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Effect of combined doses of nitrogen and phosphorus on plant growth and oil yield of menthol mint (*Mentha arvensis* L) in western Himalayan region of Uttrakhand

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Abstract
The experiment was laid out in randomized block design with three replication at CSIR-Central Institute of Medicinal and Aromatic Plant Research Centre Purara, Bageshwar (Uttrakhand) during 2014-15 with the objectives to study the effect of different level of combined doses of nutrients, viz. nitrogen and phosphorus on herb and oil yield of menthol mint. The treatments combination is five combined doses of nitrogen and phosphorus, viz. T_1 (control, N_0 P_0), T_2: N_{50} P_{20}, T_3: N_{100} P_{40}, T_4: N_{150} P_{60}, T_5: $N_{200}P_{80}$. Result indicated that the better expression of plant growth and oil yield characters was observed in T_5: $N_{200}P_{80}$ followed by T4: N_{150} P_{60}.

Keywords: Mentha arvensis, Nitrogen, phosphorus, oil content, fresh weight, dry matter, menthol mint.

1. Introduction
Menthol mint (*Mentha arvensis*) is one of the essential oil bearing plants of the family lamiaceae. This is a perennial aromatic herb has been used by market since ancient times but commercial cultivation of menthol mint in India is of recent origin. Essential oil of menthol mint containing a large varity of aroma chemicals in varying concentration like menthol, carvone, linalyl acetate and linalool used in pharmaceutical, food, flavour, cosmetic, beverages and allied industries [14]. Menthol mint is commonly grown in China, Taiwan, Brazil, India, Thailand and Japan. In India, menthol mint is cultivated in the some parts of Himachal Pradesh, Haryana, UP and Bihar. In India, the crop is mainly grown in tarai region (Nainital, Badaun, Bilaspur, Rampur, Moradabad and Bareilly), extending to part of Indo-Gangetic plains (Barabanki and Lucknow) and some parts of Punjab [11].
Menthol mint (*Mentha arvensis*). Subsp. *Haplocayx* Briq. Variety *piperascens* Malinv ex-Holmes) is a hybrid between *M. arvensis* X *M. aquatica* and grows wild all over the wet lands in China and Japan. It is vigorous in growth, highly branched and grows up to 1 meter. The leaves are lanceolate to oblong in shape. The margin is toothed and petiole is small, about 5 mm in size. The leaf surfaces, on both the sides, appear hairy and have glandular trichomes [8].
Menthol mint essential oil is the main source of natural menthol. The dementholised (DMO) is reconstituted to produce oil similar to *Mentha piperita* oil. Several of the many dozens of terpenes present in the essential oil are valuable compounds that find uses in the cosmetic and pharmaceutical industries. Menthol itself is used as a flavouring agent in mouth related products such as a fresheners, tooth pastes and chewing gums, etc [13].
Menthol mint oil because of its antimicrobial properties enhances the shelf life of edible products and grains. Menthol mint oil is an essential ingredient of ointments, pain balms lozenges and syrups. It is also used in cosmetic preparations, colognes, deodorants, cosmetics, etc [6].
The main objective of the research work of Mint in the Himalayan terrain is to assess the exact amount of combined doses of nutrients which is best suited for crop growth and oil yield. Among many plant growth factors, the nutritional requirements of the crop are consider to the most important factor [12]**.** Nitrogen and phosphorus play an important role to enhancing yield. High rate of nitrogen application increases leaf area development and overall crop assimilation, thus contributing to increased yield [2]. Alkire and Simon (1996) they concluded that the nitrogen increases essential oil yield of peppermint by influencing of growth parameters such as tiller per plant, total plant dry weight and leaf area index. Therefore, the research work was conducted to knowing the combined dose of N&P are best and beneficial for crop growth and oil yield in the particular crop growing area at Himalayan region of Uttrakhand.

