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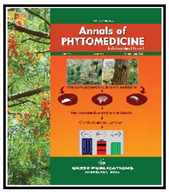

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Effect of different nitrogen levels on the yield and oil quality with economic parameters of mint (*Mentha arvensis* L.)

D. Ram[◆]*, Prabhat Kumar*, Pradip Kumar Saini and Vipin Kumar***

**Department of Horticulture, A.N.D. University of Agriculture and Technology, Kumarganj-224 229, Ayodhya Uttar Pradesh, India*

***Department of Crop Physiology, A.N.D. University of Agriculture and Technology, Kumarganj-224 229, Ayodhya, Uttar Pradesh, India*

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Abstract

The present investigation has been carried out at main experiment station, Department of Horticulture, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, India, to find out the effect of different nitrogen levels on the yield and oil quality with economic parameters of mint, in randomized block design (RBD) with nine treatment combinations and replicated thrice. Observation on various parameters, *viz*., fresh herbage yield (199.60 quintal/hectare), dry herbage yield (39.92 quintal/hectare), oil yield (177.61 liter/hectare), and oil % (0.88) content in mentha oil were noted maximum due to application of nitrogen, 140 kg/hectare. From the experiment, it is concluded that a higher economic return was obtained fresh herbage yield (199.60 quintal/hectare), dry herbage yield (39.92 quintal/hectare), oil yield (177.61 liter/hectare) with the application of nitrogen, 140 kg/hectare. It would be very helpful to the farmers for economic importance and subsequently pharmaceutical industry for getting raw material to eradicate disease and increase vitality.

1. Introduction

Japanese mint (*Mentha arvensis* L.) belongs to the family Lamiaceae. After the second world war over, Brazil was looked upon by some Japanese producers as mint was found in the Brazilian forests and they started producing mint in Brazil also. Major growing countries of mint are India (80%), China (9%), Brazil (7%), and U.S. (4%). India is a leading producer of mint oil in the world with around 14000 MT produced in 2003. At present, the mint crop is being grown on an area of about 17500 hectares, and production of 32000 MT of essential oil in the country (Anonymous, 2016-17). India contributes about 73% of total mint oil production in the world and the rest by China and Brazil. A large part of the country's oil production is exported. Because of the properties found in Japanese mint, it has penetrated almost every home in India and has made a significant influence. India is the country that consumes the most Japanese mint oil. In comparison to many other countries, India's production and productivity of Japanese mint is quite low. *M. arvensis* is cultivated in a semi-temperate region of the Himalayan hills. In india, the major mint-producing states are Uttar Pradesh, Himachal Pradesh, Punjab, and Bihar. The crop has of late involved a large sector in processing and trade activity in several small towns of Uttar Pradesh. The Sambhal, Barabanki, Rampur, Chandausi, Badaun, and Bareilly are major mint oil trading locations in India.

Corresponding author: Dr. D. Ram
Professor, Department of Horticulture, A.N.D. University of Agriculture and Technology, Kumarganj-224 229, Ayodhya, Uttar Pradesh, India
E-mail: dramnduat@gmail.com
Tel.: +91-9450717709

Low yield could be caused by a variety of circumstances. Its oil is extremely useful in various industries, *viz.*, food industry, pharmaceutical industry, and also in perfumery and flavoring industries. According to Parveen *et al.* (2020) the term "herbal plants" refers to all medicines that occur in the form of plants, plant parts (such as roots, rhizomes, stems, bark, wood, leaves, flowers, fruits, seeds, or their active ingredients), herbal preparations, or finished products containing these materials singly or in combinations. The use of herbal medicines in their various forms is rapidly expanding, owing to the significant economic benefits, they provide around the world, (Amrutanand *et al.*, 2021). Water and nitrogen are important to influence the essential oil production in mint besides phosphorous and potassium. The studies on fertilizer management on other crops, whose whole economic part is a leaf, revealed that optimum availability of nutrients throughout the growing period increases leaf production when applied through fertigation due to placement of fertilizer in an effective crop root zone and less leaching loss. The effect of row spacing (45, 60, and 75 cm) and nitrigen fertilizer (0, 100, 200, and 300 kg) nitrogen (urea/hectare) on plant growth and essential oil production and composition of scotch spearmint (*M. gracilis*) was studied in the field during 1987 and 1988, but decreased leaf stem ratio and oil concentration. Irrespective of spacing, oil yields increased as nitrogen application increased (Kothari and Singh 1995). Keeping the foregoing in mind, the study, titled "effect of different nitrogen levels on the yield and oil quality with economic parameters of mint (*M. arvensis*)," has been proposed to be carried out at Horticulture Research Farm, ANDU and T, Kumarganj, Ayodhya, Uttar Pradesh, Inida during the summer season of 2017-18 with the following objectives.

