

Effect of spacing on the performance of Rosemary (*Rosmarinus officinalis* Linn.) blue flowered genotype (NIC-23416) in mid hills of Uttarakhand under rainfed conditions

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Abstract

The present study was conducted under rainfed field conditions at Bhowali, Uttarakhand. Rosemary (*Rosmarinus officinalis* Linn.) was planted at three spacings, viz. 30×20cm, 40×30cm and 60×30cm between row to row. The results indicated that widest spacing of 60×30cm was the most favourable for plant height, plant spread, number of branches, stem diameter and herbage yield per plant in first year, whereas 40×30cm spacing was the best for these traits except herbage yield per plant in second year. But, spacing of 20 ×30 cm was the best for herbage and essential oil yield per hectare. On the basis of analysis of essential oil at 12 and 14 months after planting it was concluded that optimum harvesting time of the crop lies in between these periods.

Keywords: Rosemary, *Rosmarinus officinalis*, Mid hills, Essential oil.

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2000-2001 and 2001-2002. The crop was raised at three different spacing between row to row, viz. 30×20cm, 40×30cm and 60×30cm under natural nutritional status of soil in a Randomised Block Design (RBD) with six replications. Data were recorded on different parameters like plant growth, herbage and essential oil yield characters (Table 1). The essential oil was extracted by hydro-distillation method. A sample of essential oil was analyzed in the Chemistry Laboratory of NBPGR, New Delhi using Gas Liquid Chromatography (GLC) for the volatile constituents (Table 2).

Results and Discussion

Results indicated that the crop of rosemary exhibited differential performance for most of characters under different spacing during both the years (Table 1). Such type of responsiveness of rosemary crop to cultural practices like irrigation system and nitrogen fertilization has earlier been shown by Singh *et al* and Vashundhara *et al*⁴⁻⁵. Maximum values for plant growth characters like plant height (36.33 cm), plant spread (932.09 cm²), number of branches (20.75) and stem diameter (9.68 mm) were recorded in 60×30 cm spacing during first year whereas, planting at

Introduction

Rosemary (*Rosmarinus officinalis* Linn.) a cool loving fragrant leafy evergreen shrub, up to 2m tall, is native to Mediterranean region and grows wild in Algeria, France, Italy, Portugal and Spain. The dried leaf material and essential oil of rosemary are obtained from leaves and flowering twigs. The essential oil is extensively used in food, flavour and fragrance industries. The leading countries in production of essential oil of rosemary are Morocco, Spain, USA and Tunisia¹. India's present perspective in production of rosemary oil is negligible but increasing market demand is assumed to raise it up many folds in the future.

The rosemary is reported to prefer red sandy soil and respond well to

application of nitrogen and lime. The crop is suitable for cultivation in temperate Himalayas and Nilgiri hills^{2, 3}. However, no systematic research works have been undertaken so far on this crop for optimization of cultural requirements in rainfed hills of Uttarakhand. Therefore, this study was conducted to observe the effect of spacing between plants row to row on plant height, plant spread, number of branches, stem diameter and herbage and essential oil yield.

Materials and Methods

This investigation was carried out on rosemary blue flowered genotype (NIC-23416) at NBPGR, Regional Station, Bhowali (1600 m altitude, 29° 20' N latitude and 79° 30' longitude) during

Table 1: Performance of Rosemary genotype NIC-23416 under different spacings

S. No.	Characters	Spacings											
		First year						Second year					
		30×20 (cm)	40×30 (cm)	60×30 (cm)	±S.E. (m)	C.D. (0.05)	30×20 (cm)	40×30 (cm)	60×30 (cm)	±S.E. (m)	C.D. (0.05)		
1.	Plant height after 7 months (cm)	13.54	15.42	16.84	0.84	NS	36.00	34.44	25.11	2.77	6.18		
2.	Plant height after 10 months (cm)	31.41	32.67	36.33	1.19	2.65	39.44	39.56	28.56	3.03	6.76		
3.	Plant height after 13 months (cm)	-	-	-	-	-	42.08	40.92	46.50	2.63	NS		
4.	Plant height after 16 months (cm)	-	-	-	-	-	44.42	41.92	48.84	1.91	4.26		
5.	Plant spread after 7 months (cm ²)	120.83	117.62	146.92	13.79	NS	248.44	562.45	299.33	29.55	65.90		
6.	Plant spread after 10 months (cm ²)	735.25	711.75	932.09	60.84	135.67	402.78	792.44	472.44	53.72	119.80		
7.	Plant spread after 13 months (cm ²)	-	-	-	-	-	807.25	1016.92	1156.67	71.94	160.43		
8.	Plant spread after 16 months (cm ²)	-	-	-	-	-	1002.67	901.42	1270.33	88.94	198.34		
9.	No. of branches after 7 months	9.92	8.42	13.33	1.70	3.79	6.11	7.67	5.44	0.85	1.90		
10.	No. of branches after 10 months	16.33	16.17	20.75	2.31	NS	8.00	9.00	6.78	0.95	2.12		
11.	No. of branches after 13 months	-	-	-	-	-	23.25	19.67	26.59	1.39	3.10		
12.	No. of branches after 16 months	-	-	-	-	-	23.50	20.17	25.50	1.02	2.28		
13.	Stem diam. after 7 months (mm)	3.23	3.47	3.64	0.44	NS	4.45	4.99	4.46	0.63	NS		
14.	Stem diam. after 10 months (mm)	5.78	9.38	9.68	0.95	2.12	5.74	6.29	5.08	0.87	NS		
15.	Stem diam. after 13 months (mm)	-	-	-	-	-	8.17	10.25	11.75	0.94	2.10		
16.	Stem diam. after 16 months (mm)	-	-	-	-	-	8.99	10.20	11.24	0.88	1.96		
17.	Herbage per plant (g.)	70.84	90.83	100.00	12.95	28.88	51.67	67.78	83.89	8.24	18.38		
18.	Calculated herbage yield per hectare (q/ha)	118.06	75.70	55.55	10.41	23.21	86.12	56.48	46.61	12.80	28.54		
19.	Calculated essential oil yield (kg/ha)	55.50	27.26	20.00	8.66	19.31	32.73	21.46	17.71	5.78	12.89		

