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Influence of Row Spacing and Nitrogen Levels on Growth Rate and Nitrogen Uptake in Japanese Mint (*Mentha arvensis* L.)

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ABSTRACT

Keywords

Growth, Yield, Nitrogen levels, Spacing, Days after planting. Nitrogen uptake

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A field study was conducted during 2015-16 to investigate the effect of row spacing (30 cm, 45 cm and 60 cm) and nitrogen levels (50, 100, 150 and 200 kg/ha) on growth of Japanese mint (*Mentha arvensis* L.). The result revealed that between 45- 90 days after planting, the highest absolute growth rate (1.13 g/plant/day) was recorded at 60 cm row spacing. While, the crop growth rate (6.87 g/m^2/day) was highest at 30 cm row spacing. Highest nitrogen content in plant (2.05 %) was recorded at wider row spacing of 60 cm. While, the nitrogen uptake was highest (90.51 kg/ha) at closer row spacing of 30 cm. Between 45- 90 after planting, the highest absolute growth rate (1.14 g/plant/day), crop growth rate (6.04 g/m^2/day), nitrogen content in plant (2.40 %) and nitrogen uptake (115.16 kg/ha) were maximum with the application of 150 kg N per ha.

Introduction

Japanese mint is a perennial herb growing about 60-80 cm in height and under favourable conditions may attain a height upto 100 cm. Leaves are 2.5 – 5cm long, oblong-ovate. Flowers are in auxiliary whorls. Flowers appearing in May-June and again in September-November under cultivation. The cultivation of Japanese or corn mint originated from Brazil and China. Subsequently, China and India overtook Brazil and more recently India has taken the leading position in cultivation of this essential oil yielding plant.

The recovery of oil from the herb is 0.5-0.8 per cent. Oil is obtained through steam distillation. The oil is of golden yellow colour, containing not less than 75 percent menthol. Japanese Mint has a history of traditional and herbal medicine use, similar to most other mints. It is antiseptic, used as a digestive aid, for treating fevers, headaches and minor ailments. The mint oil is used for the production of natural menthol, dementhalised oil is for flavouring mouth washes, tooth paste and pharmaceutical preparations. In medicine, it is used against stomach disorders, rheumatism, in ointments for headaches, in cough drops, inhalations etc. The oil has a bitter cooling taste, harsh odour and is the principal source of menthol. It is used in combating cold, used as an ingredient in cough drops and related pharmaceuticals, dentifrices, cosmetics, mouth washes, scenting of tobacco products. The essential oil in *Mentha arvensis* is said to be approximately the equivalent of that produced from Peppermint. The essential oil is produced commercially and sometimes substituted for the more expensive peppermint oil. The resulting oil is often called 'Japanese Herbal Oil'.

Materials and Methods

A field experiment was conducted to study the effect of row spacing and nitrogen levels on growth of Japanese mint (*Mentha arvensis* L.) at the Department of Plantation, Spices, Medicinal and Aromatic Crops, Kittur Rani Channamma College of Horticulture, Arabhavi, University of Horticultural Sciences, Bagalkot during 2015-16. The experiment was laid out in split plot design with twelve treatments and three replications, considering spacing as main plot and nitrogen levels as sub plot. The experimental site was having sandy clay loam (vertisols) soil with neutral pH. Soil samples were collected from a depth of 0-15 cm from the experimental site adopting the standard procedure and the composite samples were used for analysis of physico-chemical properties. Stolons were planted horizontally in furrows about 2.5- 4.0 cm deep according to spacing treatments. The crop was harvested 100 days after planting. Harvesting was done with sharp sickles.

Phosphorous and potassium fertilizers at the rate of 50 and 40 kg per ha in the form of single super phosphate and muriate of potash respectively were uniformly applied to all the plots as basal dose. The fertilizer mixture was applied by broadcasting uniformly in rows to individual plots and mixed thoroughly in to the soil.