(a) To find out the different nitrogen level on yield and oil quality and;

(b) to find the economic feasibility of different treatments.

2. Materials and Methods

The present investigation entitled "effect of different nitrogen levels on the yield and oil quality with economic parameters of mint (*M. arvensis*)" was carried out at main experimental station, College of Horticulture, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, India during the year 2017-18. Geographically, the experimental site is situated between the latitude of 24.47 and 26.75 North and longitude of 82.12 and 83.98 East at the elevation of 118 meters above mean sea level. The experimental site is situated in a humid subtropical climate with three distinct seasons: summer, rainy season, and winter. The summer season occurs from march to june having dry and hot temperatures ranging from 25ºC to 47.7ºC during May and June. The rainy season lasts from July to September, with an average annual rainfall distribution of 120 cm and a relative humidity of 63.15%. However, the winter season prevails which mean to serve cold temperature during mid of October to mid of February. The experiment was designed using randomized block design (RBD) variety "Kosi" to assess the effects of different nitrogen levels on control (80 kg/hectare P_2O_5 + 60 kg/hectare K_2O + 25 tan FYM/ hectare), 20 kg, 40 kg, 60 kg, 80 kg, 100 kg, 120 kg, 140 kg, 160 kg (the yield parameters like fresh herbage yield, dry herbage yield, oil yield, and oil %) of mint.

2.1 Statistical analysis

Data collected on various yield attributes were statistically analysed using Fisher's method of analysis of variance (Ponse and Sukhatme, 1967). The significance of different treatments was determined by comparing calculated 'F' values with Fisher's F values at a 5% probability level against an appropriate degree of freedom.

3. Results

3.1 Fresh herbage yield (quintal/hectare)

The observation regarding fresh herbage yield (quintal/hectare) was recorded and shown in Figure 1. A perusal of data revealed that there were significant variations observed in fresh herbage yield due to different nitrogen level treatments. The highest fresh herbage yield, on the other hand, 199.60 quintal/hectare was obtained with the application of 140 kg nitrogen/hectare, followed by 160 kg nitrogen/hectare. Treatment 160 kg nitrogen/hectare was found at par with FYM 10 tonn/hectare and proved fresh and equally good, followed by 120 kg, 100 kg, 80 kg, 60 kg and 40 kg. Control (80 kg/ hectare P_2O_5 + 60 kg/hectare K_2O +25 tan FYM/ hectare) yielded the bare minimum of fresh herbage yield (151.53 quintal/hectare).

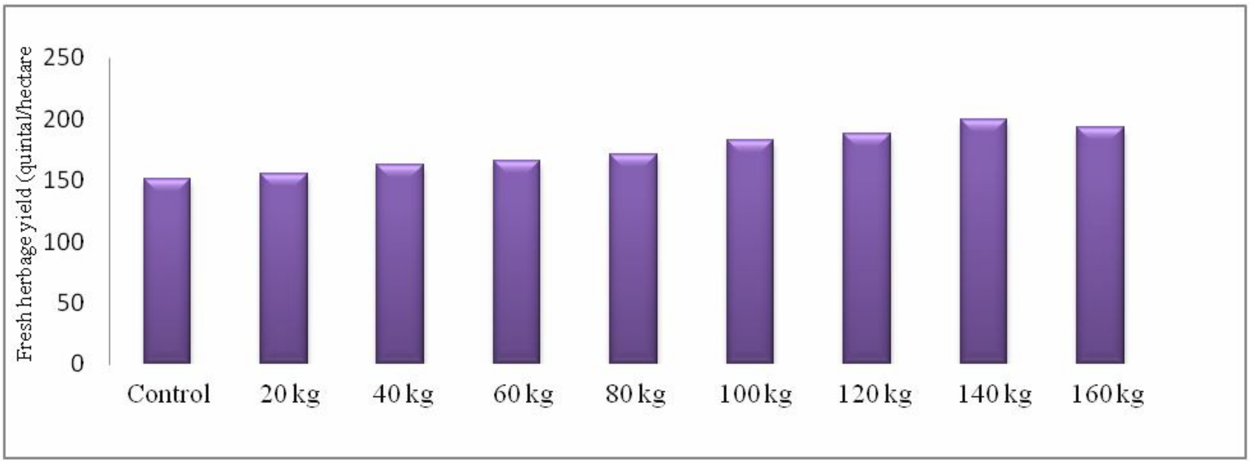

Figure 1: Effect of different nitrogen levels on fresh herbage yield (quintal/hectare).

