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Influence of Planting Method and Geometry on Growth and Yield of Menthol Mint (*Mentha arvensis* L.)

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A B S T R A C T

Field study was conducted to study the effect of planting method and geometry on growth and yield of menthol mint during 2017 at Kittur Rani Channamma College of Horticulture, Arabhavi, Karnataka. Among the different treatment combinations studied, raised bed method of planting with 60 × 30 cm spacing (P_2S_3) recorded maximum plant height and number of branches. Fresh herbage yield(g/plant) was maximum with raised bed method of planting with 60 ×30 cm spacing (P_2S_3) whereas fresh herbage yield (kg/plot, t/ha) was maximum with raised bed method of planting with 45 × 30 cm spacing (P_2S_1).

Introduction

Mentha genus belonging to family Lamiacaeae is a major source of essential oils widely used in combating cold, as an ingredient in cough drops, dentifrices, cosmetics, mouth washes, scenting of tobacco products and flavoring of beverage foods. Major Mentha genus include menthol mint (*Mentha arvensis*), spear mint (*Mentha spicata*), bergamot mint (*Mentha citrata*), pepper mint (*Mentha piperita*) and scoth mint (*Mentha cardiaca*) mainly grown for their aroma isolates like menthol, carvon, linalyl-acetate and linalool (George, 1994). Menthol oil is a rich source of menthol (75-80%) and considered as an outstanding stomachic, stimulant, antispasmodic and carminative (Kahkashan *et al.*, 2016). The cooling effect of menthol is exploited in making certain cosmetic products like lipsticks, face creams, hair lotions and shaving creams.

In pharmaceutical industry, they are utilized in tooth pastes, mouth fresheners, aerosols and as ingredient in products such as shoe polish (George, 1994). Besides, natural menthol is preferred in food and flavor industry. Synthetic menthol has also come in market but its volumes are meagre due to high cost of production.

Although India entered the global market for commercial production and export of mint

during 1980's. Today it is a leading producer of this crop in world having 0.30 million ha area with annual production of 38,000 metric tonnes of essential oil with average productivity of around 120 kilograms per hectare (Anon., 2015) which meets 75 per cent of international requirement of mint oil and stands as a world leader in production of mint with around 80 per cent of global supply of mint oil, followed by China and Japan, each producing around 10 per cent (Misra *et al.*, 2000).

In India, Uttar Pradesh is the largest mentha producing state in the country contributing 80 to 90 per cent of total production followed by Punjab, Haryana, Bihar and Himachal Pradesh (Karvy, 2011). In Karnataka, Mints are being grown in very limited area as these crops are uncommon to the growers due to lack of knowledge on scientific cultivation, processing and marketing.

Materials and Methods

A field experiment was conducted on "Studies on planting method and geometry in menthol mint" during *Kharif* season in 2017-18.

The details of the materials used and methods adopted during the course of investigation are presented below.

The experiment was laid out in split plot design with twelve treatments and three replications. The gross plot size was 4.8 × 3.6 m (17.28 m^2).

Stolon's of uniform thickness and standard size of 7.0 to 10.0 cm in length having 2-3 nodes treated with 0.3 per cent COC for 5-10 minutes before planting were used. Growth parameters were recorded at 30, 45, 60, 90 and 120 days after planting. Whereas yield (g/plant, kg/plot and t/ha) parameters were observed at harvest (120 DAP).

Results and Discussion

Growth parameters

Among the different planting methods at harvest, those plants planted on raised bed (P_2) recorded higher plant height (67.16 cm) whereas minimum plant height (64.34 cm) was noticed with ridges and furrow method of planting (P_3) (Table 1).

At same time number of branches was also significantly influenced by planting methods where the maximum number of branches (24.99) was recorded with raised bed and minimum number of branches at harvest (22.41) was recorded with ridges and furrow method of planting (Table 2). The increase in the growth attributes may be due to the favorable condition in raised bed during *kharif* season which will be free from water logging and ensure good soil aeration. This result is in contrary with the findings of Saini *et al.*, (2001) where flatbed method of planting was superior in terms of growth attributes.

