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ORIGINAL ARTICLE **OPEN ACCESS**

Influence of Nitrogen and Phosphorus on the Growth and Quality of Japanese Mint (*Mentha arvensis* L.)

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Abstract

A field experiment was conducted in 2021 at the Department of Agronomy, Agricultural Research Farm, J.V. College, Baraut (Baghpat), to study the effect of nitrogen and phosphorus on the growth, yield, and quality of Japanese mint (Mentha arvensis L.). The results revealed that plant height, number of branches per plant, and stem girth increased significantly with higher nitrogen and phosphorus levels. At 90 days after planting (DAP), the maximum plant height was recorded with the application of 200 kg N/ha, while the lowest was observed at 40 kg N/ha. The number of branches per plant also showed a substantial increase with rising nitrogen levels. A linear increase in stem girth was noted with the application of nitrogen. Similarly, phosphorus application up to 80 kg/ha positively influenced plant height, stem girth, and the number of branches per plant. These findings suggest that an optimal combination of nitrogen and phosphorus enhances the vegetative growth and yield potential of Japanese mint under field conditions.

Keywords: *Mentha arvensis*, Japanese mint, Nitrogen, Phosphorus, Essential oil, Agronomic practices, Medicinal plants, Nutrient management *etc.*

Introduction

The cultivation of aromatic plants for medicinal and culinary purposes has been practiced for centuries, serving as a significant source of valuable compounds. Among these plants, Japanese mint (*Mentha arvensis*) has gained considerable attention due to its unique aroma and wide range of applications. To maximize the growth, quality, and yield of Japanese mint, it is crucial to understand the influence of essential nutrients such as nitrogen (N) and phosphorus (P) on its development. This paper explores the effect of nitrogen and phosphorus on the growth, quality, and yield of Japanese mint, shedding light on optimal nutrient management practices for maximizing productivity.

Japanese mint (*Mentha arvensis* L.) is a commercially important aromatic and medicinal plant widely cultivated for its essential oil, particularly menthol, which is used in pharmaceuticals, cosmetics, food flavoring, and oral care products. India is one of the leading producers and exporters of mint oil globally due to its favorable agro-climatic conditions and the high economic return of this crop (Kothari *et al.*, 2004). The productivity and quality of Japanese mint are highly influenced by balanced and adequate nutrient supply, particularly nitrogen (N) and phosphorus (P). Nitrogen is a key element for vegetative growth, chlorophyll synthesis, and protein formation, while phosphorus plays a crucial role in energy transfer, root development, and flowering (Sharma *et al.*, 2010; Tomar & Verma, 2016). Several researchers have reported that optimal nitrogen levels can significantly increase leaf biomass and essential oil yield in mint (Kumar *et al.*, 2015; Ali *et al.*, 2017). Phosphorus, though required in lesser amounts than nitrogen, enhances nutrient uptake efficiency and contributes to higher oil concentration in the plant (Gupta *et al.*, 2020).

Japanese mint is a perennial herbaceous plant known for its high content of essential oil, particularly menthol. The plant's leaves and essential oil are widely used in the pharmaceutical, cosmetic, and food industries. Achieving optimal growth and maximizing the content of bioactive compounds, such as menthol, is vital for enhancing the economic and therapeutic value of Japanese mint. Japanese mint is also known as Menthol mint, Canadian Mint, Japanese Peppermint, North American Corn Mint and North American field Mint. Japanese mint is the major source of raw material for the flavor and fragrance industry. It is valuable commercially because of its high oil yield and the menthol content. Products from Japanese mint viz., essential oil, menthol, menthol crystals, dementholized oil, mint terpenes etc., are extensively used in flavor, fragrance, and pharmaceutical industries. In fragrance or perfumery, their use is because of the "lifting effect" at low concentrations. Some cosmetic goods, such as lipsticks, face creams, hair lotions, and shaving creams, also take advantage of the cooling effect. In the pharmaceutical sector, they are used as ingredients in goods including shoe polish, toothpaste, mouth fresheners, and aerosols (George, 1994). Menthol's refreshing aroma and cooling action along with its stimulant and antiseptic properties have led to its widespread use for medicinal purposes such as inhales, cough syrups and ointments.

