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Performance of Different Parts of Planting Materials and Plant Geometry on Oil yield and Suckers Production of Menthol-mint (*Mentha arvensis* L.) during Winter Season

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A B S T R A C T

Field experiment was conducted during 2017-18 at the research farm of CSIR-CIMAP Research Centre Pantnagar to evaluate the performance of different sources of planting materials and plant geometry on oil yield and suckers production of Menthol-mint (*Mentha arvensis* L.) under tarai region of Uttarakhand. The studies involved three source of planting materials (P_1-Whole shoot; P_2-Upper portion of shoot and P_3-Lower portion of shoot) and three plant geometry (S_1-50×15 cm; S_1-50×30 cm and S_1-50×Running) were applied. The study revealed that, planted as whole shoots resulted in higher suckers yields (89.78 q/ha) as evident from higher oil yield (102.76 kg/ha). Among the planting distance, broader spacing showed higher yield of oil (95.31 kg/ha) and suckers (83.52 q/ha) in menthol-mint during experimentation.

Introduction

Menthol mint (*Mentha arvensis* L.) is herbaceous perennial medicinal and aromatic crop growing to height of 20-90 cm and belongs to the family lamiaceae. Mint is a potential source of natural menthol and dementholized oil and is cultivated in the tropics and subtropical countries worldwide. Essential oils of mint especially containing varieties of aroma chemicals and major one is menthol used in medicines for cold remedies, cosmetics, mouth washes and also used as flavouring agent in various types of confectionaries and dental cream 1. The area under menthol mint cultivation in India is estimated to be 0.15 million hectares with annual production of 20,000 metric tonnes of essential oil. The crop is commercially cultivated in tarai and central part of Uttar Pradesh (Barabanki, Raebareli, Rampur, Bareli, Badaun, Moradabad, Amroha, Rudrapur Bilaspur), Punjab, Bihar and Haryana2. The plant on hydro distillation yields essential oil containing about 70-80 % menthol, which is used in various pharmaceutical, food and cosmetic preparations. Besides China and USA, India is a major producer of mint oil mostly exported to USA and European countries. Since during the last a few decades, many types of research and development viz. nutrient management, weed management, organic input, integrated nutrient management etc. have been done for increasing the yield and yield contributing characters of mint. Due to conventional breeding research and developmental techniques, it is not helpful increasing the yield of mint oil. It is thought to increase the yield and yield contributing characters of mint (*Mentha arvensis* L.) by changing or alter the phenotype the plant.

The phenotype of the plant can be changed by nipping at specific time (cutting of apical portion in each branch of mint), by this activity the mint plant may provide higher herb and oil yield. The present investigation was undertaken to develop appro-priate a new agrotechnology for mint crop which can increase the yield and yield contributing characters. This study aimed to determine the optimum sowing date and plant density of Basil for achievement of maximum oil and seed yields under *Tarai* region of Uttarakhand, India.

Materials and Methods

A field experiment was conducted at the research farm of CSIR-Central Institute of Medicinal and Aromatic Plant, Research Centre, Pantnagar (Udham Singh Nagar) Uttarakhand, India during 2017-18. The experimental site is located between 29^o N latitude and 79.38^o E longitude and at an altitude of 243 m above mean sea level. The maximum temperature ranges between 35 to 45^{o}C, and minimum between 2 to 5^{o}C. The experimental soil was sandy-loam in texture, neutral in reaction (7.2 pH), medium in organic carbon (0.52%), low in available nitrogen (135 kg ha^{-1}), and medium in available phosphorus (13 kg ha^{-1}) as well as in potassium (140 kg ha^{-1}). The *Mentha arvensis* cv. CIM-Kranti was taken as experimental crop. The experimental design was split plot design with thrice replications. The main plot treatments were three source of planting materials (P_1-Whole shoot; P_2-Upper portion of shoot and P_3-Lower portion of shoot) and sub-plot three planting distance (S_1-50×15, S_2-50×30 and S_3-50×running cm) were applied and each experimental plot was kept with 5×5 m^2. The recommended dose of fertilizer was applied in the form of N: P: K @ 120:60:40 kg/ha through DAP, Urea and MOP. The crop was kept free from weeds by hand weeding. Sampling was performed from 4 middle rows in appropriate times. Plants were harvested at physiological maturity stage when plants lower leaves turn into yellowed. Five plants randomly were selected in each plot to measure the plant height, crop spread, herbage yield, oil and suckers yield. The data relating to each character were analyzed statistically by applying the technique of analysis of variance and the significance was tested by "F" test (Gomez and Gomez, 1984).

