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Influence of Nitrogen - Phosphorus Fertilization and Time of Harvest on the Growth, Yield and Oil Content of *Mentha spicata* L.

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Abstrat

Field experiment was conducted to evaluate the influence of application of nitrogen-phosphorus fertilizer and harvesting time on growth, yield, oil content and physio-chemical properties of *M. spicata* L. oil. Eight treatment consists of different N-P fertilizer dose and four harvesting period were used for the study. Maximum plant height was found at N_2P_2 treatment. N_2P_3 fertilizer treatment produced highest herb yield. The oil content of *M. spicata* L. was maximum at 130 day harvesting period. The oil refractive index was also enhanced with increasing harvesting time. In case of interaction effect between different level of nitrogen-phosphorus and harvesting time showed highest oil concentration at N_2P_2 treatment within 130 days harvesting time. Where as the optical rotation, acid value and density of oil was remain more or less same during the whole experiment period.

Key words : *Mentha spicata*, Nitrogen-phosphorus, Fertilizer, Harvest time, Optical rotation, Acid value and Oil content.

Introduction

Mentha is a small genus of aromatic herb belongs to Labiateae family. *M. spicata* L. is one of the most important species of the genus mentha. It is popularly known as spearmint. The essential oil obtained from fresh shoot of *M. spicata* L. is rich in menthol, carvon, linalool and linanyl acetate, carvon being the most important constituent among all for industrial application (Sing hand Misra 2000). It is commercially exploited in perfumery, food, cosmetic flavors and pharmaceutical industries (Chattpadhyay *et al* 2002). The herb yields an essential oil biosynthesis in *M. spicata* L. is strongly influenced by several intrinsic and extrinsic factor including fertilizer, planting time, harvesting time and other agro-climatic factor (Singh and Misra 2000), (Singh *et al* 1995). To meet the increasing demand of *M. spicata* L. oil it urgently needs to increase its productivity. *M. spicata* L. has proved out to be of great commercial importance and consequently has attracted the attention of the researcher. It responds well to nitrogen (Tha and Singh 1979). Dan and Randhawa (2002) observed the application of nitrogen in conjugation of with phospho-

rus resulted in increasing herbage yield and oil yield (Dan and Randhawa 2002). Types of harvesting time has great influenced on mentha yield and oil content of *M. spicata* L. Singh *et al* reported the importance of harvesting time of *M. spicata* L. on its herbage yield and oil content (Singh *et al* 1991). The information regarding the effect of harvesting time and nitrogen-phosphorus nutrition of *M. spicata* L. is mearge in our local climatic condition. The present investigation, therefore was undertaken to ascertain the contribution of nitrogen-phosphorus fertilization and time of harvesting on the growth, yield and essential oil content and also physio-chemical characteristics of *M. spicata* L. oil.

Materials and Methods

The investigation was made in the field of BCSIR, Dhaka, during the period from March to November 2004. The eight nitrogen - phosphorus fertilizers were considered under study. The source of nitrogen - phosphorus were urea and triple super phosphate. The unit plot size was 2.1m x 2.1m. The row to row and plant to plant distance was 30 x 30 cm. The experiment was set in a randomized block design with three replications.

The soil properties of the experimental field are as below. Intercultural operation were done as per necessity. Data on plant height and number of branches per plant were recorded from 10 randomly selected plants in each plot and that on yield was recorded from the whole plot. For harvesting time 110 days - T_1, 120 days -T_2, 130 days -T_3, 140 days - T_4 were used for the study. The nitrogen - phosphorus fertilizer doses under study were 60 kg N/ha (N_1), 80 kg N/ha (N_2), 100 kg N/ha (N_3) and 40 kg P_2O_5/ha (P_1), 60 kg P_2O_5/ha (P_2) and 80 kg P_2O_5/ha (P_3).The essential oil from the herb was extracted by the method of steam distillation. The freshly harvested herb from each plot was subjected to steam distillation for about three hours and the oil separated out form the distillate was dehydrated over anhydrous sodium sulphate where by a pale yellow volatile oil was obtained in pure form and each treatment was determined according to standard methods (Official Methods of Analysis of AOAC 1984). The collected data were statistically analyzed and the mean values were adjudged by Duncans New Multiple Range Test (Steel and Torrie1960).