Among different spacing followed those plants planted at wider row spacing of 60 × 30 cm (S_3) were found to be tallest (68.28 cm) at harvest compared to the spacing of 45 × 45 cm (S_2) (63.02 cm).

The increased plant height in wider row spacing of 60 × 30 cm might be due to lesser competition between plants at lower plant densities for nutrients, water, light *etc.* Similar trends were observed by Kothari *et al.*, (1996) and Saini *et al.*,(2001) in *Mentha arvensis*, Chinnabbai (1991) in *Mentha viridis*, Shalaby *et al.*, (1997) in *Echinoceapurpurea*, Lakshmipathaiah (1998) in babchi (Table 1). Maximum number of branches per plant (25.64) was noticed in wider spacing S_3 (60×30 cm) at harvest, while less number of branches per plant (22.20) was recorded in closer spacing S_1 (45 ×45 cm) at harvest.

Table.1 Effect of planting method and spacing on plant height in menthol mint at 30, 45 and 60 DAP

Plant height (cm)															
Treatments	**30 DAP**					**45 DAP**					**60 DAP**				
	S_1	**S_2**	**S_3**	**S_4**	**Mean**	**S_1**	**S_2**	**S_3**	**S_4**	**Mean**	**S_1**	**S_2**	**S_3**	**S_4**	**Mean**
P_1	18.20	19.27	15.60	16.27	**17.33**	33.96	34.13	35.81	34.43	**34.58**	44.95	40.75	46.92	42.62	**43.81**
P_2	17.07	17.67	16.60	17.00	**17.08**	35.32	32.43	36.71	34.76	**34.80**	45.17	41.19	47.62	43.62	**44.40**
P_3	17.87	16.67	17.33	16.93	**17.20**	33.62	31.53	35.18	32.65	**33.24**	41.52	38.71	43.53	40.33	**41.02**
Mean	**17.71**	**17.87**	**16.51**	**16.73**		**34.30**	**32.69**	**35.90**	**33.94**		**43.88**	**40.21**	**46.02**	**42.19**	
For comparison of mean															
	S.Em ±		**CD @ 5 %**			**S.Em ±**		**CD @ 5 %**			**S.Em ±**		**CD @ 5 %**		
Planting method (P)	0.578		NS			0.26		1.02			0.65		2.58		
Row spacing (S)	0.691		NS			0.28		0.85			0.76		2.27		
S at same level of P	1.18		NS			0.50		NS			1.32		NS		
S at same or different level of P	1.19		NS			0.49		NS			1.32		NS		

P_1 = Flatbed method P_2 = Raised bed method of planting P_3 = Ridges and furrow method of planting
S_1 = 45 × 30 cm S_2 = 45 × 45 cm S_3 = 60 × 30 cm S_4 = 60 × 45 cm

Table.1 continued

Effect of planting method and spacing on plant height in menthol mint at 90 DAP and at harvest.

Plant height (cm)										
Treatments	**90 DAP**					**At harvest**				
	S_1	**S_2**	**S_3**	**S_4**	**Mean**	**S_1**	**S_2**	**S_3**	**S_4**	**Mean**
P_1	63.15	62.03	64.80	62.59	**63.14**	66.14	62.86	67.29	64.03	**65.08**
P_2	64.53	62.57	66.44	63.01	**64.13**	67.41	64.26	70.91	66.08	**67.16**
P_3	62.20	60.91	63.47	61.20	**61.94**	65.25	61.94	66.64	63.56	**64.34**
Mean	**63.29**	**61.83**	**64.90**	**62.26**		**66.26**	**63.02**	**68.28**	**64.55**	
For comparison of mean										
	S.Em ±		**CD @ 5 %**			**S.Em ±**		**CD @ 5 %**		
Planting method (P)	0.34		1.35			0.42		1.65		
Row spacing (S)	0.76		2.27			0.61		1.81		
S at same level of P	1.14		3.58			1.01		3.02		
S at same or different level of P	1.32		3.93			1.05		3.14		

P_1 = Flatbed method P_2 = Raised bed method of planting P_3 = Ridges and furrow method of planting
S_1 = 45 × 30 cm S_2 = 45 × 45 cm S_3 = 60 × 30 cm S_4 = 60 × 45 cm

Table.2 Effect of planting method and spacing on number of branches in menthol mint at 30, 45 and 60 DAP.