Nitrogen and phosphorus are two critical macronutrients that play pivotal roles in plant growth and development. Nitrogen is an essential component of proteins, nucleic acids, and chlorophyll, directly influencing plant metabolism and photosynthetic efficiency. As a vital component of chlorophyll, it plays a key role in photosynthesis and the production of photosynthates, which contribute to the development of vegetative parts. These structures are directly linked to crop yield (Kanwar, 1978). Phosphorus, on the other hand, is involved in energy transfer and plays a vital role in cellular processes such as photosynthesis, respiration, and synthesis of nucleic acids. The availability and application of nitrogen and phosphorus significantly affect the growth, quality, and yield of Japanese mint. Nitrogen deficiency often leads to stunted growth, chlorosis, and reduced essential oil content in plants. Conversely, unnecessary nitrogen fertilization can result in lush vegetative growth at the expense of reduced essential oil accumulation. Therefore, finding the appropriate nitrogen application rate is crucial for optimizing both vegetative growth and essential oil production in Japanese mint.

Phosphorus, in turn, influences root development, flowering, and seed formation in plants. Insufficient phosphorus availability can limit the overall growth and development of Japanese mint, resulting in reduced biomass and essential oil production. Conversely, excess phosphorus can negatively impact the uptake of other nutrients and contribute to environmental pollution. Thus, understanding the optimal phosphorus requirement is essential to strike a balance between growth promotion and sustainable cultivation practices.

Studies by Patra *et al.,* (2002) and Singh *et al.,* (2012) have shown that combined application of N and P results in improved physiological performance and essential oil biosynthesis in Mentha species. However, over-application can lead to environmental issues and increased production costs, necessitating research to determine the optimum nutrient levels. Therefore, the present study was undertaken to evaluate the influence of varying levels of nitrogen and phosphorus on growth, yield, and oil content of Japanese mint under field conditions. The study aims to recommend nutrient management practices that enhance both economic returns and environmental sustainability. Several studies have investigated the effect of nitrogen and phosphorus on Japanese mint, highlighting the complex interaction between nutrient availability, plant physiology, and secondary metabolite synthesis. However, there is still a need for further research to determine the ideal nutrient ratios, application timing, and methods for maximizing both growth and essential oil yield. Hence, the current study was undertaken to determine the optimal levels of nitrogen and phosphorus for improving the growth and yield of Japanese mint.

Materials and Methods

The study was carried out during the Rabi season of 2021 at the Department of Agronomy, Agricultural Research Farm, J.V. College, Baraut (Baghpat), to evaluate the impact of different nitrogen and phosphorus levels on the growth, yield, and quality of the Japanese mint (Mentha arvensis L.) variety 'Simkranti'. A factorial randomized complete block design (FRBD) was used, comprising fifteen treatment combinations with three replications. Nitrogen and phosphorus served as Factor A and Factor B, respectively. The respective fertilizers were applied to each plot based on the treatment combinations. Nitrogen, sourced from urea, was applied in two splits—initially as a basal dose and again at 45 days after planting. Phosphorus, in the form of single super phosphate, was applied entirely as a basal dose. Potassium was uniformly applied at a rate of 40 kg/ha across all plots using muriate of potash. All fertilizers were broadcast evenly in rows and well incorporated into the soil. The crop was harvested 90 days after planting by cutting the plants 1 to 4 cm above ground level with sharp sickles, in the late morning to ensure higher essential oil content. Growth observations were recorded from five randomly selected plants per replication across all treatments at 30, 60, and 90 days after planting (DAP).

Results and Discussion

Table 1 presents the data on plant height at various stages of crop growth as influenced by different levels of nitrogen, phosphorus, and their interactions. Nitrogen application significantly affected plant height at all growth stages except at 30 days after planting (DAP). At 60 DAP, the tallest plants (46.59 cm) were observed with the application of 200 kg N/ha (N_5), followed by N_4 (43.82 cm). The shortest plants (38.56 cm) were recorded with the lowest nitrogen level of 40 kg N/ha (N_1). A similar trend was noted at 90 DAP, where N_5 (200 kg N/ha) again produced the highest plant height (63.41 cm), followed by N_4 (60.02 cm), while the minimum height (56.12 cm) was seen in N_1.

Phosphorus levels also significantly influenced plant height at all stages except at 30 DAP. At 60 DAP, the highest plant height (44.12 cm) was recorded with 80 kg P_2O_5/ha (P_3), while the lowest (39.13 cm) was noted with 40 kg P_2O_5/ha (P_1). A similar pattern continued at 90 DAP, with P3 producing the tallest plants (60.39 cm) and P_1 the shortest (57.93 cm).

