The Pharma Innovation Journal 2021; 10(11): 233-236

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(11): 233-236

www.thepharmajournal.com
Received: 13-08-2021
Accepted: 26-09-2021

M Pavithra
M.Sc. Scholar, Department of Plantation, Spices, Medicinal and Aromatic Crops, KRC College of Horticulture, Arabhavi, Karnataka, India

D Srikantaprasad
Assistant Professor, Department of Plantation, Spices, Medicinal and Aromatic Crops, KRC College of Horticulture, Arabhavi, Karnataka, India

TN Pushpa
Assistant Professor, Department of Plantation, Spices, Medicinal and Aromatic Crops, KRC College of Horticulture, Arabhavi, Karnataka, India

JS Hiremath
Assistant Professor and Head, Department of Plantation, Spices, Medicinal and Aromatic Crops, KRC College of Horticulture, Arabhavi, Karnataka, India

S Jalawadi
Assistant Professor, AICRP on Fruits KRC College of Horticulture Arabhavi, Karnataka, India

ST Nandimath
Assistant Professor, Department of Agric. Economics, KRC College of Horticulture, Arabhavi, Karnataka, India

Corresponding Author:
M Pavithra
M.Sc. Scholar, Department of Plantation, Spices, Medicinal and Aromatic Crops, KRC College of Horticulture, Arabhavi, Karnataka, India

Effect of spacing, bio formulations and bio fertilizers on growth of menthol mint (*Mentha arvensis* L.)

M Pavithra, D Srikantaprasad, TN Pushpa, JS Hiremath, S Jalawadi and ST Nandimath

Abstract
The present study was carried out at Kittur Rani Channamma College of Horticulture, Arabhavi, Belagavi district, Karnataka during 2019-2020. The experiment was laid out as per Split plot design with two main factors and seven sub treatments replicated thrice. Among the spacing treatments, wider spacing (60 × 30 cm) recorded maximum plant height (34.40, 39.30, 47.35 and 62.73 cm at 45, 60, 90 DAP and at harvest, respectively), plant spread (43.99 and 67.21 cm at 90 DAP and at harvest, respectively) and number of branches (11.88 and 29.85 at 60 and 90 DAP, respectively). Among the bio formulations and bio fertilizers maximum plant height (36.10, 41.73, 50.27 and 66.80 cm), plant spread (35.98, 40.50, 47.67 and 73.12 cm) and number of branches (6.12, 14.70, 38.03 and 49.73) were recorded with RDF + AMF + PG + HA at 45, 60, 90 DAP and at harvest, respectively.

Keywords: Menthol mint, spacing, bio formulations, bio fertilizers, days after planting

Introduction
Mints are aromatic perennial herbs of Lamiaceae family having quadrangular stem and leaves with essential oil present in sub cuticular glands. They are the third most valuable flavouring agents after vanilla and citrus in the world. Four species of mints are reported to be cultivated commercially *i.e*., menthol mint (*Mentha arvensis* L), peppermint (*M. piperita*), bergamot mint (*M. citrata*) and spearmint (*M. spicata*), among which menthol mint is the only species cultivated in tropics or subtropical regions of India (George, 1994) [7]. On distillation, mint herb gives essential oil (0.5 to 0.8%) having menthol (75-80%), menthone (3.6–19.32%), iso-menthone (2.65–3.56%) and limonene (0.98-4.47%) (Brar *et al*., 2014) [4]. Menthol mint being a fast growing crop, spacing is an effective yield influencing factor which depends on growing conditions. The spacing not only impacts agronomic and economic parameters such as leaf and essential oil yield but also the qualitative character of many aromatic crops (Solomon and Beemnet, 2011) [15]. Considering the hazards of chemicals used in farming, it has become imperative to use all the available sources of plant nutrients in a judicious way and integrated nutrient management system comprising usage of chemical fertilizers along with bio-formulations and bio-fertilizers.

Material and Methods
The study was carried during *kharif*, 2019 at the Kittur Rani Channamma College of Horticulture, Arabhavi of University of Horticultural sciences, Bagalkot, Karnataka, India. Arabhavi is situated in Northern dry Zone of Karnataka state, receiving an annual average rain fall of 449.25 mm.

