



## Research Paper

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# Effect of spacing and time of harvest on nutrient uptake in medicinal coleus under irrigated condition

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**ABSTRACT :** A field investigation to know the effect of spacing and time of harvest on nutrient uptake in medicinal coleus was conducted at Kittur Rani Channamma College of Horticulture, Arabhavi during *Kharif* 2004 and 2005. Closer spacing of 60 cm x 20 cm recorded significantly higher nutrient uptake (21.6, 2.6 and 25.3 kg / ha of N, P and K, respectively) in tubers. Higher uptake of N, P and K at 160 (18.8, 2.2 and 21.7 kg / ha, respectively) and 180 DAP (17.9, 2.2 and 20.7 kg / ha, respectively) was recorded in tubers. Spacing and time of harvest did not influence the total uptake of nutrients. Higher uptake of NPK (102.1, 11.2 and 117.1 kg / ha, respectively) was recorded at 140 DAP in top portion.

**KEY WORDS :** Spacing, Time of harvest, Uptake, Tuber, Biomass

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**M**edicinal coleus (*Coleus forskohlii* or *Plectranthus forskohlii*) is an ancient herb whose medicinal properties are known to the people since long time. Its use as an ancient drug is recorded in Ayurvedic materia medica under the Sanskrit name *Makandi* or *Mayini* and belongs to the family Lamiaceae. In Ayurvedic literature it was mentioned as *pashanabhedhi* which means treatment of ailments associated with cardiovascular, central nervous, bronchopulmonary and renal systems (Shah, 1996). There are several ethnomedicinal uses of tubers and leaves of coleus for human as well as veterinary ailments. It is also extensively used for preparation of pickles in households and in industries in the states of Gujarat, Maharashtra, Karnataka and Tamil Nadu. The special feature of this plant is that its tuberous roots contain an alkaloid known as *forskolin* which is exclusive to the species. Since the *forskolin* extracted from the tuberous roots is used to develop drugs against hypertension, glaucoma, asthma, congestive heart failure and certain types of cancer (De Souza, 1991) the crop is now being cultivated as commercial medicinal crop.

Originally it grows as wild plant in small areas. It has annual stem with perennial tuberous root system. The coleus

grows profusely with more vegetative growth causing improper source-sink relationship (Rajangam, 2005). Nutrient management especially the major plant nutrients (NPK) is of more important in this crop as the economic part is below the ground (tuberous roots). The nutrient requirement and uptake of crop varies with location and management conditions, especially when it is intensively cultivated as commercial crop under irrigated area. The agro techniques like spacing and time of harvest largely influence the plant growth and nutrient uptake. This crop comes for harvest at five and half months (165 days) after planting (Shah, 1996) and highest yields can be obtained at 180 days after planting (Jayalakshmi, 2003). In view of the need to study its requirements of nutrients and uptake pattern, a study on effect of spacing and time of harvest on nutrient uptake in medicinal coleus under irrigated condition was taken up.

## RESEARCH METHODS

A field experiment was carried out at Kittur Rani Channamma College of Horticulture, Arabhavi, Karnataka during *Kharif* 2004 and 2005 under irrigated condition. The experimental site was clay loam in texture with organic carbon of 0.62 %, pH 8.0, EC 0.2 dS / m and bulk density of

1.34 g / cc. The available N (228 kg / ha), P<sub>2</sub>O<sub>5</sub> (17.5 kg/ha) were low and K<sub>2</sub>O was in medium range (300 kg /ha). Land was converted into ridges and furrows. The terminal shoot cuttings (10-12 cm long having 3- 4 pairs of leaves) of medicinal coleus cultivar K-8 was planted at 60 cm x 20 cm spacing. The cuttings were dipped in 0.1 % carbendazim solution for five minutes before planting. Irrigation was given once in 4-5 days during initial period till establishment and once in 10-12 days at later stages to maintain optimum soil moisture. Farm yard manure (FYM) @ 10 t / ha was applied three weeks before planting and mixed thoroughly in soil. Nitrogen, phosphorus and potassium were applied in the form of urea, single super phosphate and muriate of potash, respectively. The required quantity of fertilizer mixture containing 50 per cent of N and entire dose of P and K (Table 3) was applied to each plot after 20 days of planting in small furrows opened with a marker and mixed thoroughly in the soil. Remaining 50 per cent of the N was applied at 30 days after first application in both the experiments.