2. Materials and Methods

A field experiment was conducted during the crop growing season in a year 2014-15 at CSIR-Central Institute of Medicinal and Aromatic Plant Research Centre Purara, Bageshwar (Uttrakhand). The experiment was laid out in randomized block design with three replications. The experimental materials for the investigation consisted Kosi genotypes of menthol mint. The genotypes of menthol mint were planted in a plot having 2.70x1.35 m. area. There were 18 plants in each plot planted a row and plant spacing of 45x45 cm. Before the planting of crop the experimental field soil were analyzed for its physical and chemical properties indicated in table 1. The treatments were comprised with five different combined doses of N&P showed in table 2. Climatic condition during the crop growing season the monthly data are presented in the table 3. All the recommended package of practices, plant protection measures except fertilizers doses were timely followed for raising a good and healthy crop. Five randomly selected plants from each replication were used for recording observations viz. Fresh herb yield t/ha, Dry matter yield t/ha., (dry weight was determined by oven drying at 70 ^{0}C to constant weight) oil content percentage, and oil yield l/ha. The mean value of pooled data was used for estimating the analysis of variance, as per standard statistical procedure.

Table 1: Physical and Chemical analysis of field soil of experimental site.

Soil parameter	Particulars
Soil type	Sandy loam
Soil pH	6.2
Organic carbon content	0.36 %
Available N	160.3 kg/h
Available p	7.5 kg/h
Available K	130 Kg/h

Table 2: Showed detail of experimental treatments.

Treatments	Fertilizer combination
T_1	N_0 P_0 (control)
T_2	N_{50} P_{20}
T_3	N_{100} P_{40}
T_4	N_{150} P_{60}
T_5	$N_{200}P_{80}$

Table 3: Monthly averages of climatic data during the crop growing season.

Climate factor	February	March	April	May	June
Minimum temp. (^{0}C)	28.0	31.0	32.2	39.6	41.0
Maximum temp. (^{0}C)	4.0	5.0	10.2	11.1	14.0
Relative humidity (%)	79.61	68.1	78.0	72.0	62.0
Rain fall (mm)	-	-	-	24	32

2.1 Hydro- distillation of essential oil

Essential oil was extracted from 100 gm herb sample. Fresh plant material was partially dried and then placed into a Clevenger apparatus. The distillation was carried out using herb and water in 3:1 ratio for a period of 1 hrs. The extracted oil was separated from water and dehydrated by using anhydrous NA_2 SO_4.

2.2 Statistical analysis

The experimental data were analyzed statistically as per the method described by Cochran and Cox. The interpretation of results was based on "f" test at 0.05 level of significance.

3. Result and discussion

3.1 Fresh herb yield (t)

Maximum fresh herb yield of 28.56 t/ha was recorded under the treatments T_5 ($N_{200}P_{80}$) followed by T_4 (N_{150} P_{60}). Minimum fresh herb yield (23.05 t/ha) was recorded under the treatments control (N_0P_0). Data indicates that the herb yield of menthol mint was significantly affected by increases in the level of nitrogen and phosphorus application. This is because of high rate of nitrogen and phosphorus. Nitrogen and phosphorus has been play an important role for vegetative growth and development of crops. These are essential element which is effectively involved in the process of photosynthesis. Nitrogen is a major element of all living cells and it is a necessary compound of all proteins, enzymes etc. Nitrogen also involved in metabolic processes of the plants in the synthesis and transfer of energy. These results are in conformity with those of. Patra *et al* in 1998 observed that the highest herb in mint with NPK doses of 150: 60:60 kg/ha respectively

3.2 Dry matter yield (t)

Maximum dry matter of 6.2 t/ha was recorded under the treatment T_5 ($N_{200}P_{80}$) followed by treatment T_4 ($N_{150}P_{60}$). Minimum fresh yield (3.2 t/ha) was recorded at control (N_0P_0). Similar result was reported by Clerk *et al*. (1980) in peppermint and Duriyaprapan *et al* (1986) in Japanese mint.

3.3 Oil content (%)

The high level of fertilizers did not affect the essential oil content. The highest essential oil content of 0.91 % was found in T_5 and was significantly higher than the values found in all other fertilizer treatments. The result showed that the increasing rate of fertilizer application decreased the essential oil content relative to the lower rate of fertilizer application. Similar results were reported for menthol mint by Kumar *et al* in 1999.

