

ORIGINAL ARTICLE

Effect of Integrated Nutrient Management on growth and yield of Japanese mint (*Mentha arvensis* L.)

Gurmanpreet Kaur, Amanpreet Singh, Harpreet Singh and Kamalesh Kumar

Department of Agronomy, G.S.S.D.G.S. Khalsa College, Patiala- 147001

ABSTRACT

Japanese mint (*Mentha arvensis* L.) is one of the important commercial and essential oil bearing industrial crop cultivated in Punjab. Integrated nutrient management is an important approach to use the organic manure with optimum level of NPK fertilizers, as it will not only improve the growth status, but also sustained the crop yield. Field experiment was conducted during Rabi season of 2017-18 in randomized block design with three replications. Among all the treatments, the highest growth and yield was recorded in the treatment T₁₁ (50 % NPK + 2 tonne FYM + 1 tonne vermicompost + 1 tonne poultry manure) and this treatment was statistically at par with the treatment T₁₀ (50 % NPK + 1 tonne vermicompost + 1 tonne poultry manure).

Keywords: INM, Growth and Yield, Manure, Japanese mint

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INTRODUCTION

Japanese mint (*Mentha arvensis* L.) is one of the important commercial and essential oil bearing industrial crop cultivated in Punjab. The member of genus (*Mentha*) is popular referred as “mints” and belongs to family Lamiaceae, also known as Japanese mint, which also includes other important essential oil-yielding plants. Menthol-mint is a perennial herbaceous medicinal and aromatic plant growing up to a height of 40 to 90 cm, and is a potential source of natural menthol and many other constituents viz. mint terpenes, menthone, Isomenthone, methyl acetate, etc. These chemicals are widely used in pharmaceutical, cosmetics, food and flavor industries. India is one of the few countries in world where all type of aromatic plants are cultivated in one or other part owing to diverse climatic conditions. In Punjab, Japanese mint (*Mentha arvensis* L.) and Spearmint (*Mentha spicata* L.) are the two common species are being grown on area of about 60,000 hectares [1]. Out of these two cultivated mint species *Mentha arvensis* L. occupies major position and contributes more than 80% of total production of essential oil in Punjab. Fresh herbs of *Mentha arvensis* L. contains 0.5% to 0.8% of oil, which is natural source of natural menthol (70 to 85%) and number of terpenoids of economic importance. The major constituents generally identified in Japanese mint are menthol, p-menthone, l-menthol, isomenthol, neo-menthol, methyl acetate and series of other trace compounds [2]. However, proportion of various constituents vary considerably according to genetic makeup, geographical and ecological conditions and growth stage of crop [3]. Herbage and oil yield of the Japanese mint are also dependent upon the technology used in raising the crop and prevailing climatic conditions. Normally, Japanese mint can be grown both in tropical as well as sub-tropical regions. The optimum temperature for mint cultivation is 25°C-30 °C. The rainfall requirement of mint is 100 cm to 110 cm. Light showers at the time of planting and good sunny days at harvesting stage is best for its high yielding and good quality of herbage. Japanese mint can be cultivated on wide range of soil. However, loam, sandy loam and deep soil rich in organic matter and are best for its cultivation. The soil should be well drained and loose textured for better growth of mint leaves. Mint leaves thrive well in fertile soil with pH range of 6.5 to 8.0 as it does not grow on clay soils, avoid these soils for mint farming. Water stagnation should be avoided in the field. Mint can also be grown on red and black soils. Application of Lime is used for the treatment of the acidic soil. In Punjab mainly three varieties of mentha are grown i.e. spearmint, peppermint and Japanese mint. ‘Kosi’ variety is most commonly grown due to its high yielding. It gives highest herb as well as oil yield when harvested. It also produces best quality of menthol. Nowadays the agricultural research is focused on evolving ecologically sound, sustainable and socio-economically viable technologies. Many such nature friendly farming practices were evolved and