The treatment consisted of four spacing levels (60 cm x 30 cm, 75 cm x 20 cm, 45 cm x 30 cm and 60 cm x 20 cm with plant population of 55555, 66666, 74074 and 83333 plants / ha, respectively and three time of harvest treatments viz., 140, 160 and 180 days after planting (DAP). The gross plot size was 9.0 m x 3.0 m. The experiment was laid out in Split Plot Design and replicated thrice. The data on biomass production and its accumulation in different parts were recorded. Nitrogen (N), phosphorus (P) and potassium (K) content on dry weight basis in different plant parts (leaf, stem and tubers) of coleus was estimated as per the procedure laid down by Jackson (1967) at harvest. The total N, P and K concentration in different plant parts (leaf, stem and tubers) was multiplied by their respective biomass yield to obtain per hectare uptake of N, P and K in different plant parts. The sum total of uptake in different plant parts was calculated as

the total N, P and K uptake in kilogram per hectare. Data were analyzed statistically as per the standard procedure (Gomez and Gomez, 1984) and means were subjected to the Duncan's multiple range test (DMRT).

## RESEARCH FINDINGS AND DISCUSSION

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

### Effect of spacing :

Spacing levels influenced the uptake of nutrients. The increase in trend in the uptake of total N (100.4 to 128.0 kg/ha), P (10.3 to 14.3 kg/ha) and K (114.6 to 146.0 kg/ha) was recorded with decrease in spacing (60 cm x 30 cm to 60 cm x 20 cm) though spacing levels did not influence N and K uptake significantly (Tables 1). The increase in total uptake of N, P and K at closer spacing (60 cm x 20 cm) was 27.5, 38.8 and 27.4 %, respectively, compared to wider spacing (60 cm x 30 cm). Significantly higher uptake of N, P and K (21.6, 2.6 and 25.3 kg/ha, respectively) was recorded in tubers in closer spacing (60 cm x 20 cm). In tubers the uptake of N, P and K in closer spacing (60 cm x 20 cm) was 67.4, 73.3 and 68.7%, respectively was higher than the wider spacing level (60 cm x 30 cm). Though spacing levels did not influence the the nutrient uptake in top portion significantly, however, at closer spacing (60 cm x 20 cm) the N, P and K uptake was higher by 21.46, 32.95 and 21.18 per cent, respectively, than the wider spacing (60 cm x 30 cm). Though spacing levels did not influence the nutrient content significantly but, higher uptake of nutrients at closer spacing was due to higher biomass yield per hectare. There was increase in the total biomass production and also in tuber and top portion of the crop as the spacing was decreased from 60 cm x 30 cm to 60 cm x 20 cm (Fig. 1). Jayalakshmi

**Table 1 : Uptake (kg/ha) of nitrogen, phosphorus and potassium in medicinal coleus as influenced by spacing levels (Pooled of 2004 and 2005)**

Spacing (S)	Nitrogen			Phosphorus			Potassium		
	Top	Tuber	Total	Top	Tuber	Total	Top	Tuber	Total
60 cm x 30 cm (55,555 pl/ha)	87.6 <sup>a</sup>	12.9 <sup>b</sup>	100.4 <sup>a</sup>	8.8 <sup>a</sup>	1.5 <sup>b</sup>	10.3 <sup>b</sup>	99.6 <sup>a</sup>	15.0 <sup>c</sup>	114.6 <sup>a</sup>
75 cm x 20 cm (66,666 pl/ha)	98.5 <sup>a</sup>	16.3 <sup>b</sup>	114.8 <sup>a</sup>	10.6 <sup>a</sup>	2.0 <sup>ab</sup>	12.6 <sup>ab</sup>	111.8 <sup>a</sup>	18.8 <sup>b</sup>	130.7 <sup>a</sup>
45 cm x 30 cm (74,074 pl/ha)	98.6 <sup>a</sup>	16.4 <sup>b</sup>	115.0 <sup>a</sup>	11.3 <sup>a</sup>	2.0 <sup>ab</sup>	13.3 <sup>ab</sup>	114.5 <sup>a</sup>	18.7 <sup>b</sup>	133.2 <sup>a</sup>
60 cm x 20 cm (83,333 pl/ha)	106.4 <sup>a</sup>	21.6 <sup>a</sup>	128.0 <sup>a</sup>	11.7 <sup>a</sup>	2.6 <sup>a</sup>	14.3 <sup>a</sup>	120.7 <sup>a</sup>	25.3 <sup>a</sup>	146 <sup>a</sup>
LSD (0.05)**	NS	4.3	NS	NS	0.8	3.5	NS	3.3	NS