Physio-chemical properties of the soil in the experiment field

Texture	pH	Organic matter	Total nitrogen	Available µg/g soil							
Sandy clay loam	7.2	1.52%	0.04%	N	P	Na	Ca	Mg	Cu	Zn	K
				79.3	0.45	20.3	135.2	242.9	4.08	7.5	21.3

Results and Discussion

Fertilizer effect

The plant height is an important character which influence the herbage yield of *M. spicata* L. Plant height was maximum with N_2P_2 (Table I). The next value obtained from the plot received fertilizer at the rate of 80 kg N_2 + 40 kg P_2O_5 (N_2P_1). It is closely followed by N_2P_3 treatment. Minimum plant height per plant was obtained from control plants. Fertilizer applied at the rate of 80 kg N+60 kg P_2O_5 (N_2P_2) produced highest number of branches per plant. The next number of branch obtained from N_2P_3 treatment. The leaf length and leaf breath were highest at N_2P_2 and N_2P_3 treatment respectively. The value of leaf length and leaf breath were ranged from 3.6 to 4.3cm and 2.4 to 3.3cm respectively. The maximum herb yield was produced from the plot receiving fertilizer at the rate 80 kg N/ha + 60 kg P_2O_5/ha. This results were in close agreement with the Dan and Randhawa. The percentage of oil content *M. spicata* L. oil as affected by nitrogen phosphorus fertilizer treatment varied from 0.55 % to 0.73 %. The highest percentage of oil obtained from N_2P_2 treatment. It is closely followed by N_2P_3 treatment. Additional doses of nitrogen phosphorus fertilizer showed decline response of mentha oil content. The moisture content of mentha oil

Table I. Effect of different level of nitrogen - phosphorus fertilization on the growth, herbage yield, oil content and physio - chemical characteristics of *M. spicata* L. oil

Fertilizer treatment	Plant height (cm) per plant	No. of branch per plant	Leaf length (cm)	Leaf breath (cm)	Total fresh herb (t/ha)	Oil (%)	Mois - ture (%)	Acid value	Refrac- tive index at 22°c	Density at 22° c	Optical rota- tion
N_0P_0	53.1c*	13.1c	3.6b	2.4b	11.39c	0.55c	73.70a	2.75a	1.4732a	0.9213a	-14.3a
N_1P_1	57.1b	16.1b	3.9a	2.6b	13.01b	0.61c	73.76a	2.76a	1.4736a	0.9203a	-14.3a
N_1P_2	57.5b	18.2b	4.1a	2.9ab	13.21b	0.61b	69.10b	2.76a	1.4830a	0.9206a	-14.4a
N_1P_3	58.5b	18.2a	4.0a	2.9ab	13.20a	0.61b	69.12b	2.75a	1.4731a	0.9204a	-14.1a
$N2P_1$	61.9a	18.3a	4.2a	3.0a	15.30a	0.63b	73.71a	2.76a	1.4730a	0.9214a	-14.2a
N_2P_2	62.6a	19.8a	4.3a	3.1a	15.39a	0.73a	73.72a	2.78a	1.4828a	0.9212a	-14.3a
N_2P_3	61.8a	19.6a	4.2a	3.3a	15.41a	0.72a	69.01a	2.78a	1.4811a	0.9212a	-14.5a
N_3P_1	57.2b	16.2b	4.21a	3.2a	14.93ab	0.71a	73.04a	2.78a	1.4712a	0.9211a	-14.5a
N_3P_2	58.1b	16.1b	4.01a	3.0a	13.15ab	0.61b	69.20b	2.76a	1.4720a	0.9212a	-14.3a
N_3P_3	58.1b	16.0b	4.1a	3.1a	13.17b	0.60b	69.21b	2.70a	1.4711a	0.9211a	-14.4a

* Means with the same letter are not different from one another at the 5% level of significance.

ranged from 69.01 to 73.76. N_1P_1 treatment produced highest value (73.76) of moisture content. The refractive index value ranged from 1.4711 to 1.4830. The highest refractive index obtained from N_1P_2 treatment. It is closely followed by N_2P_2 treatment. The optical rotation and density of oil obtained from each treatment did not show any significant change with different fertilizer treatment. Shahidullah *et al* (1997) reported similar result regarding optical rotation and density of oil of *M. spicata* L.

Effect of harvest time :

The results on the effect of harvest time on growth, yield component, herb yield and oil content of *M. spicata* L. have been presented in Table II. Results indicate that plant height increased progressively with increase in age of plants and the maximum plant height (64.1cm) attended at the age of 140 days of the herbs. It was significantly higher from the rest of the harvesting time. The next higher value came from 130 days. The number of branches per plant did not differ significantly due to change of stage of harvesting. The highest leaf length was 4.2cm and leaf breath was 3.2cm at 130 day harvest. The earlier harvest showed lower values of leaf length and breath. Herbage yield increased progressively with the increase in age of plant up to 130 days. The highest yield was noticed in 130 days. The results are in agreement with those of Raj *et al* (2003). The oil content of *M. spicata* L. increased progressively with increaseing of the harvest time up to 130 days after which the value declined. This next value obtained from 120 days harvest time. Raj *et al* (2003) found higher oil content in mentha at 130 days of harvesting. The youngest herbs gave the lower value of oil content. The moisture is maximum at 120 days of harvest. It was closely followed by 130 days of harvest. The

Table II. Effect of harvesting time on the growth, herbage yield, oil content and physio - chemical characteristics of *M. spicata* L. oil.