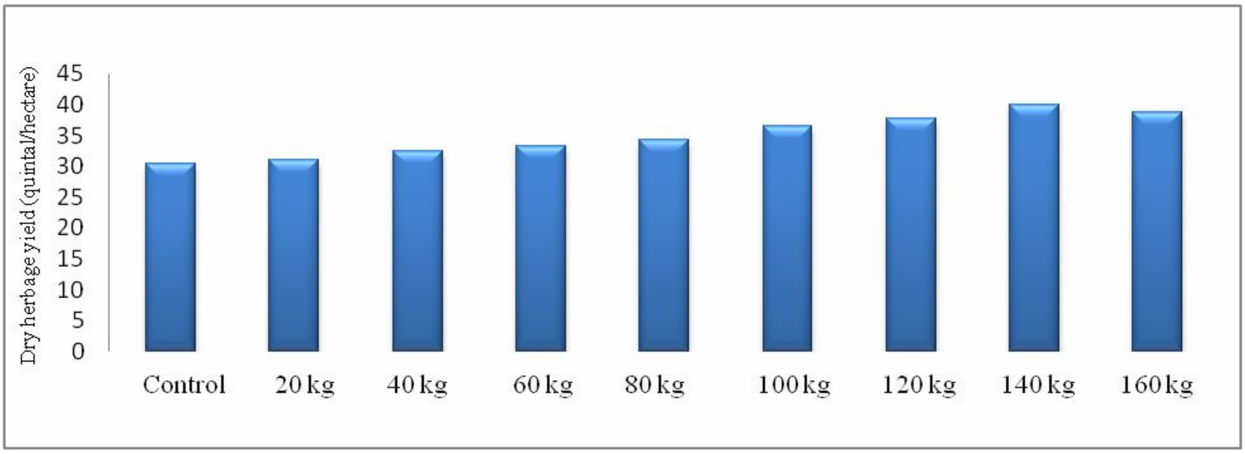

Figure 2: Effect of different nitrogen levels on dry herbage yield (quintal/hectare).

3.2 Dry herbage yield (quintal/hectare)

Data about dry herbage yield (quintal/hectare) was recorded and shown in Figure 2. A perusal of data revealed that there was significant variation observed in dry herbage yield due to different nitrogen treatments. However, the maximum dry herbage yield (39.92 quintal/hectare) was obtained with the application of 140 kg nitrogen/hectare, followed by 160 kg nitrogen/hectare. Treatment 120 kg nitrogen/hectare with 37.69 quintal/hectare and 36.57 quintal/ hectare were found at par with 140 kg nitrogen/hectare. While, the lowest herbage yield (17.91 quintal/hectare) was observed in control (80 kg/hectare P_2O_5 + 60 kg/hectare K_2O+25 tan FYM/hectar).

3.3 Oil yield (liter/hectare)

Data about oil yield (liter/hectare) was recorded and shown in Figure 3. A perusal of data revealed that there was significant variation observed in yield due to various treatment factors, *viz.*, different organic sources. However, the maximum oil (177.61 liter/hectare) was obtained with the application of 140 kg nitrogen/hectare which was found significantly superior to rest and at par with the application of 160 kg nitrogen/hectare and followed by other treatments. In control, the least amount of oil (106.07 liter/hectare) was obtained.