**Table 2 : Uptake (kg/ha) of nitrogen, phosphorus and potassium in medicinal coleus as influenced by time of harvest (Pooled of 2004 and 2005)**

Harvesting time (H)	Nitrogen			Phosphorus			Potassium		
	Top	Tuber	Total	Top	Tuber	Total	Top	Tuber	Total
140 DAP	102.1 <sup>a</sup>	13.6 <sup>b</sup>	115.8 <sup>a</sup>	11.2 <sup>a</sup>	1.6 <sup>b</sup>	12.8 <sup>a</sup>	117.1 <sup>a</sup>	16.0 <sup>b</sup>	133.2 <sup>a</sup>
160 DAP	93 <sup>c</sup>	18.8 <sup>a</sup>	111.8 <sup>a</sup>	9.9 <sup>b</sup>	2.2 <sup>a</sup>	12.1 <sup>a</sup>	109.4 <sup>b</sup>	21.7 <sup>a</sup>	131.1 <sup>a</sup>
180 DAP	98.2 <sup>b</sup>	17.9 <sup>a</sup>	116.1 <sup>a</sup>	10.7 <sup>ab</sup>	2.2 <sup>a</sup>	12.9 <sup>a</sup>	108.5 <sup>b</sup>	20.7 <sup>a</sup>	129.1 <sup>a</sup>
LSD (0.05)	3.8	1.2	NS	0.8	0.4	NS	4.3	1.5	NS

NS=Non-significant

(2003) also observed similar trend in coleus.

### Effect of time of harvest:

At the harvesting times of 160 and 180 DAP, significantly higher uptake values of N (38.2 and 31.6%, respectively), P (37.5 and 37.5%, respectively) and K (35.6 and 29.3%, respectively) in tubers were recorded over 140 DAP (Table 2). But, the uptake of N (102.1 kg/ha), P (11.2 kg/ha) and K (117.1 kg/ha) in top portion at 140 DAP was significantly higher than at 160 and 180 DAP (Table 2). The differences among harvesting times for nutrient uptake could be related to the differences in biomass yield (Fig. 2) and concentration of nutrients. The concentration of N and K was higher during early stage. The drop in concentration of P with aging of the plant was not as conspicuous as that of N and K (Table 5). The findings of the present study are in line

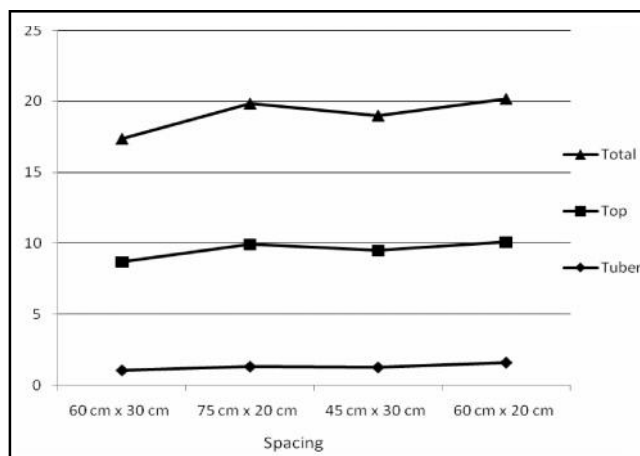


Fig. 1 : Biomass production and its accumulation in tuber and top portion in medicinal coleus as influenced by spacing

Table 3 : Uptake (kg/ha) of nitrogen, phosphorus and potassium in medicinal coleus as influenced by interaction of spacing and time of harvest (Pooled of 2004 and 2005)