Number of branches															
Treatments	**30 DAP**					**45 DAP**					**60 DAP**				
	S_1	**S_2**	**S_3**	**S_4**	**Mean**	**S_1**	**S_2**	**S_3**	**S_4**	**Mean**	**S_1**	**S_2**	**S_3**	**S_4**	**Mean**
P_1	2.60	2.27	2.87	2.53	**2.56**	5.80	5.03	7.10	6.00	**5.98**	10.09	8.44	11.46	9.26	**9.81**
P_2	2.93	2.33	2.20	2.13	**2.39**	6.00	5.13	7.80	6.50	**6.35**	10.80	8.48	12.49	9.49	**10.31**
P_3	2.23	2.40	2.37	2.53	**2.38**	5.53	4.73	6.67	5.73	**5.66**	10.21	7.94	11.28	9.34	**9.69**
Mean	**2.58**	**2.33**	**2.48**	**2.39**		**5.77**	**4.96**	**7.19**	**6.07**		**10.36**	**8.28**	**11.74**	**9.36**	
For comparison of mean															
	S.Em ±		**CD @ 5 %**			**S.Em ±**		**CD @ 5 %**			**S.Em ±**		**CD @ 5 %**		
Planting method (P)	0.12		NS			0.07		0.28			0.11		0.46		
Row spacing (S)	0.13		NS			0.07		0.22			0.08		0.26		
S at same level of P	0.23		NS			0.13		NS			0.17		0.53		
S at same or different level of P	0.23		NS			0.12		NS			0.15		0.45		

P_1 = Flatbed method P_2 = Raised bed method of planting P_3 = Ridges and furrow method of planting
S_1 = 45 × 30 cm S_2 = 45 × 45 cm S_3 = 60 × 30 cm S_4 = 60 × 45 cm

Table.2 continued

Effect of planting method and spacing on number of branches in menthol mint at 90 DAP and at harvest.

Number of branches										
Treatments	**90 DAP**					**At harvest**				
	S_1	**S_2**	**S_3**	**S_4**	**Mean**	**S_1**	**S_2**	**S_3**	**S_4**	**Mean**
P_1	22.33	18.13	23.67	19.43	**20.89**	24.27	22.33	25.60	23.63	**23.95**
P_2	23.40	18.47	24.20	20.20	**21.56**	25.43	23.27	26.87	24.40	**24.99**
P_3	22.73	18.03	22.93	19.57	**20.81**	22.47	21.00	24.47	21.70	**22.41**
Mean	**22.82**	**18.32**	**23.6**	**19.73**		**24.05**	**22.20**	**25.64**	**23.24**	
For comparison of mean										
	S.Em ±		**CD @ 5 %**			**S.Em ±**		**CD @ 5 %**		
Planting method (P)	0.13		0.51			0.23		0.90		
Row spacing (S)	0.11		0.32			0.20		0.60		
S at same level of P	0.21		NS			0..38		NS		
S at same or different level of P	0.19		NS			0.35		NS		

P_1 = Flatbed method P_2 = Raised bed method of planting P_3 = Ridges and furrow method of planting
S_1 = 45 × 30 cm S_2 = 45 × 45 cm S_3 = 60 × 30 cm S_4 = 60 × 45 cm

Table.3 Effect of planting method and spacing on fresh herbage yield in menthol mint at harvest

Fresh herbage yield															
Treatments	**g/plant**					**Kg/plot**					**t/ha**				
	S_1	**S_2**	**S_3**	**S_4**	**Mean**	**S_1**	**S_2**	**S_3**	**S_4**	**Mean**	**S_1**	**S_2**	**S_3**	**S_4**	**Mean**
P_1	400.45	355.82	443.87	380.72	**395.21**	27.98	14.23	22.19	9.64	**18.51**	24.26	12.34	19.25	8.36	**16.05**
P_2	403.66	359.51	460.08	388.71	**402.99**	28.25	14.38	23.00	9.68	**18.82**	24.50	12.47	19.95	8.40	**16.33**
P_3	396.70	351.25	440.61	373.89	**390.61**	27.76	14.05	22.02	9.34	**18.29**	24.08	12.19	19.10	8.10	**15.86**
Mean	**400.27**	**355.52**	**448.18**	**381.10**		**27.99**	**14.22**	**22.40**	**9.55**		**24.28**	**12.33**	**19.43**	**8.28**	

