm	Un-rooted	Flat bed

Table 2. Effect of plant density, type of cutting on dry root yield (tonnes per acre).

Plant Density (Spacing)	Type of cutting		Mean
	Rooted	Un rooted	
60*20cm	2.29	2.23	2.26
60*30cm	2.17	1.33	1.75
60*45cm	1.72	1.63	1.68
Mean	2.06	1.73	
	Interaction		
	Plant Density	Type of cutting	Plant Density* Type of cutting
SEm	0.025	0.020	0.03
CD (@at5%)	0.052	0.042	0.07

Table 3. Effect of plant density and method of planting on dry root yield (tonnes per acre).

Plant Density (Spacing)	Method of planting		Mean
	Ridge & furrow	Flatbed	
60*20cm	2.55	1.98	2.26
60*30cm	1.88	1.61	1.75
60*45cm	1.68	1.68	1.68
Mean	2.04	1.769	
Interaction			
	Plant Density	Method of planting	Plant Density* Method of planting
SEm	0.025	0.020	0.03
CD (@at5%)	0.052	0.042	0.07

Table 4. Effect of plant density and coleus lines on dry root yield (tonnes per acre).

Plant Density (Spacing)	Coleus Lines		Mean
	Chinthapalli local	K-8 Variety	
60*20cm	2.09	2.43	2.26
60*30cm	1.56	1.94	1.75
60*45cm	1.22	2.14	1.68
Mean	1.62	2.17	
Interaction			
	Plant Density	Coleus lines	Plant Density* Coleus lines
SEm	0.025	0.020	0.03
CD (@at5%)	0.052	0.042	0.07

Method of planting also had significant effect on dry root yield. Ridge & furrow method observed maximum dry root yield (2.04) over flat bed method. This could be due to the root polymorphism in coleus species consisting of fibrous, non tuberous and tuberous roots as explained. In ridge & furrow method, more number of tuberous roots were observed compared to flat bed. In flat bed, number of fibrous and non tuberous was more to that of tuberous roots compared to ridge & furrow method. This might be the reason for more root fresh weight per plant in flat bed but lesser dry root yield per acre compared to ridge & furrow method. In flat beds non tuberous and fibrous roots accounted for root fresh weight but their contribution is not reflected in final dry root yield. The present results are in conformity with that of Sajjapongse and Roan (1981) in Sweet Potato.

Coleus liens were also significantly differed on dry root yield. K-8 variety recorded maximum (2.17) dry root yield over chintapalli local (1.62). It might be due to genetical control of dry matter partitioning. Leaf area also might have

Table 5. Interaction effect of plant density, type of cutting and method of planting and coleus lines on dry root yield (tonnes per acre).

Treatment	Description (Coleus Lines-Spacing-Type of cutting-Method of Planting)	Mean
T1	Local – 60 x 20 cm – rooted – ridge and furrow	2.30
T2	Local – 60 x 20 cm – rooted – flat bed	1.09
T3	K-8 – 60 x 20 cm – rooted – ridge & furrow	3.09
T4	Local – 60 x 20 cm – rooted – flat bed	2.45
T5	Local–60x20cm – unrooted – ridge & furrow	2.05
T6	Local – 60 x 20cm - – unrooted – flat bed	2.93
T7	K-8 – 60 x 20cm - unrooted – ridge & furrow	2.74
T8	K8 – 60 x 20cm – unrooted – flat bed	1.44
T9	Local – 60 x 30cm – rooted- ridge & furrow	1.95
T10	Local – 60 x 30 cm – rooted – flat bed	0.68
T11	K-8 - 60 x 30cm – rooted - ridge & furrow	1.74
T12	K8 – 60 x 30cm – rooted – flat bed	0.94
T13	Local – 60 x 30cm –unrooted ridge & furrow	1.11
T14	Local – 60 x 30 cm – unrooted – flat bed	2.49
T15	K-8 - 60 x 30cm – unrooted ridge & furrow	2.75
T16	K8 – 60 x 30cm – unrooted – flat bed	2.33
T17	Local – 60 x 45cm – rooted ridge & furrow	1.32
T18	Local – 60 x 45 cm – rooted – flat bed	0.64
T19	K-8 - 60 x 45cm – rooted ridge & furrow	2.35
T20	K8 – 60 x 45cm – rooted – flat bed	2.22
T21	Local – 60 x 45cm – unrooted ridge & furrow	1.74
T22	Local – 60 x 45cm – unrooted - flat bed	1.16
T23	K-8– 60 x 45 cm – unrooted – ridge & furrow	1.3
T24	K-8 – 60 x 45 cm – unrooted – flat bed	2.7
SEm : 0.071		
CD (at 5%) : 0.147		

played a key role in bulking of tubers. K-8 as an improved variety synthesizes and translocates more food material ultimately leads to maximum bulking of roots resulting into more dry root yield.

From the present study it may be concluded that, Coleus gave the best growth and yield when improved K-8 variety rooted cuttings transplanted at closure spacing of 60 cm x 20 cm on ridge and furrow method of planting.

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