The experimental plots were provided with the calculated quantity of fertilizers as per the treatments. Out of total quantity, half dose of nitrogen and full dose of phosphorous and potash were supplied as basal dose at the time of planting. The remaining half quantity of nitrogen was given as top dressing at 30 days after planting.

Absolute growth rate (AGR) (g/plant/day)

It expresses the increasing dry weight per plant in unit time and was calculated by using the following formula (Radford, 1967) and expressed as g/plant/day.

$$\text{AGR} = \frac{(W_2 - W_1)}{(t_2 - t_1)}$$

Where,

W_1= Total dry weight of the plant (g) at time t_1

W_2= Total dry weight of the plant (g) at time t_2

$t_2 - t_1$= Time interval in days.

Crop growth rate (CGR) (g/m^2/day)

It is the rate of dry matter production per unit ground area per unit time. It was calculated by using the formula given by Watson (1952) and expressed as (g/m^2/day).

$$CGR = \frac{(W_2 - W_1)}{(t_2 - t_1)} X \frac{1}{A}$$

W_1= Dry weight of the plant at time t_1
W_2= Dry weight of the plant at time t_2
A = Land area

Plant analysis

Dried whole plant samples of leaves, stem and roots were ground to a fine powder separately and the content of nitrogen in the plant tissue was analyzed by using suitable methods of analysis.

The total nitrogen (%) was determined by Kjeldhal method as outlined by Piper (1966). Plant sample of 1 g each was digested with digestion mixture ($CuSO_4$, K_2SO_4 and Se in 10:4:1 ratio) in a digestion chamber along with 25 ml of concentrated sulphuric acid. The digested mixture was then distilled and the ammonia released was trapped in four per cent boric acid with mixed indicator. This was titrated against standard sulphuric acid.

Soil analysis

The nitrogen uptake was determined by using Micro – Kjeldhal digestion and distillation as outlined by Piper (1966) and expressed in Kg per hectare.

Results and Discussion

The row spacing levels had significant effect on absolute growth rate. Between 45 - 90 DAP, the maximum (1.13 g/plant/day) AGR was observed in row spacing of 60 cm (S_3). While the minimum (0.93 g/plant/day) AGR was noticed at 30 cm row spacing (S_1). This might be due to higher dry matter accumulation per unit area. Closer row spacing of 30 cm (S_1) had significant effect on CGR and recorded more (6.87 g/m^2/day) CGR between 45 – 90 DAP. Increased CGR at closer row spacing might be due to increase in plant population per unit area which led to higher dry matter accumulation. Similar findings were also obtained by Chinnabbai (1991) in *Mentha viridis*.

Between 45 - 90 DAP, the highest (1.14 g/plant/Day) AGR was recorded at nitrogen level of N_3 (150 kg/ha), While the minimum (0.88 g/ plant/Day) AGR was observed in N_1 (50 kg/ha). This might be due to better vegetative growth in terms of highest plant height, number of leaves, branches and total dry matter accumulation in the plants supplied with higher levels of nitrogen. The maximum (6.04 g/m^2/day) CGR was recorded with the application of N_3 (150 Kg/ha). This might be due to reduced plant height, fewer number of branches and leaves, smaller leaf area at lower dose of nitrogen. Higher dose of nitrogen helps in dry matter accumulation in plants. Similar trend was observed by Rai *et al.*, (1977) in Japanese mint and Santhosh *et al.*, (2010) in garden cress.

Significant difference was observed for nitrogen content in plants due to row spacing. Nitrogen content was highest (2.05 %) in wider row spacing of 60 cm (S_3). This might be due to the fact that in wider spacing there was possibility for the better shoot growth due to light penetration which in turn increases root growth and helps in better uptake of nitrogen from the soil. Plants grown at 30 cm row spacing recorded maximum nitrogen uptake (90.51 kg/ha) and minimum (76.08 kg/ha) was noticed at 60 cm (S_3). This supports the fact that more the plant population more will be the nitrogen uptake per unit area. Similar results were reported by, Rao *et al.*, (1990) in palmrosa and Bali *et al.*, (1992) in dill.