developed by the farmers of ancient period and the same became available to the successive generation. In plight of generation welfare, the traditional knowledge which has been subjected to a process of refinement through generations of experience were given negligible importance are now receiving recognition. The plants which are used for medicinal purposes should not have any residue or pesticide otherwise, they become more of poison than medicine. Hence, to domesticate and popularize this valuable medicinal plant there is a need to make more effort for the organic and inorganic production of this plant in commercial level. After prolonged use of synthetic fertilizers, the world is now giving importance to organically grown products. Continuous use of inorganic fertilizers without organic manures can cause unsustainable soil productivity by reducing microbial activity and affecting soil health apart from causing nutritional imbalance in soil. Hence, it is necessary to establish an alternate solution by integrated use of organic manures and inorganic fertilizers without affecting productivity. In terms of nutrients, Japanese mint is a very demanding crop. The plants need high rates of nitrogen, phosphorus and potassium, in order to produce high yields for several years. Application of nitrogen leads to fast vegetative growth whereas potassium provides vigour to the crop and makes the mint crop resistant from certain diseases. Phosphorous application encourages the root system of the plant. Nitrogen increases essential oil yield of mint by influencing a variety of growth parameters such as tillers per plant, total plant dry weight and leaf area index [2]. Organic manures like farmyard manure, vermicompost and poultry manure increase the quality of crop. Moreover information on different aspects of growth, development and nutrient aspect of farmyard manure, vermicompost and poultry manure is lacking in Japanese mint. In view of these, the investigation was carried out to study the "Effect of integrated nutrient management on growth and yield of Japanese mint".

MATERIAL AND METHODS

The study was carried out at Campus for Research and Advanced Studies, Dhablan, G.S.S.D.G.S Khalsa College, Patiala during the *Rabise* as on of 2017-18. The field trial was laid out in randomized block design with eleven treatments T₁: (Control), T₂: (50 % NPK), T₃: (50 % NPK + 2 tonne FYM, T₄: (50 % NPK + 2.5 tonne FYM), T₅: (50 % NPK + 2 tonne FYM + 1 tonne vermicompost), T₆: (75 % NPK + 0.5 tonne poultry manure + 0.5 tonne vermicompost), T₇: (75 % NPK + 1 tonne vermicompost), T₈: (75 % NPK + 1 tonne poultry manure), T₉: (50 % NPK + 2 tonne FYM + 1 tonne poultry manure), T₁₀: (50 % NPK + 1 tonne vermicompost + 1 tonne poultry manure), T₁₁: (50 % NPK + 2 tonne FYM + 1 tonne vermicompost + 1 tonne poultry manure) in three replications. Before planting of Japanese mint (*Mentha arvensis* L.) crop mechanical and chemical analysis of composite soil samples were performed to determine the status of soil in the year 2016-17.

The soil of experimental field was clayey in texture with pH (7.3), organic carbon (0.65 %), low in available nitrogen (310 kg ha⁻¹), medium in available phosphorous (19 kg ha⁻¹) and medium in available potassium (130 kg ha⁻¹). Five plants were randomly selected for taking all observations and analysis for yield estimation. The grain yield was worked out on net plot yield. The analysis and interpretation of data were completed by using OPSTAT developed by CCS HAU, Hisar and as per randomized block design.

RESULT AND DISCUSSION

Effect of integrated nutrient management on growth parameters and nitrogen content of leaves

Plant height (cm) at 30 DAS interval

The integrated nutrient management significantly influenced the plant height at all the stages of crop growth (Table 1). The data revealed that, among different treatments of INM, the application dose of 50% NPK along with 2 tons FYM, 1 tonne poultry manure and 1 tonne vermicompost (T₁₁) had shown the significantly higher plant height (24.73, 36.81, 39.69 and 40.63 cm) at 30, 60, 90 DAP and at harvest respectively, whereas these values of crop height at statistically at par with the treatment application of 50% NPK along with 1 tonne poultry manure and 1 tonne vermicompost (T₁₀). However, the significantly minimum plant height was recorded under control i.e. (T₁). These same results in the plant height were also reported by Suresh and Senthinathan [4] and Verma *et al.* [3].

Number of leaves per plant at 30 DAS interval

The mean values for number of leaves per plant shown in table 1 showed the presence of significant variation in the leaves by different levels of Integrated nutrient management in Japanese mint plants.

The integrated nutrient management significantly influenced the number of leaves per plant at all the stages of crop growth. The data revealed that, among different treatments of INM, the application dose of 50% NPK along with 2 tons FYM, 1 tonne poultry manure and 1 tonne vermicompost (T₁₁) had shown the significantly more number of leaves plant⁻¹ (226.39, 239.19, 247.73 and 248.97) at 30, 60, 90 DAP and at harvest respectively, whereas, these values of number of leaves per plant were statistically at par with the

treatment application of 50% NPK along with 1 tonne. These favorable conditions could have increased the nutrient availability and the water holding capacity of the soil resulting in enhanced growth and yield whereas, due to fertilizers the number of leaves increased as per the findings of Izhar *et al.* [7] and Kumar and Sood [8].