Interaction (S x H)	Nitrogen			Phosphorus			Potassium		
	Top	Tuber	Total	Top	Tuber	Total	Top	Tuber	Total
60 cm x 30 cm - 140 DAP	90.9e-g	11.0d	101.9d	9.0de	1.3d	10.4e	105.1ef	12.6e	117.7fg
60 cm x 30 cm - 160 DAP	84.0g	14.3c	98.3d	8.2e	1.6d	9.9e	98.3fg	16.5cd	114.7g
60 cm x 30 cm - 180 DAP	87.7fg	13.4cd	101.1d	9.1d	1.7cd	10.8e	95.6g	16.0cd	111.5g
75 cm x 20 cm - 140 DAP	105.4a-c	13.2cd	118.6bc	11.2bc	1.6d	12.7cd	118.4a-c	15.4de	133.8c-e
75 cm x 20 cm - 160 DAP	93.3d-f	18.8b	112.1c	9.8d	2.3b	12.1cd	109.9c-e	21.9b	131.8de
75 cm x 20 cm - 180 DAP	97.0c-e	16.8b	113.8c	10.8c	2.1bc	13.0cd	107.2d-f	19.2bc	126.4ef
45 cm x 30 cm - 140 DAP	103.4a-c	13.3cd	116.7bc	12.0ab	1.6d	13.6bc	122.2ab	16.1cd	138.3b-d
45 cm x 30 cm - 160 DAP	93.8d-f	17.6b	111.4c	10.8c	2.1bc	12.9cd	113.4b-e	19.9b	133.3c-e
45 cm x 30 cm - 180 DAP	98.5c-e	18.3b	116.8bc	11.0c	2.2c	13.3bc	107.9de	20.1b	128.1e
60 cm x 20 cm - 140 DAP	107.0ab	17.0b	126.0ab	12.4a	2.1bc	14.4ab	122.8ab	20.1b	142.9a-c
60 cm x 20 cm - 160 DAP	100.9b-d	24.6a	125.4ab	10.9c	2.9a	13.7bc	116.0a-d	28.4a	144.4ab
60 cm x 20 cm - 180 DAP	109.5a	23.1a	132.7a	12.0ab	2.8a	14.8a	123.1a	27.5a	150.6a
LSD (0.05)	7.7	2.5	9.4	0.8	0.4	1.0	8.6	3.1	8.9

Table 4 : Nutrient content (%) in medicinal as influenced by spacing levels (Pooled of 2004 and 2005)

Spacing (S)	Nitrogen		Phosphorus		Potassium	
	Top	Tuber	Top	Tuber	Top	Tuber
60 cm x 30 cm (55,555 pl/ha)	1.14 <sup>a</sup>	1.23 <sup>a</sup>	0.115 <sup>a</sup>	0.148 <sup>a</sup>	1.30 <sup>a</sup>	1.46 <sup>a</sup>
75 cm x 20 cm (66,666 pl/ha)	1.14 <sup>a</sup>	1.26 <sup>a</sup>	0.122 <sup>a</sup>	0.152 <sup>a</sup>	1.30 <sup>a</sup>	1.46 <sup>a</sup>
45 cm x 30 cm (74,074 pl/ha)	1.20 <sup>a</sup>	1.34 <sup>a</sup>	0.137 <sup>a</sup>	0.161 <sup>a</sup>	1.39 <sup>a</sup>	1.52 <sup>a</sup>
60 cm x 20 cm (83,333 pl/ha)	1.26 <sup>a</sup>	1.38 <sup>a</sup>	0.138 <sup>a</sup>	0.165 <sup>a</sup>	1.41 <sup>a</sup>	1.62 <sup>a</sup>
LSD (0.05)**	NS	NS	NS	NS	NS	NS

NS=Non-significant

Table 5 : Nutrient content (%) in medicinal as influenced by time of harvesting (Pooled of 2004 & 2005)