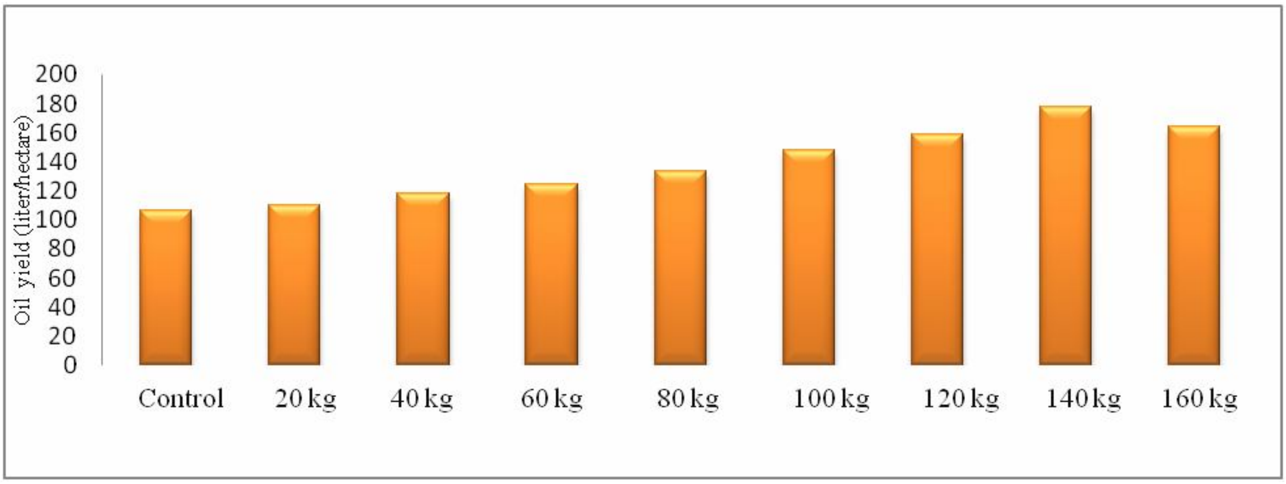

Figure 3: Effect of different nitrogen levels on oil yield (liter/hectare).

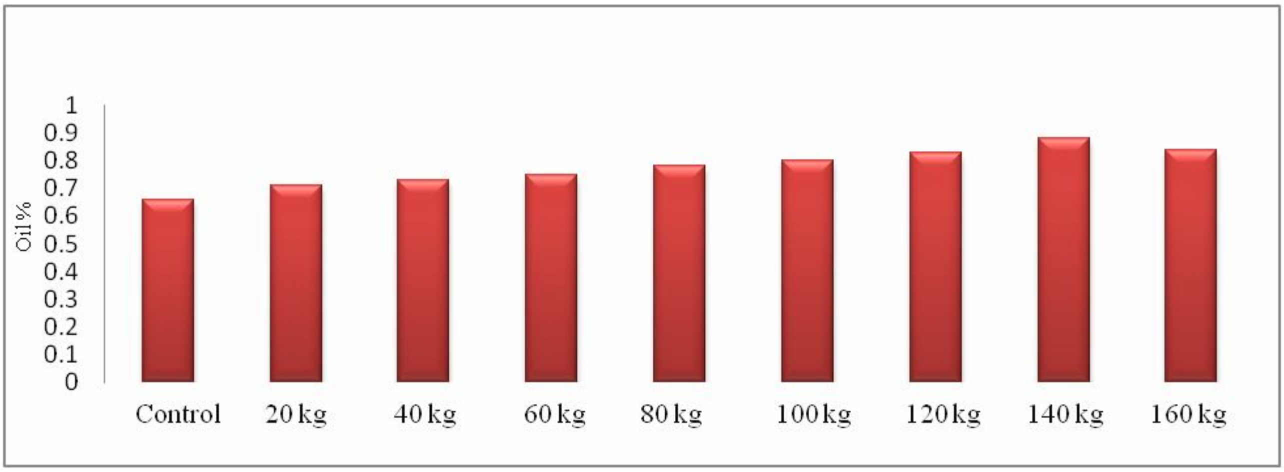

Figure 4: Effect of different nitrogen levels on oil %.

3.4 Oil %

The result showed in Figure 4 showed that the oil % was influenced by different nitrogen levels, however, they were found non-significant. The maximum oil % content (0.88 %) was recorded with the application of 140 kg nitrogen/hectare which was found non-significant superior over the application of 20 kg nitrogen/ hectare and control and followed by other treatment. Under control, the minimum oil per cent (0.66 %) was recorded.

4. Economics studies

The economics analysis includes the cost of cultivation, gross income, the net return, and cost-benefit ratio per hectare worked out based on current market rates of each commodity and payment made for farm labour, farm machines, irrigation, *etc.*, which were required during the period of experimentation of mint. The details estimated cost of different commodities has been given in the

Table 1. The gross income per hectare was estimated based on the total production of fresh herbs yield and oil yield (kg/hectare) and its current market rate. The net returns per hectare were estimated by subtraction of the total cost of cultivation from gross income, which is shown in the Table 1. It may be visualized from the Table 1. That the total cost involved in the cultivation of mentha was approximately Rs./hectare.

4.1 Cost of cultivation (Rs./hectare)

The data on the cost of cultivation has been presented in a Table 1. The maximum cost of cultivation of Rs. 51410 was noted with the 160 kg nitrogen/hectare treatment. However, the minimum cost of cultivation of Rs. 50290 was recorded with control.

4.2 Gross return (Rs./hectare)

The data on gross return has been presented in Table 1. It is observed from the data that the gross return was increased with increasing oil yield of mentha, the maximum gross return of Rs.142088 was recorded with the 140 kg nitrogen/hectare treatment, while the minimum gross return of Rs.84856 was noted with control.

4.3 Net returns (Rs./hectare)

Data given in the Table 1 indicated that the maximum net returns of Rs. 90818 was recorded with treatment 140 kg nitrogen/hectare and the minimum net return of Rs. 34566 was noted with control treatment.