Although the interaction between nitrogen and phosphorus levels was not statistically significant at any stage of growth, the treatment combination N_5P_3 (200 kg N/ha + 80 kg P_2O_5/ha) resulted in the tallest plants, measuring 49.20 cm at 60 DAP and 64.31 cm at 90 DAP. Conversely, the shortest plants were recorded under the N_1P_1 treatment (40 kg N/ha + 40 kg P_2O_5/ha), with heights of 36.38 cm and 54.82 cm at 60 and 90 DAP, respectively.

The data pertaining to the number of branches per plant at different stages of crop growth as influenced by nitrogen and phosphorus levels and their interaction are presented in Table 2. The results revealed that application of nitrogen had significant influence on production of number of branches at all the stages of plant growth except at 30 DAP. Among the nitrogen level at 60 DAP, N_4 (160 kg N/ha) recorded maximum number of branches per plant (12.33) and was followed by N_5 (11.00). The lowest number of branches per plant (8.67) was noticed in N1 (40 kg N/ha). At later stage of crop growth (90 DAP), the highest (18.33) and lowest number of branches (14.67) were recorded in plants supplied with 160 kg N per ha (N_4) and 40 kg N per ha (N_1), respectively. Significant variation in number of branches per plant was observed at all the stages of crop growth except at 30 DAP due to application of phosphorus. At 60 DAP, maximum number of branches per plant (10.73) was observed in P_3 (80 kg P2O5/ha) which was followed by P_2 (60 kg P/ha) and minimum (9.93) was observed in P_1 (40 kg P_2O_5/ha). At 90 DAP, higher number of branches per plant (16.73) was noticed at 80 kg P2O5 per hectare (P_3) and minimum (15.93) was observed at 40 kg P_2O_5 per hectare (P_1). Number of branches per plant did not differ significantly at any stages of plant growth (30, 60, 90 DAP) due to interaction of nitrogen and phosphorus levels. However, at 3 DAP; treatment N_3P_3 recorded more number of branches (3.67). Whereas, the treatment N_4P3 recorded maximum number of branches at 60 and 90 DAP (13.00 and 19.00, respectively). At 30 DAP, treatment N_2P_1 recorded the least number of branches (2.33).Whereas, at 60 and 90 days after planting, the least number of branches (8.32 and 14.28, respectively) was observed in N_1P_1 treatment combination.

The data on stem girth at different stages of crop growth as influenced by nitrogen and phosphorus levels and their interactions are presented in Table 3. Application of nitrogen significantly influenced the stem girth at all growth stages of crop except at 30 DAP. At 60 DAP, the highest stem girth (6.20 mm) was recorded in plants supplied with 160 kg nitrogen (N_4) and was followed by N_5 (6.05 mm). The lowest stem girth (5.83 mm) was observed in plants supplied with 40 kg nitrogen (N_1). Similarly at 90 DAP, N_4 (160 kg N/ha) recorded maximum stem girth (10.78 mm) which was followed by N5 (10.18 mm), while the lowest (8.58 mm) was noticed at 40 kg nitrogen per hectare (N_1).

Application of phosphorus had significant effect on stem girth at all the stages of crop growth except at 30 DAP. At 60 DAP, treatment P_3 (80 kg P_2O_5/ha) recorded the highest stem girth (6.12 mm) and the lowest (5.92 mm) was found in P_1 (40 kg P_2O_5/ha). Similarly at 90 DAP, the application of 80 kg of phosphorus per hectare (P_3) recorded the highest stem girth (9.85 mm) and the lowest (9.32 mm) was found inP1 (40 kgP_2O_5/ha).

There were no significant differences due to interaction effect of nitrogen and phosphorus levels on stem girth at all the stages of growth. However, the combination of 160 kg nitrogen per hectare and 80 kg phosphorus per hectare (N_4P_3) recorded maximum stem girth at all the stages (4.21 mm, 6.32 mm and 11.26 mm, respectively at 30, 60 and 90 days after planting). Whereas, the minimum stem girth of 3.62 mm, 5.72 mm and 8.27 mm was noticed at 30, 60 and 90 DAP in N_1P_1 treatment combination, respectively.