Dry weight per plant

It is evident from the data presented in table 1 which depicted that dry weight has some notable variations due to integrated nutrient management among different treatments. The integrated nutrient management significantly influenced the plant dry weight per plant at all the stages of crop growth. The data revealed that, among different treatments of INM, the application dose of 50% NPK along with 2 tons FYM, 1 tonne poultry manure and 1 tonne vermicompost (T₁₁) had shown significantly more dry weight per plant (16.97, 29.97 and 36.98 g) at 60, 90 DAP and at harvest respectively, whereas these values of crop as dry weight per plant were followed by the treatment application of 50% NPK along with 1 tonne poultry manure and 1 tonne vermicompost (T₁₀). However, significantly lower dry weight plant⁻¹ was noticed under control i.e. (T₁). The similar results by Mahmoud Al – Hassan [6] and Sumathi *et al.* [9] seen with application of inorganic manures.

Plant spread (cm)

Japanese mint endowed highly spreading nature of branches. In case of availability of both organic and inorganic matters in abundance encourages the horizontal growth of plants leading to plants with significantly larger plant spread. The data on plant spread presented in the Table 2. Data recorded on plant spread increase consistently with the advancement of crop age and reached its maximum at maturity and thereafter, a minor change was observed. Integrated nutrient management through inorganic sources of nutrients significantly influenced plant spread at all the stages of crop growth. A critical increase in plant spread in data indicated was maximum between 30 DAP and 60 DAP, whereas, the rate of growth was at its peak at 90 DAP but, there was a smaller change in the spread at harvest stage. The integrated nutrient management significantly influenced the plant spread at all the stages of crop growth. The data revealed that, among different treatments of INM, the treatment T₁₁. The increase of internodes leads to the increase in no. of leaves plant⁻¹, thereby, resulting in better plant spread. Singh *et al.* (2013) in their experiment revealed a greater plant spread in INM treatments.

Table 1. Effect of integrated nutrient management on growth studies along with nitrogen content.

Treatments	Plant height (cm)				No. of leaves per plant				Plant spread (cm)				Nitrogen content (%)
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	120 DAS	
T1	15.47	26.16	27.41	28.13	71.43	80.12	85.35	85.91	5.91	9.15	12.11	16.23	2.35
T2	16.17	27.57	28.71	29.87	82.31	92.93	105.79	106.12	6.25	11.56	15.36	19.62	2.48
T3	17.49	28.09	29.15	30.72	102.26	116.38	124.21	124.89	6.89	12.82	17.55	21.07	2.59
T4	18.52	29.71	31.62	32.95	119.70	127.44	135.43	136.04	7.53	14.91	20.13	24.51	2.76
T5	19.14	30.81	32.17	33.57	136.18	151.61	163.23	163.97	8.88	15.64	21.69	25.84	2.90
T6	22.07	34.89	36.48	38.02	159.24	192.39	208.99	209.63	13.34	20.60	24.73	28.93	3.35
T7	20.93	33.28	34.66	35.15	156.17	171.42	182.03	182.84	12.89	18.56	23.54	27.13	3.24
T8	20.01	31.37	33.79	34.61	153.22	169.31	175.41	176.21	9.92	16.81	22.18	26.04	3.08
T9	22.96	35.23	37.75	38.65	210.43	220.04	229.19	229.88	14.59	22.19	25.84	29.37	3.53
T10	23.32	36.46	38.13	39.84	215.11	224.91	230.34	230.97	15.88	24.88	27.58	31.64	3.73
T11	24.73	37.51	39.69	40.63	226.39	239.19	247.73	248.97	16.97	25.92	28.39	32.77	4.06
CD@5%	1.77	1.98	1.79	1.59	1.59	1.77	1.68	1.76	1.68	1.47	1.37	1.59	0.17

Total nitrogen content present in leaves (%)

Integrated nutrient management had a significant influence on nitrogen content present in the leaves (Table 1). Among all the treatments, the application of different plant nutrients increases the total nitrogen content in the leaves of the crop plants at all growth stages due to higher photosynthetic rate. Thus, significantly higher total nitrogen content (4.06 %) was recorded in (T₁₁) however, it was statistically at par with the treatment application of (T₁₀). However, significantly lower total nitrogen content was noticed under control i.e. (T₁). Another factor contributing to the better plant growth with

poultry manure might be the presence of high nitrogen content and increased availability of native soil nitrogen and biological activity by Singh *et al.* [10].