Harvesting time (days)	Plant height (cm) per plant	No. of branch per plant	Leaf length (cm)	Leaf breath (cm)	Total fresh herb (t/ha)	Oil (%)	Moisture (%)	Acid value	Refractive index at 22°c	Density at 22° c	Optical rotation
110	60.2c*	18.3a	4.0a	2.9a	14.01b	0.63a	73.60a	2.75a	1.4670a	0.9201a	-14.2a
120	62.0b	18.6a	4.0a	3.0a	14.30ab	0.63a	73.75a	2.76a	1.4690a	0.9201a	-14.3a
130	62.2b	18.5a	4.2a	3.2a	15.30a	0.72a	73.70a	2.75a	1.4730a	0.9202a	-14.2a
140	64.1a	18.6a	4.1a	3.1a	15.10a	0.70a	72.62a	2.75c	1.4821a	0.9203a	-14.4a

* Means with the same letter are not different from one another at the 5% level of significance.

refractive index was also higher when harvesting was done after 140 days. Refractive index of oil was higher by increasing harvesting time. Raj *et al* (2003) recorded the similar results of refractive index.

Interaction effect of fertilizer and harvest time

In case of interaction effect the highest plant height was obtained from the plot receiving the fertilizer at the rate of 80 kg N + 60 kg P_2O_5 (N_2P_2) per hectare with 130 days harvesting (Table III). It is closely followed by N_2P_3 treatment with the same harvesting period. Fertilizer applied at the rate of 100 kg N + 80 kg P_2O_5 (N_3P_3) per hectare with 130 days harvesting time produced highest number of branches. The maximum herbage yield obtained from the plot which received the fertilizer at the rate of 100 kg N + 60 kg P_2O_5 (N_3P_2) per hectare within the harvest-period of 130 days. The results are in partial agreement with those reported by K. Singh *et al* who recorded the maximum herbage yield of *M. spicata* L. by applying nitrogen at the rate of 100 kg N per hectare within the harvest period of 130 days. Oil content of *M. spicata* L. as affected by N-P fertilizer treatment and harvest time varied from 0.55% - 0.79%. The maximum amount of oil of *M. spicata* L. obtained from N_2P_2 treatment at 130 days harvest. The next higher value of mentha oil noted from N_2P_1 treatment within same harvest period. The percentage of moisture ranges from 72.02-75.65. The higher harvesting time enhanced the refractive index. The acid value, optical rotation, density of oil obtained from each treatment did not show any significant change with different fertilizer treatment and harvesting time.

Table III. Interaction effect of nitrogen-phosphorus fertilization and time of harvest on growth, herbage yield, oil content and physio-chemical characteristics of *M. spicata* L. oil

Harvesting time (days)	Fertilizer treatment	Plant height (cm)	No. of branch per plant	Total fresh herb (t/ha)	Oil (%)	Moisture (%)	Acid value	Refractive index at 22^OC	Density at 22^OC	Optical rotation
	N_0P_0	53.4d*	13.2c	11.30c	0.55d	72.18b	2.71a	1.4601a	0.9203a	-14.30a
	N_1P_1	58.2c	16.2b	13.10bc	0.60c	72.18b	2.75a	1.4670a	0.9203a	-14.31a
	N_1P_2	58.3c	16.2b	13.40bc	0.61c	72.17b	2.75a	1.4610a	0.9231a	-14.41a
110	N_1P_3	59.2c	16.3b	13.25bc	0.60c	73.10b	2.76a	1.4611a	0.9201a	-14.19a
	N_2P1	59.0c	16.3b	13.15bc	0.60c	73.10b	2.75a	1.4610a	0.9201a	-14.21a
	N_2P_2	60.1c	16.4b	13.17bc	0.60c	72.10b	2.76a	1.4612a	0.9231a	-14.50a
	N_2P_3	60.1c	17.1ab	12.27bc	0.61c	72.20b	2.77a	1.4610a	0.9221a	-14.42a
	N_3P1	60.1c	17.1ab	14.40b	0.66b	72.15b	2.79a	1.4615a	0.9212a	-14.31a
	N_3P_2	60.2c	17.2ab	14.60b	0.67b	72.13b	2.75a	1.4617a	0.9224a	-14.60a
	N_3P_3	60.2c	17.1ab	13.15bc	0.65b	72.14b	2.76a	1.4616a	0.9213a	-14.20a

Table III to be contd.