Plant height showed a significant increase with higher nitrogen application. At 90 days after planting (DAP), the tallest plants (63.41 cm) were observed with the highest nitrogen level of 200 kg/ha (N_5), while the shortest plants (56.12 cm) were recorded at the lowest nitrogen level of 40 kg/ha (N_1). This positive effect of nitrogen on plant height is likely due to its role in promoting cell division and elongation, stimulating meristematic growth, and being efficiently utilized by the plant, resulting in taller growth. These findings align with the studies by Singh and Singh (1977), Mahantesh *et al.*, (2017), and Shormin *et al.*, (2009) in *Mentha arvensis*, Chinnabbai (1991) in Mentha viridis, Singh and Ramesh (2002) in sweet basil, Santosh *et al.*, (2010) in garden cress, Verma *et al.*, (2010) in clary sage, Laura *et al.*, (2011) in French basil, Tuncturk *et al.*, (2011) in fenugreek, and Patel and Kushwaha (2013) in *Ocimum species*.

Similarly, the number of branches per plant also increased significantly with higher nitrogen levels. The maximum number of branches (18.33) was recorded at 160 kg N/ha (N_3), whereas the minimum (14.67) was observed with 40 kg N/ha (N_1). This increase in branching over time may be attributed to nitrogen availability during the vegetative growth stage and the effectiveness of split nitrogen application. These results are consistent with findings by Mahantesh *et al.*, (2017), Singh and Singh (1977), Santosh *et al.*, (2010), Verma *et al.*, (2010), Tuncturk *et al.*, (2011), and Patel and Kushwaha (2013).

Stem girth also followed a linear trend with increasing nitrogen levels. The thickest stems (10.78 mm) were found with 160 kg N/ha (N_4), while the thinnest (8.58 mm) occurred with 40 kg N/ha (N_1), likely due to better nitrogen availability at critical growth stages. Similar observations were made by Mahantesh *et al.*, (2017) in *Mentha arvensis*.

At 90 DAP, phosphorus application also had a significant effect on plant height. The maximum height (60.39 cm) was observed with 80 kg P_2O_5/ha (P_3), while the minimum (57.93 cm) occurred with 40 kg P_2O_5/ha (P_1). Phosphorus likely enhanced plant height by stimulating cell division, boosting metabolic activity, and facilitating energy production (ATP synthesis), which supports biochemical and enzymatic functions. It also plays a key role in root development and early plant establishment. These findings agree with the work of Sharma *et al.,* (1975) and Munshi (1992) in *Mentha arvensis*.

Branch productions also significantly increased with higher phosphorus levels at 90 DAP. The highest number of branches (16.73) was recorded with 80 kg P_2O_5/ha (P3), while the lowest (15.93) was seen with 40 kg P_2O_5/ha (P_1). This increase is likely due to the formation of secondary and tertiary branches during later growth stages, supported by improved nutrient uptake and energy transfer from phosphorus. These findings align with Sharma *et al.*, (1975).

Stem girth showed a steady increase with rising phosphorus doses. The maximum girth (9.85 mm) was observed with 80 kg P_2O_5/ha (P_3), while the minimum (9.32 mm) was recorded at 40 kg P_2O_5/ha (P_1). This could be attributed to better phosphorus availability during early growth, contributing to stronger stem development. Similar trends were reported by Singh *et al.*, (1983) in Mentha citrata.

Conclusions

In conclusion, nitrogen and phosphorus play crucial roles in the growth, quality, and yield of Japanese mint. Achieving the optimal balance of these nutrients is essential for maximizing the accumulation of bioactive compounds, such as menthol, while ensuring sustainable cultivation practices. Understanding the interplay between nutrient availability and plant physiology will provide valuable insights for developing efficient nutrient management strategies, enhancing the economic viability and therapeutic potential of Japanese mint cultivation.

Reference

Ali, A., Khan, M.A., and Qasim, M. (2017). Role of N and P fertilization in the yield and oil content of mint. *Pak. J. Bot*., 49(4), 1459–1463.

Chinnaibbai, J., (1991). Effect of row spacing and nitrogen level on growth and herbage yield of mint (*Mentha viridis*L.). *M.Sc Thesis, Univ. Agri. Sci. Hyderabad*.

George, C.K., (1994). Export of mint oils from India and world trade. *Indian Perfumer*, 38(3): 76-81

Gupta, A., Yadav, S.S., and Singh, J. (2020). Impact of phosphorus fertilization on essential oil content in aromatic plants. *Agricultural Reviews*, 41(3), 210–216.

Kanwar, J.S., (1978), Soil fertility theory and practice. *ICAR, New Delhi*, p 533.

Kothari, S.K., Bhattacharya, A.K., and Ramesh, S. (2004). Effect of nitrogen on growth, herbage yield and oil quality of Japanese mint. *Industrial Crops and Products*, 19(3), 231–235.