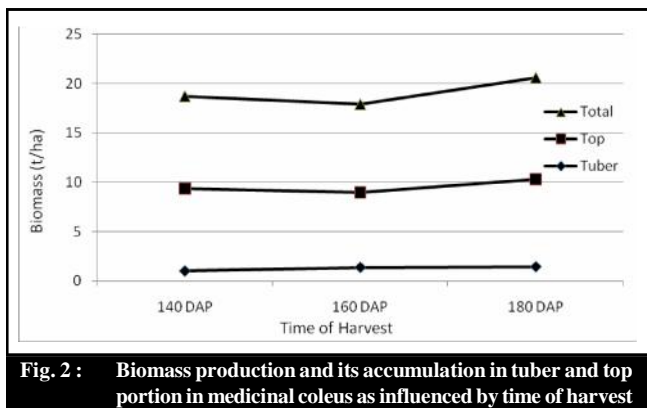
Harvesting time (H)	Nitrogen		Phosphorus		Potassium	
	Top	Tuber	Top	Tuber	Top	Tuber
140 DAP	1.22 <sup>a</sup>	1.35 <sup>a</sup>	0.133 <sup>a</sup>	0.162 <sup>a</sup>	1.40 <sup>b</sup>	1.58 <sup>a</sup>
160 DAP	1.23 <sup>a</sup>	1.34 <sup>a</sup>	0.131 <sup>a</sup>	0.158 <sup>a</sup>	1.44 <sup>a</sup>	1.55 <sup>a</sup>
180 DAP	1.11 <sup>b</sup>	1.22 <sup>b</sup>	0.121 <sup>a</sup>	0.151 <sup>a</sup>	1.22 <sup>c</sup>	1.42 <sup>b</sup>
LSD (0.05)	0.04	0.08	NS	NS	0.04	0.07

NS=Non-significant

**Table 6 : Nutrient content (%) in medicinal coleus as influenced by interaction of spacing and time of harvesting (Pooled of 2004 and 2005)**

Interaction (S x H)	Nitrogen		Phosphorus		Potassium	
	Top	Tuber	Top	Top	Tuber	Top
60 cm x 30 cm - 140 DAP	1.17 <sup>bc</sup>	1.28 <sup>ab</sup>	0.116 <sup>a</sup>	0.152 <sup>a</sup>	1.35 <sup>c</sup>	1.50 <sup>ab-c</sup>
60 cm x 30 cm - 160 DAP	1.18 <sup>bc</sup>	1.26 <sup>ab</sup>	0.116 <sup>a</sup>	0.147 <sup>a</sup>	1.37 <sup>bc</sup>	1.46 <sup>b-d</sup>
60 cm x 30 cm - 180 DAP	1.08 <sup>d</sup>	1.16 <sup>b</sup>	0.112 <sup>a</sup>	0.146 <sup>a</sup>	1.18 <sup>d</sup>	1.41 <sup>cd</sup>
75 cm x 20 cm - 140 DAP	1.19 <sup>bc</sup>	1.32 <sup>ab</sup>	0.126 <sup>a</sup>	0.155 <sup>a</sup>	1.34 <sup>c</sup>	1.54 <sup>a-c</sup>
75 cm x 20 cm - 160 DAP	1.18 <sup>bc</sup>	1.29 <sup>ab</sup>	0.123 <sup>a</sup>	0.154 <sup>a</sup>	1.39 <sup>bc</sup>	1.50 <sup>a-c</sup>
75 cm x 20 cm - 180 DAP	1.06 <sup>d</sup>	1.18 <sup>b</sup>	0.119 <sup>a</sup>	0.148 <sup>a</sup>	1.17 <sup>d</sup>	1.34 <sup>d</sup>
45 cm x 30 cm - 140 DAP	1.23 <sup>ab</sup>	1.39 <sup>a</sup>	0.142 <sup>a</sup>	0.166 <sup>a</sup>	1.45 <sup>ab</sup>	1.63 <sup>a</sup>
45 cm x 30 cm - 160 DAP	1.4 <sup>ab</sup>	1.38 <sup>a</sup>	0.143 <sup>a</sup>	0.164 <sup>a</sup>	1.50 <sup>a</sup>	1.58 <sup>ab</sup>
45 cm x 30 cm - 180 DAP	1.12 <sup>cd</sup>	1.26 <sup>ab</sup>	0.126 <sup>a</sup>	0.154 <sup>a</sup>	1.23 <sup>d</sup>	1.35 <sup>d</sup>
60 cm x 20 cm - 140 DAP	1.30 <sup>a</sup>	1.43 <sup>a</sup>	0.147 <sup>a</sup>	0.172 <sup>a</sup>	1.45 <sup>ab</sup>	1.65 <sup>a</sup>
60 cm x 20 cm - 160 DAP	1.30 <sup>a</sup>	1.41 <sup>a</sup>	0.140 <sup>a</sup>	0.164 <sup>a</sup>	1.48 <sup>a</sup>	1.63 <sup>a</sup>
60 cm x 20 cm - 180 DAP	1.17 <sup>bc</sup>	1.29 <sup>ab</sup>	0.128 <sup>a</sup>	0.156 <sup>a</sup>	1.31 <sup>c</sup>	1.56 <sup>ab</sup>
LSD (0.05)	0.08	0.15	NS	NS	0.08	0.13