Effect of integrated nutrient management on yield parameters and Economics

Fresh herbage yield (q ha⁻¹)

The data pertaining to the effect of integrated nutrient management on total fresh herbage yield is given in table 2. It is clearly indicated that there was a wide range of variations for the fresh herbage yield of plants. Integrated nutrient management had a significant influence on fresh herbage yield of Japanese mint. Among all the treatments, the application of different plant nutrients increases the herbage of the crop plants at harvest stage. Thus, significantly maximum total fresh herbage yield (257.63 ha⁻¹) was recorded in treatment application of T₁₁ however, it was statistically at par with the treatment application of 50% NPK along with 1 tonne poultry manure and 1 tonne vermicompost (T₁₀). However, significantly minimum total fresh herbage yield was noticed under control i.e. (T₁). The benefit of INM addition is improving the herbage yield was also reported by Patra *et al.* [12] and Chand *et al.* [13] in menthol mint (*Mentha arvensis* L.).

Oil yield (L ha⁻¹)

The data representing the effect of integrated nutrient management on total fresh herbage yield are given in table 2. Integrated nutrient management had a significant influence on oil yield of Japanese mint. Among all the treatments, the application of different plant nutrients increases the oil yield of the crop plants at harvest stage. Thus, significantly maximum oil yield (150.23 L ha⁻¹) was recorded in (T₁₁) however, it was statistically at par with the treatment application of 50% NPK along with 1 tonne poultry manure and 1 tonne vermicompost (T₁₀). However, significantly minimum oil yield was noticed under control i.e. (T₁). The higher yield of essential oil under these conditions results from higher herbage yield, despite the marginal decrease of the oil concentration in the leaves have also been reported earlier by Jha *et al.* [14], Hoseinzadehet *al.* [15], Kale *et al.* [16] and Ram and Kumar [18].

Table 2. Effect of integrated nutrient management on yield attributes

Treatments	Plant spread (cm)				Fresh herbage yield (q ha ⁻¹)	Oil yield (L ha ⁻¹)	Oil content (%)
	30 DAS	60 DAS	90 DAS	120 DAS			
T1	5.91	9.15	12.11	16.23	205.05	93.34	0.68
T2	6.25	11.56	15.36	19.62	214.18	102.15	0.83
T3	6.89	12.82	17.55	21.07	218.32	108.28	0.86
T4	7.53	14.91	20.13	24.51	221.43	113.48	0.88
T5	8.88	15.64	21.69	25.84	225.59	116.75	0.89
T6	13.34	20.60	24.73	28.93	235.17	122.13	0.95
T7	12.89	18.56	23.54	27.13	233.73	124.04	0.93
T8	9.92	16.81	22.18	26.04	228.34	120.43	0.91
T9	14.59	22.19	25.84	29.37	240.56	125.52	0.96
T10	15.88	24.88	27.58	31.64	255.41	148.25	0.97
T11	16.97	25.92	28.39	32.77	257.63	150.23	0.99
CD @ 5%	1.68	1.47	1.37	1.59	1.59	1.77	0.01

Oil content(%)

Integrated nutrient management had a significant influence on the oil content of Japanese mint are shown in Table 2. Among all other treatments, the application of different plant nutrients increases the oil content of the crop plants at harvest stage. The significantly maximum oil content (150.23 L ha⁻¹) was noted in (T₁₁) with treatment application of 50% NPK, 2 tons FYM, 1 tonne poultry manure and 1 tonne vermicompost however, it was statistically at par with the treatment T₁₀. The increase in oil content may be due to the effect of fertilizers in accelerating the metabolism reactions and stimulating enzymes. The lowest concentration of essential oils in present study was noted in plants grown with the highest level of nutrients, an observation previously reported for *Anethum graveolens*. Mona [17] also reported that trends, but in direct contrast to results for *Mentha arvensis* L.

CONCLUSION

Among all the treatments, the highest growth, yield and nitrogen uptake was recorded in the treatment (T₁₁) with the application dose of 50% NPK along with 2 tonne FYM, 1 tonne poultry manure and 1 tonne vermicompost and this treatment was statistically at par with the treatment (T₁₀) 50% NPK along with 1 tonne poultry manure and 1 tonne vermicompost However, the study requires more critical testing at various locations with staggered survey before the recommendations have to be made.

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