Kumar, R., Meena, R.K., and Pathak, R.K. (2015). Response of mint to graded levels of nitrogen. *Indian Journal of Horticulture*, 72(1), 112–116.

Laura, F., Giuseppina, S. and Vittoria, R. (2011). The influence of different nitrogen treatments on the growth and yield of basil (*Ocimum basilicum* L.). *J. Chem. Eng.*, 5: 799-803.

Mahantesh, P.S., Gangadharappa, P.M., Hiremath, J.S., Sharatbabu, A.G., Pooja, M.R. and Nischitha, M. (2017), Effect of row spacing and nitrogen levels on growth and yield of Japanese mint (*Mentha arvensis* L.). *Int. J. Agri. Sci.,* 9(21): 4222-4225.

Munshi, P.S., (1992). Nitrogen and phosphorus nutrition response in Japanese mint cultivation. *Acta Hort.,* 306: 436-443

Patel, K. and Kushwaha, N.K. (2013). Studies on influence of species, nitrogen and spacing on parameters of plant growth at various stages of basil. *Int. J. Pharm. & Life Sci.,* 4(10): 3028-3034.

Patra, D.D., Anwar, M. and Chand, S. (2002). Integrated nutrient management in coriander and mentha. *Journal of Medicinal and Aromatic Plant Sciences*, 24(1), 35–39.

Santosh, C., Keshawa, G.L. and Yadav, L.R. (2010), Effect of row spacing's and nitrogen levels on productivity of garden cress (*Lepidium sativum*). *Ind. J. Agric. Sci.,* 80(8): 752-754.

Sharma, S.N., and Prasad, R. (2010). Fertilizer use and plant nutrition. *Indian Journal of Agronomy*, 55(2), 123–132.

Sharma, V., Singh, R. and Choudhari, M.A. (1975), Effect of application of N, P and K on growth and yield of essential oil and menthol in *Mentha arvensi(L.). J. Pafai.,* 6(1): 20-24

Singh V.P and Singh, N.P. (1977). Performance of Mentha species in relation to levels of nitrogen application. *Indian Perfumer,* 23:184-188.

Singh, M. and Ramesh, S., (2000), Effect of irrigation and nitrogen on herbage, oil yield and water use efficiency in rosemary grown under semi-arid tropical conditions. *J. Med. Arom. Pl. Sci.,* 22: 659-662.

Singh, M., Singh, D.V. and Rai, R. (2012). Influence of nitrogen and phosphorus on oil yield and composition in Japanese mint. *Journal of Essential Oil Research*, 24(4), 383–387.

Singh, V.P., Bhattacharya, A.K., Singh, A.K., Singh, K. and Singh, J.P. (1983). Effect of N and P ferlitizers on the herb and oil yields and quality of Mentha citrata oil. *Indian Perfumer*, 27: 24-27.

Tomar, R.K. and Verma, A. (2016). Nutrient uptake and productivity of medicinal crops under different fertility regimes. *Journal of Agronomic Science*, 12(2), 49–53.

Tuncturk, R., Celen, A. and Tuncturk, M., (2011), Effect of Nitrogen and spacing levels on growth and yield attributes of fenugreek (*Trigonella foenumgrecaum* L.). *Turk. J. Field Crops*, 16(1): 69-75.

Verma, R., Laiq-ur, R., Ram swaroop, V., Chauhan, A., Singh, A. and Kalra, A. (2010). Effect of nitrogen and phosphorus levels on plant growth and yield attributes of clary sage (*Salvia sclarea* L.). *Int. J. Agron. Pl. Prod*., 1(4): 129-137.