The current study on menthol mint cv. Kosi was conducted following split plot design with spacing as main plots and seven bio formulations and bio fertilizers as sub plot and replicated thrice. Uniformly thick underground stolons of Menthol mint measuring 7.0 to 10.0 cm length were planted in plots of 5.40 m × 3.60 m size as per the spacing treatment. Menthol mint received 75: 60: 40 kg ha^{-1} of N:P:K in the form of Urea, SSP and MOP as basal dose just before planting and 75 kg ha^{-1} of N at thirty days after planting as top dressing. Arbuscular Mycorrhizal Fungi (AMF) and *Glomus bagyarajii* (5 g/stolon) were added at the time of planting. Panchagavya was drenched at the rate of 3% at 15 days interval up to harvest of crop as per the treatment details and humic acid of 0.2% concentration (10 grams of potassium salt of humic acid containing approximately 60% humic acid, 10% fulvic acid and 10% potassium was diluted in five liters of water) is used for treating stolons before planting and

drenching at 15 days interval till harvest as per the treatment details. Stolons were treated with waste decomposer (WDC) solution before planting and at fifteen days interval till harvest as per the treatment details.

Observations on growth parameters were recorded on five randomly selected plants in each plot of different treatments at 45, 60, 90 Days After Planting (DAP) and at harvest.

Treatment details

Factor - A (Spacing)

S_1 – 45 x 30 cm

S_2 – 60 x 30 cm

Factor - B (Bio fertilizers and bio formulations)

B_1 - RDF (control)

B_2 - RDF + AMF

B_3 - RDF + AMF + HA

B_4 - RDF + AMF + PG

B_5 - RDF + AMF +PG + HA

B_6 - RDF + WDC

B_7 - RDF +AMF + WDC

RDF = Recommended dose of fertilizer; HA = Humic acid; PG = Panchagavya; AMF= Arbuscular Mycorrhiza Fungi; WDC= Waste decomposer.

Result and Discussion

Effect of spacing on menthol mint

The plant development at all spacing levels has significantly influenced plant height. Plants with a wider spacing of 60 × 30 cm (S_2) recorded maximum height (34.40, 39.30, 47.35 and 62.78 cm, respectively) as compared to the narrow spacing of 45 × 30 cm (32.92, 35.17, 45.23 and 58.38 cm, respectively). The increased plant height in 60 x 30 cm of wider row spacing may be due to lesser competition for nutrients, light and water *etc*. between plants at lower plant densities. The results are in accordance with the findings of Kothari and Singh (1996), Saini *et al.* (2001) [12], Nithin *et al.* (2018) [8] and Mahantesh (2018) in *Mentha arvensis* L., Chinnabbai (1991) [6] in *Mentha viridis* and Ramachandra *et al.* (2002) [10] in patchouli.

Spacing had significant influence on plant spread at later stages of plant growth, but not at 45 and 60 DAP. Higher plant spread (43.99 and 67.21 cm, respectively) was noticed in wider spacing (60 × 45 cm) and the lower (42.77 and 62.63 cm, respectively) was recorded in closer spacing (45 × 30 cm). The higher plant spread in 60 × 45 cm spacing could be attributed to the maximum availability of area, lesser competition for nutrients, light and water and more number of branches gives rise to more plant growth. The results are in accordance with the findings of Nithin *et al.* (2018) [8] in *Mentha arvensis and* Ramachandra *et al.* (2002) [10] in patchouli

Number of branches were significantly influenced by spacing at 60 and 90 DAP. Higher number of branches were registered with wider spacing of 60 × 30 cm (11.88 and 29.85, respectively) while lower in closer spacing 45 ×30 cm (11.40 and 27.89, respectively). The increase in number of branches at wider row spacing might be attributed to the availability of more spatial area between rows which helps more light interception due to maximum surface area, lesser competition for nutrients, light and water. Auxins are produced at growing tip and diffuse downwards which inhibit the development of lateral buds. These are broken down by sun light, and it occurs in wider spaced plants and allows the lower dormant lateral buds to develop, and buds between the leaf stalk and stem produce new shoots which results in development of more number of branches. The results were in line with the findings of Salim *et al.* (2014) [13], Nithin *et al.* (2018) [8] and Mahantesh (2018) in *Mentha arvensis*, Chinnabbai (1991) [6] in *Mentha viridis*, Balyan *et al.* (1990) [2] in *Ocimum americanum* and Ramachandra *et al.* (2002) [10] in patchouli.

Effect of bio formulations and bio fertilizers on menthol mint

Bio formulations and bio fertilizers had significant influence on growth parameters at all stages of development.