Table.1 Effect of row spacing and nitrogen levels on Absolute growth rate and crop growth rate in Japanese mint (*Mentha arvensis* L.)

Treatments	AGR (g/ plant/Day)					CGR (g/m^2/day)*10^2				
	45 – 90 DAP					45 – 90 DAP				
	N_1	N_2	N_3	N_4	Mean	N_1	N_2	N_3	N_4	Mean
S_1	0.76	0.89	1.09	0.98	**0.93**	5.60	6.58	8.07	7.24	**6.87**
S_2	0.89	1.04	1.13	1.07	**1.03**	4.39	5.12	5.56	5.27	**5.08**
S_3	1.01	1.15	1.21	1.17	**1.13**	3.76	4.25	4.50	4.33	**4.21**
Mean	**0.88**	**1.02**	**1.14**	**1.07**		**4.58**	**5.31**	**6.04**	**5.61**	

For comparison of mean				
	S.Em ±	CD @ 5 %	S.Em ±	CD @ 5 %
Row spacing(S)	0.031	0.121	0.146	0.575
Nitrogen (N)	0.029	0.086	0.150	0.447
S at same level of N	0.053	NS	0.268	NS
N at same or different level of S	0.050	NS	0.260	NS

AGR: Absolute growth rate CGR: Crop growth rate DAP: Days after planting

Main plot treatments (S)

S_1: 30 cm
S_2: 45 cm
S_3: 60 cm

Sub plot treatments (N)

N_1: 50 kg/ha
N_2: 100 kg/ha
N_3: 150 kg/ha
N_4: 200 kg/ha

Table.2 Effect of row spacing and nitrogen levels on nitrogen content in plant and nitrogen uptake in Japanese mint (*Mentha arvensis* L.)

Treatments	Nitrogen content (%)					Nitrogen uptake (Kg/ha)				
	N_1	**N_2**	**N_3**	**N_4**	**Mean**	**N_1**	**N_2**	**N_3**	**N_4**	**Mean**
S_1	1.15	1.54	2.15	2.03	**1.71**	47.85	76.21	127.41	110.59	**90.51**
S_2	1.38	1.72	2.45	2.12	**1.91**	47.14	70.01	112.77	91.92	**80.46**
S_3	1.50	1.83	2.62	2.26	**2.05**	47.70	66.08	105.31	85.25	**76.08**
Mean	**1.34**	**1.69**	**2.40**	**2.13**		**47.56**	**70.76**	**115.16**	**95.92**	

For comparison of mean

	S.Em ±	CD @ 5 %	S.Em ±	CD @ 5 %
Row spacing(S)	0.057	0.225	2.253	8.848
Nitrogen (N)	0.072	0.213	2.933	8.714
S at same level of N	0.122	NS	4.942	NS
N at same or different level of S	0.124	NS	5.079	NS

Main plot treatments (S)

S_1: 30 cm
S_2: 45 cm
S_3: 60 cm

Sub plot treatments (N)

N_1: 50 kg/ha
N_2: 100 kg/ha
N_3: 150 kg/ha
N_4: 200 kg/ha

Significant difference in nitrogen content in plants was due to the nitrogen. Application of 150 kg NPK per ha (N_3) recorded highest nitrogen content (2.40 %) in plant and the lowest nitrogen content of 1.34 per cent was observed in N_1 (50 kg NPK/ha). This might be due to the higher available nitrogen in the soil due to application of nitrogenous fertilizers to the soil and their preferential absorption. Similar results were noticed by, Saxena and Singh (1996) in Japanese mint. The highest nitrogen uptake to the tune of 115.16 kg per ha was recorded due to application of 150 kg N per ha (N_3) and the lowest nitrogen uptake (47.56 kg/ha) was observed in plants supplied with 50 kg N per ha (N_1). The availability of increased level of nitrogen in the soil increased the uptake of nitrogen through the increased growth and dry matter production by the crop. Similar kind of results was recorded earlier by Balyan and Sobti (1990) in *Ocimum gratissium* and Prakasa rao *et al.*, (2007) in French basil.

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