For comparison of mean						
	S.Em ±	**CD @ 5 %**	**S.Em ±**	**CD @ 5 %**	**S.Em ±**	**CD @ 5 %**
Planting method (P)	1.65	6.48	0.07	0.29	0.06	0.25
Row spacing (S)	1.48	4.41	0.08	0.24	0.07	0.21
S at same level of P	2.77	NS	0.14	NS	0.12	NS
S at same or different level of P	2.57	NS	0.14	NS	0.12	NS

P_1 = Flatbed method P_2 = Raised bed method of planting P_3 = Ridges and furrow method of planting
S_1 = 45 × 30 cm S_2 = 45 × 45 cm S_3 = 60 × 30 cm S_4 = 60 × 45 cm

The increase in number of branches at wider row spacing could be attributed to the availability of more spatial area for spreading between rows of crop. Similar trends were observed by Chinnabbai (1991) in *Mentha viridis*, Balyan *et al.,* (1987) in *Ocimum americanum*, Lakshmipathaiah (1998) in babchi, Singh (2000) in *Phyllanthus amarus* (Table 2).

The interaction of planting method and spacing had significant effect on plant height at 90 DAP and at harvest. Maximum plant height 66.44 and 70.91 cm were noticed with crops grown on raised bed method of planting with spacing 60 × 30 cm (P_2S_3). These increase in plant height might be due to better soil aeration, free from water logging and less competition between the plants (Table 1).

Interaction of planting method and spacing differed significantly with number of branches at 60 DAP with maximum number of branches (12.49) recorded in crops grown on raised bed method of planting with 60 × 30 cm spacing (P_2S_3).

These increase in number of branches might be due to increase in plant height at interaction of raised bed with spacing 60 × 30 cm (Table 2).

Yield parameters

Menthol mint planted on raised bed method of planting (P_2) was significantly superior in terms of fresh herbage yield (402.99 g/plant, 18.82 kg/plot and 16.33 t/ha), while minimum fresh herbage yield (390.61 g/plant, 18.29 kg/plotand15.86 t/ha) was recorded in ridge and furrow method of planting. The increase in fresh herb yield in raised bed method might be due to increase in leaf area which resulted in production of more number of photosynthates resulting in better plant growth in terms of plant height, spread, and branches. These findings are in contrary to Saini *et al.,* (2001) where flatbed method of planting was superior in terms of yield attributes. Menthol mint planted at 60 × 30 cm (S3) was significantly superior in terms of fresh herbage yield (448.18 g/plant), while minimum fresh herbage yield (355.52 g/plant), was recorded in 45 × 45 cm (S2).

The higher fresh herbage yield per plant at wider spacing might be due to increase in leaf area which resulted in production of more number of photosynthates. Similar results were obtained earlier by Pushpalatha *et al.,* (2003) in makoi and Subodhini *et al.,* (2005) in *Centella asiatica*. Menthol mint planted in 45 × 30 cm was significantly superior in terms of fresh herbage yield (27.99 kg/plot and 24.28 t/ha), while minimum fresh herbage yield (9.55 kg/plot and 8.28 t/ha) was recorded in 60 × 45 cm. The increase in yield (kg/plot, t/ha) at 45 × 30 cm spacing might be due to increase in plant population per unit area.

These results are in conformity with Sarma *et al.,* (1975) in *Mentha arvensis,* Raman and Vasudevan (1976) in *Mentha citrata*, Yadav *et al.,* (1985), Kassahun *et al.,* (2011) and Vinod and Meenu (2011) in *Mentha piperita*, Umesh *et al.,* (1990) in clocimum (Table 3).

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