Results and Discussion

Growth attributes

Crop growth attributes data (Table 1) revealed that taller plants (51.89 cm) with maximum crop spread (72.67 cm) was recorded in P_1-Whole shoot treatment which was significantly higher to P_2-Upper portion of shoot (top plant part) and P_3-Lower portion of shoot (lower plant part) except P_2-Upper portion of shoot in crop spread (68.33 cm) which is at par with P_1-Whole shoot treatment, however, P_2-Upper portion of shoot was also received maximum crop height (48.11 cm) and crop spread (68.33 cm) as compared to P_3-Lower portion of shoot treatment during experimentation (Table 1). It was might be due to better growth and performance of plant part which supported growth parameters in planting treatment. Among the spacing treatments, wider space (S_2-50×30 cm) recorded the highest plant height (53.33 cm) and crop spread (72.11 cm), respectively, which was at par with closer spacing (S_1-50×15 cm) in crop spread only and significantly superior to (S_3-50×running) treatment. However, plant spacing (S_1-50×15 cm) also showed that significantly higher plant height (49.00) and crop spread (64.89 cm) as compared to spacing (S_3-50×running) during experimentation. Similar findings were also reported by Anwar *et al.*, 2010; Chand *et al.*, 2006 & 12; Kothari *et al.*, 1987 and Kumar *et al.*, 2002.

Herbage and suckers yield

Herbage and suckers yield is considered to be a function of various source of planting materials were planted (Table 1). The highest herbage (172.74 q/ha) and suckers yield (89.18 q/ha) were recorded by P_1-Whole shoot treatment which was significantly higher to P_2-Upper portion of shoot (top plant part) and P_3-Lower portion of shoot (lower plant part), however, P_2-Upper portion of shoot (top plant part) was also received higher herbage (158.88 q/ha) and suckers yield (73.54 q/ha) as compared to P_3-Lower portion of shoot (lower plant part) treatment during experimentation (Table 1).

Among the plant spacing treatments, wider space (S_2-50×30 cm) was recorded the highest herbage yield (167.07 q/ha) and suckers yield (83.52 q/ha), respectively, in comparison to closer spacing (S_1-50×15 cm) and (S_3-50×running) treatment. Plant spacing (S_1-50×15 cm) also showed that significantly higher herbage yield (167.07 q/ha) and suckers yield (83.52 q/ha) as compared to S_3-50×running spacing. However, spacing (S_3-50×running) treatment was received least herbage yield (137.67 q/ha) and suckers yield (51.18 q/ha) as compared to both wider spacing (S_2-50×30 cm and S_1-50×15 cm) treatment during experimentation (Table 1). Its might be due to influenced by closer and wider spacing on herbage and suckers yield m^{-2} contributed maximum yield which ultimately increased the yield. Similar results were supported by Nakawuka *et al*., 2014, Patra *et al.*, 2000, Ram *et al.*, 1998, 2006 & 10, Ram and Kumar, 1998 and Rathi *et al.*, 2014, Saxena and Singh, 1996 & 1998 and Shormin, 2005.

Oil content and oil yield

Oil yield is considered to be a function of various yield attributing characters *viz.*, oil content/kg biomass and biomass yield. Oil content and oil yield was significantly influenced by source of planting materials (Table 1). The highest Oil content (0.60 %) and oil yield (102.76 kg/ha) recorded by P_1-Whole shoot treatment which was significantly higher to P_2-Upper portion of shoot (top plant part) and P_3-Lower portion of shoot (lower plant part), however, P_2-Upper portion of shoot (top plant part) was also received higher oil yield (92.72 kg/ha) as compared to P_3-Lower portion of shoot (lower plant part) treatment during experimentation (Table 1).