Combined application of Recommended Dose of Fertilizers (RDF), bio formulations and bio fertilizers has increased height of the plant, plant spread and number of branches at all the stages of plant growth in menthol mint. Higher plant heights (36.10, 41.73, 50.27 and 66.80 cm, respectively), plant spread (35.98, 40.50, 47.67 and 73.12 cm, respectively), and number of branches (6.12, 14.70, 38.03 and 49.73/plant, respectively) were recorded in the treatment B_5 application of RDF, AM fungus, along with drenching of panchagavya (PG) and humic acid (HA). While the lower plant height (30.10, 33.22, 42.60 and 55.33 cm, respectively), plant spread (29.00, 32.97, 39.53 and 59.32 cm, respectively) and numbers of branches (2.88, 9.13, 21.08 and 26.20, respectively) were recorded with the control treatment (B_1) *i.e.*, application of recommended dose of fertilizers at harvest. This might be due to conductive atmosphere is created in the soil by AM fungi which enhances the availability and absorption rate of nutrients, plant growth hormones, nitrogen fixation, phosphorous availability (improves P supply) by increasing uptake of relatively immobile phosphate ions, due to the ability of the fungal Extra-Radical Mycelium (ERM) to grow beyond the phosphate depletion zone that quickly develops around the root, improved contact with soil particles through the binding effect of hyphae, enabling water and nutrients to be extracted from smaller pores decomposition of organic matter and production of organic acids, synthesis of vitamins, amino acids, auxins and gibberellins also supply micronutrients which help in breaking apical dominance and also division of cells which accelerate growth of plants. Panchagavya possess almost all the major nutrients, micro nutrients and growth hormones (IAA & GA), amino acids, vitamins, required for crop growth and microbial fauna (*Pseudomonas*, *Azetobacter and Phosphobacteria*) and acts as tonic to enrich soil, induce plant vigour with quality production. It also improves the water holding capacity of soils because it acts as organic manure (Chandra *et al*., 2019) [5]. Humic acid increases fertilizer efficiency as it mediates and improves major plant nutrient uptake (nitrogen, phosphorous and potassium). It enhances the presence of beneficial microorganisms in the soil, able to complex various cat ions (pseudo-chelation) and serve as a sink for polyvalent cations in the soil increase the organic matter content, tilth and water retention of the soil, therefore improving the nutrients exchange capacity, increasing soil water retention, which enhances rapid cell division, proliferation and rapid growth of the plants. Organic acids increase the availability of P in soils mainly through both decreased adsorption of P and increased solubilization of P compounds (Bolan, 1994) [3]. The results are in accordance with the findings of Prabhu and Arumugam, (2013) [9] and Aswani (2020) [1] in menthol mint, Sadaghiani *et al*. (2011) [11] and Shirzadi *et al.* (2015) [14] in basil.

The effect of interaction between spacing, bio formulations and bio fertilizers did not influence on the plant height, plant spread and number of branches significantly.

Conclusion

The experiment can be concluded as planting of menthol mint at 60 × 30 cm spacing combined with application of recommended dosage of fertilizers + AMF + panchagavya + humic acid s good for its growth. Combined application of bioformulations and biofertilizers can become an eco-friendly technology to increase the profit and encourage organic mint farmers.

Table 1: Effect of spacing, bio formulations and bio fertilizers on plant height (cm) of menthol mint (*Mentha arvensis* L.)

Treatments	45 DAP			60 DAP			90 DAP			At harvest		
Bio formulations and Bio fertilizers	Spacing											
	45*30	60*30	Mean (S)	45*30	60*30	Mean	45*30	60*30	Mean (S)	45*30	60*30	Mean
B_1	27.87	32.33	30.10	29.97	36.47	33.22	41.67	43.53	42.60	54.10	56.57	55.33
B_2	33.20	33.87	33.53	33.23	38.27	35.75	44.27	45.53	44.90	55.77	61.00	58.38
B_3	34.27	36.07	35.17	39.47	41.40	40.43	47.80	50.60	49.20	62.87	67.60	65.23
B_4	34.60	35.33	34.97	37.07	40.87	38.97	47.00	49.53	48.27	59.93	64.20	62.07
B_5	35.27	36.93	36.10	40.40	43.07	41.73	48.93	51.60	50.27	64.27	69.33	66.80
B_6	31.60	32.53	32.07	30.90	36.57	33.73	42.87	44.20	43.53	54.87	58.00	56.43
B_7	33.67	33.73	33.70	35.17	38.43	36.80	44.07	46.47	45.27	56.87	62.40	59.63
Mean (B)	32.92	34.40	37.16	35.17	39.30	37.23	45.23	47.35	46.29	58.38	62.73	60.55
	S.Em ±		CD @ 5%	S.Em ±		CD @ 5%	S.Em ±		CD @ 5%	S.Em ±		CD @ 5%
Spacing	0.17		1.12	0.24		1.58	0.34		2.26	0.34		2.24
Bio	0.90		2.65	0.70		2.07	0.32		0.96	0.45		1.34
SXB at same S	0.45		NS	0.63		NS	0.91		NS	0.90		NS
SXB at same or different S	1.19		NS	0.95		NS	0.77		NS	0.69		NS