	N_1P_1	64.2a	18.4a	13.24bc	0.66b	74.95a	2.73a	1.4651a	0.9201a	-14.2a
	N_1P_2	63.1a	18.2a	14.61b	0.67b	72.14b	2.76a	1.4650a	0.9205a	-14.5a
	N_1P_3	60.1ab	18.3a	14.50b	0.65b	74.81a	2.75a	1.4652a	0.9203a	-14.2a
120	N_2P_1	62.2ab	18.1a	14.40b	0.66b	75.11a	2.76a	1.4655a	0.9234a	-14.1a
	N_2P_2	60.2ab	18.2a	14.50b	0.67b	72.10b	2.75a	1.4652a	0.9204a	-14.2a
	N_2P_3	60.1c	18.4a	14.20b	0.66b	75.11a	2.75a	1.4653a	0.9236a	-14.4a
	N_3P_1	60.1c	18.3a	16.25a	0.67b	75.15a	2.77a	1.4652a	0.9217a	-14.3a
	N_3P_2	62.3ab	18.2a	16.11a	0.69b	72.16b	2.76a	1.4654a	0.9226a	-14.4a
	N_3P_3	61.9b	18.1a	14.20b	0.70a	75.41a	2.77a	1.4653a	0.9237a	-14.3a
	N_1P_1	62.1ab	18.3a	14.30b	0.77a	72.14b	2.75a	1.4702a	0.9205a	-14.2a
	N_1P_2	62.0ab	18.1a	14.41b	0.76a	75.65a	2.75a	1.4710a	0.9235a	-14.5a
	N_1P_3	62.1ab	18.4a	16.40a	0.77a	75.64a	2.75a	1.4711a	0.9215a	-14.2a
	N_2P_1	62.2ab	18.2a	15.90ab	0.78a	74.15a	2.70a	1.4713a	0.9214a	-14.3a
130	N_2P_2	64.3a	19.8a	15.91ab	0.79a	74.10a	2.75a	1.4714a	0.9213a	-14.4a
	N_2P_3	64.2a	19.7a	16.51a	0.76a	74.16a	2.72a	1.4713a	0.9211a	-14.0a
	N_3P_1	64.1a	19.7a	14.12b	0.76a	72.02b	2.73a	1.4714a	0.9225a	-14.2a
	N_3P_2	63.9a	19.9a	14.40b	0.77a	72.03b	2.72a	1.4713a	0.9225a	-14.1a
	N_3P_3	63.2a	19.8a	13.39bc	0.76a	74.16a	2.73a	1.4713a	0.9227a	-14.4a
	N_1P_1	60.1c	17.2ab	14.41b	0.67b	75.43a	2.71a	1.4810a	0.9221a	-14.4a
	N_1P_2	62.1ab	17.2ab	14.24b	0.66b	72.14b	2.77a	1.4809a	0.9231a	-14.3a
	N_1P_3	62.2ab	17.1ab	14.30b	0.68b	72.13b	2.78a	1.4810a	0.9213a	-14.6a
140	N_2P_1	62.1ab	18.1ab	14.40b	0.67b	72.14b	2.79a	1.4815a	0.9214a	-14.2a
	N_2P_2	61.1ab	17.2ab	13.12bc	0.68b	75.11a	2.75a	1.4814a	0.9221a	-14.3a
	N_2P_3	60.1c	17.3ab	13.12bc	0.68b	72.11b	2.71a	1.4812a	0.9220a	-14.2a
	N_3P_1	60.1c	17.1ab	14.50b	0.67b	72.16b	2.75a	1.4814a	0.9213a	-14.1a
	N_3P_2	62.1ab	17.2ab	14.10b	0.67b	75.15a	2.76a	1.4813a	0.9210a	-14.4a
	N_3P_3	62.2ab	18.1a	14.30b	0.67b	72.14b	2.76a	1.4814a	0.9213a	-14.2a

* Means with the same letter are not different from one another at the 5% level of significance.

Conclusion

From the present study it can be concluded that *M. spicata* L. has presently grown an experimental basis to evaluate its potential for commercial cultivation in our country. The results of the study suggested that growth and yield of *M. spicata* L. herbs as well as oil yield could significantly be improved by the application of NP fertilizer and proper harvesting time (130 days). Agronomic treatmemts for mentha species had not been standardized in our country. So further researches are needed in this direction with different mentha species to establish the present findings.

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