4.4 Cost-benefit ratio

The data on the benefit cost ratio has been presented in a Table 1. It is clear from the data that the maximum benefit-cost ratio of 2.77 was noted with the 160 kg/hectare nitrogen treatment combination and the minimum benefit of 1.68 was recorded control treatment.

Table 1: Economics of the different treatment combinations ratio

Treatments	Total cost of cultivation	Gross return (Rs./hectare)	Net return (Rs./hectare)	Cost benefit ratio
Control	50290	84856	34566	1:1.68
20 kg	50430	88152	37722	1:1.74
40 kg	50570	94744	44174	1:1.87
60 kg	50710	99720	49010	1:1.96
80 kg	50850	106992	56142	1:2.20
100 kg	50990	118496	67506	1:2.32
120 kg	51130	126648	75518	1:2.47
140 kg	51270	142088	90818	1:2.77
160 kg	51410	131096	79686	1:2.55

5. Discussion

Data on fresh herbage yield as influenced by different nitrogen levels shown that nitrogen (140 kg/hectare) application resulted in a higher fresh herbage yield (199.60 quintal/hectare) than other nitrogen treatments combined and control (151.53 quintal/hectare). Increased fresh herbage output contributing variables such as plant height, plant spread, stem width, and numerous branches could explain the significantly greater fresh herbage yield in treatment nitrogen (140 kg/hectare). Singh *et al.* (1989), Randhawa *et al.* (1984), Russell *et al.* (1993), Anwar *et al.* (1993) have all reported on the favourable effect of nitrogen on herbage yield. It is fact that in present soil, farmyard manure (FYM) is decreasing day-by-day due to the use of an increasing amount of chemical fertilizers for the production of plant organs. It means organic farmyard manure (FYM) might be rated as the best source with optimum quantity (25 tonn/ hectare) in terms of increasing fresh herbage yield of mentha. Data on dry herbage yield indicated that significant variation was due to different nitrogen treatments. The application of nitrogen (140 kg/ hectare) resulted in the highest dry herbage yield (39.92 quintal/ hectare). The higher dry herbage yield through nitrogen (140 kg/ hectare) might be due to vigour fresh and the development of foliage that is expressed in the case of fresh herbage yield. Similar results were observed by Dhanjal *et al.* (2003), Alsafar *et al.* (2009). Data on oil yield revealed that different organics dosages caused significant variance. The maximum oil yield (177.61 liter/hectare) was obtained due to the application of nitrogen (140 kg/hectare). The higher oil yield through nitrogen (140 kg/hectare), might be due to higher foliage resulting in higher oil yield as similar results were observed in the case of fresh herbage yield. Similar results were observed by Singh *et al.* (1989), Bahal *et al.* (2000). Data on oil % content in mentha oil was found non-significant variation observed due to various nitrogen doses. The maximum oil % content (0.88) was obtained with the application of nitrogen (140 kg/hectare). Similar results were observed by Valtcho *et al.* (2012), Bahal *et al.* (2000). Farmers will not embrace agricultural advice unless they are economically feasible, and recommendations for scientific crop management will not be accepted until treatments are not economically viable. In this regard, the economic analysis of several nitrogen treatments in the current study revealed that the treatment nitrogen 140 kg/hectare had the greatest cost of cultivation. This was due to higher input costs and a higher cost of 160 kg nitrogen/ hectare. The highest gross return was achieved with treatment nitrogen 140 kg/hectare. The treatment nitrogen 140 kg/hectare resulted in a greater net return per rupee invested (2.47) due to higher dry herbage output and lower cultivation costs and lower cost of farmyard manure (FYM).

6. Conclusion

Nitrogen (140 kg/hectare) was used to get the highest fresh herbage production, dry herbage yield, oil yield, and oil per cent content. The application of nitrogen (140 kg/hectare) had the highest net return (Rs. 90818) and cost-benefit ratio (2.77) among the various nitrogen levels applied. Nitrogen (140 kg/hectare) performed better in improving fresh and dried herb yield, oil yield (liter/hectare), and quality. According to the overall experimental results, larger dry herb yields of mentha can be produced with the application of nitrogen (140 kg/hectare) for a higher economic return. The current discovery is particularly significant in the context of raising farmer understanding of the usage of varying nitrogen concentrations to increase the oil production of vital medicinal plants (Mentha and others). In order to preserve the quality value of mentha processed products in the international market, it is also necessary to investigate the usefulness of various nitrogen levels in increasing their quality.

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Conflict of interest

The authors declare no conflicts of interest relevant to this article.

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