Note:
Sub plot treatments (B): **B_1** – RDF (control) **B_2** – RDF + AMF **B_3** – RDF + AMF + HA **B_4** – RDF + AMF +PG **B_5** – RDF + AMF +PG + HA **B_6** – RDF + WDC **B_7** – RDF +AMF + WDC.
RDF: Recommended Dose of Fertilizer AMF: Arbuscular Mycorrhiza Fungi WDC: Waste Decomposer HA: Humic acid PG: Panchagavya
DAP: Days after planting.

Table 2: Influence of spacing, bio formulations and bio fertilizers on plant spread (cm) of menthol mint (*Mentha arvensis* L.)

Treatments	45 DAP			60 DAP			90 DAP			At harvest		
Bio formulations and bio fertilizers	Spacing											
	45*30	60*30	Mean (S)	45*30	60*30	Mean	45*30	60*30	Mean (S)	45*30	60*30	Mean
B_1	28.07	29.93	29.00	32.87	33.07	32.97	38.13	40.93	39.53	56.77	61.87	59.32
B_2	31.50	31.07	31.28	34.50	34.33	34.42	43.03	43.20	43.12	57.87	62.70	60.28
B_3	34.70	34.13	34.42	38.17	39.20	38.68	46.57	46.87	46.72	67.13	72.57	69.85
B_4	34.00	33.47	33.73	37.73	37.83	37.78	45.47	44.27	44.87	66.97	71.17	69.07
B_5	35.03	36.93	35.98	39.50	41.50	40.50	46.73	48.60	47.67	71.07	75.17	73.12
B_6	29.43	30.67	30.05	33.83	33.27	33.55	40.57	42.20	40.38	57.40	62.63	60.02
B_7	32.13	32.27	32.20	34.73	34.57	34.65	38.87	41.83	41.35	61.23	64.40	62.82
Mean (B)	32.12	32.64	32.38	35.90	36.25	36.08	42.77	43.99	43.38	62.63	67.21	64.92
	S.Em ±		CD @ 5%	S.Em ±		CD @ 5%	S.Em ±		CD @ 5%	S.Em ±		CD @ 5%
Spacing	0.31		NS	0.36		NS	0.13		0.90	0.49		3.21
Bio	0.56		1.66	0.71		2.08	0.79		1.12	0.97		2.87
SXB at same S	0.82		NS	0.95		NS	0.36		NS	1.29		NS
SXB at same or different S	1.13		NS	0.99		NS	1.04		NS	1.37		NS

Note:
Sub plot treatments (B): **B_1** – RDF (control) **B_2** – RDF + AMF **B_3** – RDF + AMF + HA **B_4** – RDF + AMF +PG **B_5** – RDF + AMF +PG + HA **B_6** – RDF + WDC **B_7** – RDF +AMF + WDC.
RDF: Recommended Dose of Fertilizer AMF: Arbuscular Mycorrhiza Fungi WDC: Waste Decomposer HA: Humic Acid PG: Panchagavya
DAP: Days after planting.

Table 3: Number of branches of menthol mint (*Mentha arvensis* L.) as influenced by spacing bio formulations and bio fertilizers

Treatments	45 DAP			60 DAP			90 DAP			At harvest		
Bio formulations and Bio fertilizers	Spacing											
	45*30	60*30	Mean (S)	45*30	60*30	Mean	45*30	60*30	Mean (S)	45*30	60*30	Mean
B_1	2.60	3.17	2.88	8.77	9.50	9.13	20.73	21.43	21.08	24.43	27.97	26.20
B_2	3.37	3.60	3.48	9.60	10.33	9.97	22.63	25.10	23.87	32.10	36.33	34.22
B_3	4.63	5.97	5.30	13.97	14.27	14.12	34.07	36.43	35.25	44.27	46.13	45.20
B_4	4.23	4.93	4.58	13.60	13.60	13.60	32.83	34.77	33.80	38.87	42.80	40.83
B_5	5.43	6.80	6.12	14.33	15.07	14.70	36.93	39.13	38.03	48.83	50.63	49.73
B_6	3.07	3.33	3.20	9.47	10.03	9.75	21.87	23.23	22.55	29.87	33.20	31.53
B_7	3.60	3.87	3.73	10.10	10.33	10.22	26.13	28.83	27.48	35.67	37.90	36.78
Mean (B)	3.85	4.52	4.19	11.40	11.88	11.64	27.89	29.85	28.87	36.29	39.28	37.79
	S.Em ±		CD @ 5%	S.Em ±		CD @ 5%	S.Em ±		CD @ 5%	S.Em ±		CD @ 5%
Spacing	0.13		NS	0.05		0.33	0.30		1.99	0.37		NS