NOTE: - = Data were not recorded; NS= Not Significant

40×30 cm appeared promising for these traits in second year.

Maximum herbage yield per plant was obtained in 60×30cm spacing in both the years (100.00g in first year and 83.89 g in second year) followed by spacing of 40×30 cm (90.83 g in first year and 67.78 g in second year) with non-significant differences. It was presumably due to the fact that wider spacings facilitated the plant to get more opportunity of spreading and growth resulting in higher herbage yield per plant. However, herbage yield per hectare was lower in wider spacings due to accommodation of least number of plants in one hectare land. Plant spread and growth in wider spacings under low moisture and nutrient regime of rainfed soils were not too pronounced to compensate per hectare yields. Therefore, close planting of 30×20 cm should be adopted in low moisture and nutrient level of soils of rainfed areas.

The oil content of the herbage in different treatments did not vary significantly. It ranged from 0.35 to 0.36 per cent. Thus, total herbage yield was main source of essential oil yield per hectare. The essential oil yield per hectare was also maximum in 30×20 cm spacing in both the years (55.50 kg in first year and 32.73 kg in second year) followed by that in 40×30 cm spacing (27.26 kg in first year and 21.46 kg in second year). Widest spacing of 60×30 cm resulted in lowest essential oil yield per hectare in both the years i.e. 20.00 kg in first year and 17.71 kg in second year. Therefore, closer spacing is beneficial in rosemary for cultivation on an extensive land.

The samples of essential oil of two stages, viz. after 12 and 14 months of

Table 2: Chemical composition of essential oil in Rosemary blue flowered (NIC-23416)

S. No.	Chemical constituents	Percentage present in essential oil after 12 months of planting	Percentage present in essential oil after 14 months of planting
1.	α -Thujene	0.1233	0.0456
2.	α -Pinene	6.7210	10.6204
3.	Camphene	2.7627	3.5051
4.	Sabinene	0.0641	1.0708
5.	β -Pinene	0.7913	0.0750
6.	α -Phellandrene	0.1777	0.3847
7.	Δ -3-Carene	0.1005	0.2608
8.	cis- β -Ocimene	0.9627	1.2602
9.	1:8 Cineole	11.8826	15.0378
10.	γ -Terpinene	-	0.0470
11.	Terpenolene	0.0576	0.0683
12.	Linalool	4.7932	5.1607
13.	Camphor	21.5759	20.5651
14.	Citronellal	0.0467	0.0567
15.	Menthone	0.6337	0.5384
16.	Iso-menthone	0.2512	0.3184
17.	Iso-borneol	18.0531	14.2197
18.	Borneol	1.2073	1.1184
19.	α -Terpineol	1.0986	1.3363
20.	Verbenone	10.9878	8.7729
21.	Citronellol	0.9947	1.1330
22.	Citral (1)	0.6219	0.5327
23.	Citral (2)	1.0089	1.2523
24.	Iso-bornyl acetate	1.9146	1.1761
25.	Caryophyllene	0.1184	0.1576

planting were analyzed to assess the concentration of different active principles. The results indicated that similar chemical constituents were present in essential oil at both the stages although their per cent concentration was slightly higher in sample collected from 14 months old plants. The major chemical constituents in the essential oil of rosemary i.e., camphor 20.57-21.58;

iso-borneol 14.22-18.05; 1:8 cineole 11.88-15.04; α -pinene 6.72-10.62; verbenone 8.77-10.99; linalool 4.79-5.16 and camphene 2.76-3.51 were observed during 12-14 months (Table 2). Therefore, optimum stage of harvesting can be done anytime after 12 months of planting to 14 months rather than keeping the plants in field for 18 months as is recommended in some



Fig. 1: Seedlings of Rosemary, blue flowered NIC-23416 for transplantation

yield, plant height, number of branches, etc. which results in to good essential oil yield per hectare under rainfed conditions in mid hills of Uttarakhand.

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Fig. 2: Close-up of a plant of Rosemary, blue flowered, NIC-23416



Fig. 3: Plant population of Rosemary at a stage of 12 month

literature. Singh *et al* has also recommended the crop for harvesting at full flowering stage (i.e., 12 months after planting)⁴.

Conclusion

On the basis of above study it can be concluded that spacing between row to row plays an important role in herbage