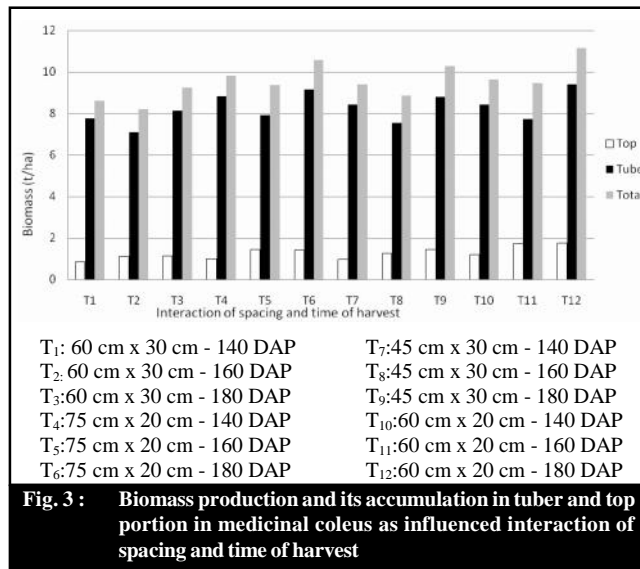
NS=Non-significant

**Fig. 2 :** Biomass production and its accumulation in tuber and top portion in medicinal coleus as influenced by time of harvest

with those of Kabeerathumma *et al.* (1991) in yam (*Dioscorea rotundata*) and Kiruthikadevi (2002) in ashwagandha. However, total uptake of N, P and K did not differ significantly due to harvesting times (Table 2). Contrarily, Jayalakshmi (2003) recorded highest uptake of N, P and K at 180 DAP in coleus.

#### Interaction effect of spacing and time of harvest:

Uptake values of N, P and K recorded at the treatment combinations 60 cm x 20 cm - harvesting at 180 DAP (132.7, 14.8 and 150.6 kg/ha, respectively), 60 cm x 20 cm - harvesting at 160 DAP (125.4, 13.7 and 144.4 kg/ha, respectively) and 60 cm x 20 cm - harvesting at 140 DAP (126.0, 14.4 and 142.9 kg/ha, respectively) was recorded higher (Table 3). The higher uptake in the above treatment combination was due to higher biomass production (Fig. 3) and higher concentration of nutrients (Table 6). Similar trend of uptake of N, P and K was recorded in top portion and tubers.

**Fig. 3 :** Biomass production and its accumulation in tuber and top portion in medicinal coleus as influenced interaction of spacing and time of harvest

T<sub>1</sub>: 60 cm x 30 cm - 140 DAP  
 T<sub>2</sub>: 60 cm x 30 cm - 160 DAP  
 T<sub>3</sub>: 60 cm x 30 cm - 180 DAP  
 T<sub>4</sub>: 75 cm x 20 cm - 140 DAP  
 T<sub>5</sub>: 75 cm x 20 cm - 160 DAP  
 T<sub>6</sub>: 75 cm x 20 cm - 180 DAP  
 T<sub>7</sub>: 45 cm x 30 cm - 140 DAP  
 T<sub>8</sub>: 45 cm x 30 cm - 160 DAP  
 T<sub>9</sub>: 45 cm x 30 cm - 180 DAP  
 T<sub>10</sub>: 60 cm x 20 cm - 140 DAP  
 T<sub>11</sub>: 60 cm x 20 cm - 160 DAP  
 T<sub>12</sub>: 60 cm x 20 cm - 180 DAP

#### Conclusion:

Thus, it was found that spacing levels and time of harvest influenced the uptake of nutrients (NPK) in tubers. However, the total nutrient uptake and its uptake in top portion of the crop was not influenced significantly by spacing levels and also time of harvesting although there was increase in trend in uptake of nutrients with decrease in spacing and increase in crop duration.

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