3.4 Oil yield (l)

The essential oil yield increased significantly with increasing the rate of fertilizer application. Maximum oil yield (261 l/ha) was recorded in T_5 followed by T_4. The lowest essential oil yield was found in T_1 (control). The higher essential oil yield with increasing rate of fertilizer application was probably due to higher growth rate. Similar result was also repeated by Piccaglia *et al* (1993), who reported that some agronomic factor also affected the essential oil content of mint.

Table 4: Effect of combined doses of N and P on plant growth and oil yield parameter.

Treatments	Fresh herb yield (t/ha)	Dry matter yield (t/ha)	Oil content (%)	Oil yield (l/ha)
T_1 (N_0 P_0)	23.05	3.2	0.74	200
T_2 (N_{50} P_{20})	24.27	3.1	0.82	225
T_3 (N_{100} P_{40})	25.32	4.4	0.80	232
T_4 (N_{150} P_{60})	27.47	5.6	**0.91**	248
T_5 ($N_{200}P_{80}$)	28.56	6.2	0.87	**261**
SEM ±	0.6351	0.8944	0.0076	0.3651
CD at 5%	2.0711	2.0625	0.0175	0.8420

Table 5: Effect of combined doses of N and P on chemical profile of menthol mint (*Mentha arvensis* L) in western Himalayan region

Compound	Mentha arvensis				
	Content (%)				
	T_1	T_2	T_3	T_4	T_5
(3Z)-Hexenol	t	t	t	-	t
α-Pinene	0.4	0.4	0.5	0.4	0.5
Camphene	t	t	t	-	t
Sabinene	0.1	0.1	0.2	0.2	0.2
β-Pinene	0.4	0.4	0.5	0.5	0.5
Myrcene + 3-Octanol	0.8	0.7	0.7	0.7	0.8
p-Cymene	-	-	-	-	t
Limonene	0.7	0.9	0.6	0.8	1.1
1,8-Cineole	t	t	t	-	t
cis-Sabinene hydrate	t	t	t	0.2	-
Linalool	0.1	0.1	0.1	-	0.1
Isopulegol	0.3	0.4	0.3	0.3	0.3
Menthone	7.9	9.7	6.6	8.4	9.5
Isomenthone	4.4	4.9	4.2	4.6	4.4
Menthol	82.7	80.2	83.4	80.6	80.0
Pulegone	0.3	0.3	0.4	0.3	0.3
Carvone	0.5	0.5	0.5	0.5	0.5
Piperitone	0.1	t	t	-	t
Menthyl acetate	0.2	0.1	0.2	0.2	0.2
(E)-Caryophyllene	t	0.1	0.2	-	0.2
Caryophyllene oxide	t	t	t	-	t

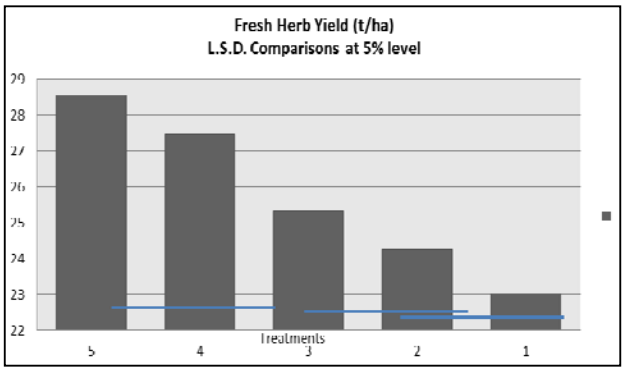

Fig 1: Effect of combined doses of N and P on fresh herb yield

4. Conclusion

Result showed that the increasing rate of fertilizer application decreased the essential oil content while increasing the oil yield, that's why the oil content are non-significant for increasing dose of combined fertilizers. Whereas the high rate of combined doses of nitrogen and phosphorus fertilizers significantly affects the growth and yield of mint. A fertilizer dose of 200 kg N and 80 kg P/ha were significantly increased the plant growth and herb yield. The study provided useful information to the farmers and commercial growers of Himalayan region regarding the fertilizer doses for further application especially in western Himalayan region of Uttrakhand.

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