Bio	0.19	0.55	0.22	0.65	0.64	1.88	0.41	1.21
SXB at same S	0.36	NS	0.13	NS	10.80	NS	0.99	NS
SXB at same or different S	0.28	NS	0.29	NS	0.89	NS	0.65	NS

Note:

Sub plot treatments (B): **B_1** – RDF (control) **B_2** – RDF + AMF **B_3** – RDF + AMF + HA **B_4** – RDF + AMF +PG **B_5** – RDF + AMF +PG + HA **B_6** – RDF + WDC **B_7** – RDF +AMF + WDC.

RDF: Recommended Dose of Fertilizer AMF: Arbuscular Mycorrhiza Fungi WDC: Waste Decomposer HA: Humic Acid PG: Panchagavya

Reference

1. Aswani JS, Pushpa TN, Srikantprasad D, Chaya PP, Biradar IB, Gangaraddi V. Influence of biofertilizers and bioformulations on biomass and essential oil yield of menthol mint (*Mentha arvensis* L.). Med. Plants 2020;12(1):139-143.
2. Balyan SS, Sobti SN. Effect of inter and intra row spacing on growth, yield and eugenol content in *Ocimum gratissimum* L. (*Clocimum*). Indian Perfumer 1990;34:217-224.
3. Bolan NS. Influence of low molecular weight organic acids on the solubilization of P. Biology and Fertility of Soils 1994;18:311-319.
4. Brar SK, Gill BS, Brar AS, Kaur T. planting date and straw mulch affected biomass yield, oil yield and oil quality of Japanese mint (*Mentha arvensis* L.) harvested at successive interval. J. Essent. Oil-Bear. Plants 2014;17(4):676-695.
5. Chandra MS, Naresh RK, Lavanya N, Varsha N, Chand SW, Chandana P *et al*. Production and potential of ancient liquid organics panchagavya and kunapajala to improve soil health and crop productivity: A review, J. Pharmacogn. Phytochem 2019;8(6):702-713.
6. Chinnabbai J. Effect of row spacing and nitrogen level on growth and herbage yield of mint (*Mentha viridis* L.). M.Sc. Thesis, Univ. Agri. Sci. Hyderabad 1991,
7. George CK. Export of mint oils from India and world trade. Indian Perfumer 1994;38(3):76-81.
8. Nithin MG, Farooq Md, Pushpa TN, Srikantaprasad D, Biradar IB. Influence of planting method and geometry on growth and yield of menthol mint (*Mentha arvensis* L.). Int. J. Curr. Microbiol. App. Sci 2018;7(9):1277-1283.
9. Prabu M, Arumugam S. Organic nutrition in growth and yield of japanese mint (*Mentha arvensis* L.). The Asian J. Hort 2013;8(1):126-128.
10. Ramachandra KM, Vasundhara M, Farooqi AA, Srinivasappa KN. Evaluation of patchouli (*Pogostemon cablin* Benth.) varieties in relation to different plant densities. Indian Perfumer 2002;46:7-14.
11. Sadaghiani MR, Hassani A, Barin M, Danesh YR, Sefidkon F. Effects of Arbuscular Mycorrhizal fungi on growth, essential oil production and nutrients uptake in basil. J. Med. Plants Res 2011;4(21):2222-2228.
12. Saini SS, Jagmohan K, Gill BS. Effect of planting methods and row spacing on the growth and yield of japanese mint (*Mentha arvensis* L.). Indian perfumer 2001;46(4):361-364.
13. Salim EA, El Hassan GM, Khalid HES. Effect of spacing and seasonal variation on growth parameters, yield and oil content of mint plants, J Forest products and industries 2014;3(2):71-74.
14. Shirzadi F, Ardakani MR, Asadirahmani H, Asgari A. Effects of mycorrhiza (*Glomus intraradices*), azotobacter (*Azotobacter chrocooccum*) and vermicompost on yield and essential oil of basil (*Ocimum Basilicum* L.) in organic agriculture. Int. J Biosci 2015;6(7):1-6.
15. Solomon AM, Beemnet MK. Row spacing and harvesting age affect agronomic characteristics and essential oil yield of japanese mint (*Mentha arvensis* L.). Med. Aromat. Plant Sci. Biot 2011;5(1):74-76.