Among the plant spacing treatments, wider space (S_2-50×30 cm) was recorded the highest oil content (0.58 %) and oil yield (95.31 kg/ha) in comparison to closer spacing (S_1-50×15 cm) and (S_3-50×running) treatment. However, spacing (S_3-50×running) treatment was received least oil content (0.56 %) and essential oil yield (77.82 kg/ha) as compared to both wider spacing (S_2-50×30 cm and S_1-50×15 cm) treatment during experimentation (Table 1). Its might be due to influenced by planting part and closer and wider spacing on oil content and oil yield either decreased or increased. Similar results were supported by Singh *et al.*, 1989, 1998, 1999 & 2000 and Upadhyay *et al.*, 2014.

Table.1 Performance of different source of planting materials and spacing on oil and suckers production of *Mentha arvensis*

Treatments	Plant Height (cm)	Crop Spread (cm)	Herbage yield (kg/m^2)	Herbage yield (q/ha)	Suckers yield (kg/m^2)	Suckers yield (q/ha)	Oil (%)	Oil yield (kg/ha)
Planting Materials								
P_1-Whole shoot	51.89	72.67	1.73	172.74	0.89	89.18	0.60	102.76
P_2-Upper portion of shoot	48.11	68.33	1.59	158.88	0.74	73.54	0.58	92.72
P_3-Lower portion of shoot	42.78	55.11	1.31	131.12	0.42	41.68	0.53	69.36
SEm±	1.13	3.62	0.03	3.46	0.04	4.25	0.02	3.38
LSD (p=0.05)	3.13	10.05	0.10	9.61	0.12	11.80	0.06	9.38
Planting Distance								
S_1-(50×15 cm)	53.33	72.11	1.58	158.01	0.70	69.70	0.58	91.70
S_2-(50×30 cm)	49.00	64.89	1.67	167.07	0.84	83.52	0.57	95.31
S_3-(50×Running)	40.44	59.11	1.38	137.67	0.51	51.18	0.56	77.82
SEm±	2.52	2.56	0.03	2.75	0.04	3.65	0.04	6.53
LSD (p=0.05)	5.50	5.58	0.06	5.99	0.08	7.96	NS	14.24
Interaction	NS	NS	NS	NS	*	*	NS	NS

Table.1a Interaction effect of planting materials and spacing on suckers yield (kg/m^2) of *Mentha arvensis*

Interaction	S_1-(50×15 cm)	S_2-(50×30 cm)	S_3-(50×Running)	Average
P_1-Whole shoot	0.94	1.15	0.59	0.89
P_2-Upper portion of shoot	0.74	0.92	0.54	0.74
P_3-Lower portion of shoot	0.41	0.44	0.40	0.42
Average	0.70	0.84	0.51	0.68
SEm± for spacing at the same level of planting parts.	0.06			
CD (P=0.05)	0.14			
SEm± for planting parts at the same or different levels of spacing.	0.07			
CD (P=0.05)	2.42			

Table.1b Interaction effect of planting materials and spacing on suckers yield (q/ha) of *Mentha arvensis*

Interaction	S_1-(50×15 cm)	S_2-(50×30 cm)	S_3-(50×Running)	Average
P_1-Whole shoot	94.00	114.60	58.93	89.18
P_2-Upper portion of shoot	74.37	91.97	54.30	73.54
P_3-Lower portion of shoot	40.73	44.00	40.30	41.68
Average	69.70	83.52	51.18	68.13
SEm± for spacing at the same level of planting parts.	6.33			
CD (*P*=0.05)	13.79			
SEm± for planting parts at the same or different levels of spacing.	6.69			
CD (*P*=0.05)	2.42			

From the above discussion, consequently, it may be concluded that menthol-mint was most responsive to whole shoot treatment and wider space (S_2-50×30 cm) for growth, essential oil and suckers yield in comparison with upper portion of shoot (top plant part) and lower portion of shoot (lower plant part) treatments along with closer (S_1-50×15 cm) and (S_3-50×running) spacing treatment under irrigated conditions of Pantnagar. Thus, it is concluded that combined application of whole shoot treatment and wider spacing (S_2-50×30 cm) may serve as a potent source for the eco-friendly, economically, and quality cultivation of menthol-mint in northern Indian plain zones.

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