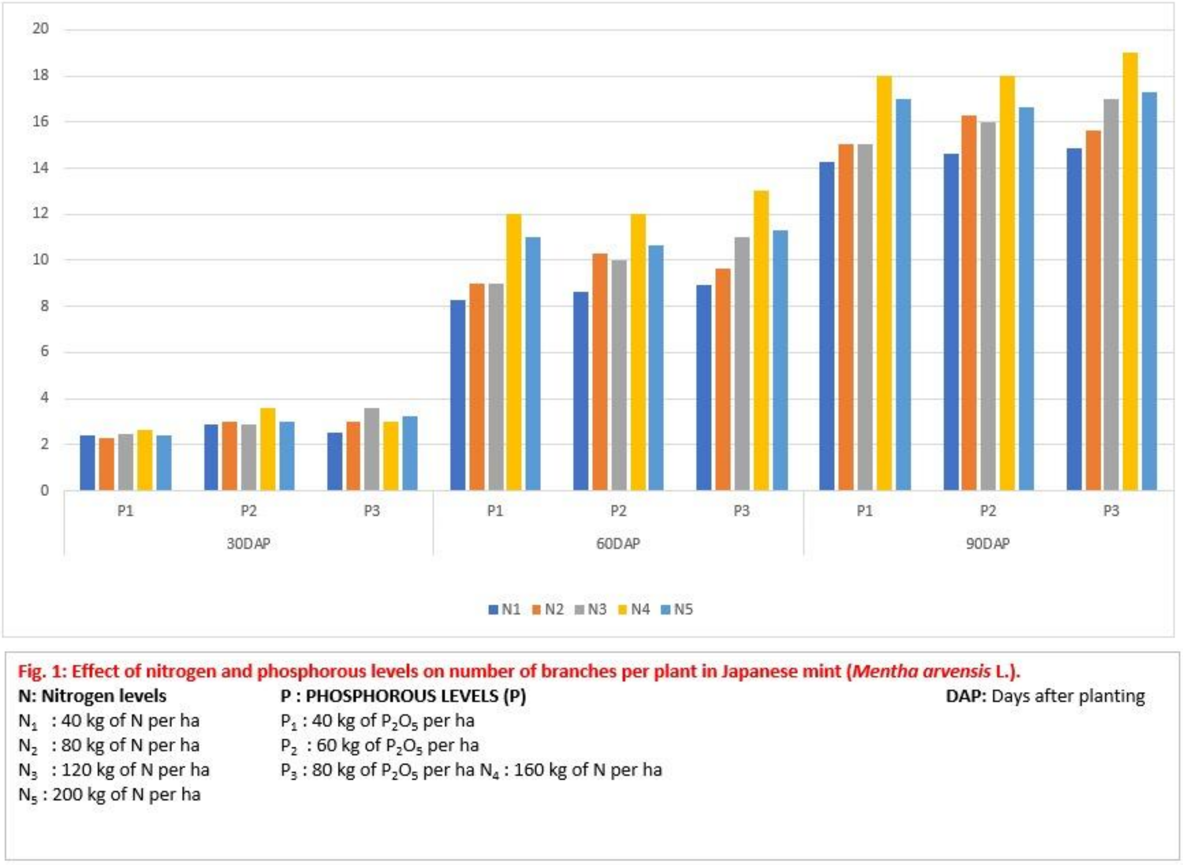

Fig. 1: Effect of nitrogen and phosphorus levels on number of branches per plant in Japanese mint (*Mentha arvensis* L.)

Table 1: Effect of nitrogen and phosphorus levels on plant height (cm) in Japanese mint (*Mentha arvensis* L.)

Treatments	Plant height (cm)											
	30DAP				60DAP				90DAP			
	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
N_1	20.11	21.25	20.94	20.76	36.37	39.32	39.98	38.55	54.81	55.60	57.93	56.11
N_2	22.23	21.22	20.51	21.32	37.17	41.40	42.53	40.36	55.70	56.84	58.81	57.11
N_3	21.30	21.42	21.45	21.39	38.04	42.39	43.22	41.21	57.25	57.23	59.88	58.12
N_4	20.87	20.92	20.78	20.85	40.84	45.00	45.62	43.82	59.18	59.8	60.96	59.98
N_5	21.63	20.32	20.87	20.94	43.1	47.38	49.19	46.55	62.68	63.23	64.30	63.40
Mean	21.22	21.02	20.90		39.10	43.09	44.10		57.92	58.54	60.37	
	S. Em±		CD at 5%		S. Em±		CD at 5%		S. Em±		CD at 5%	
N	0.35		NS		0.39		1.09		0.28		0.79	
P	0.28		NS		0.29		0.88		0.23		0.62	
NXP	0.61		NS		0.68		NS		0.51		NS	

N: Nitrogen levels N_1: 40 kg of N per ha N_2: 80 kg of N per ha N_3: 120 kg of N per ha N_4: 160 kg of N per ha N_5: 200 kg of N per ha
P: Phosphorus levels (P) P_1: 40 kg of P_2O_5 per ha P_2: 60 kg of P_2O_5 per ha P_3: 80 kg of P_2O_5 per ha
DAP: Days after planting
NS: Non-significant

Table 2: Effect of nitrogen and phosphorus levels on number of branches per plant in Japanese mint (*Mentha arvensis* L.)

Treatments	Number of branches											
	30DAP				60DAP				90DAP			
	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
N_1	2.39	2.87	2.52	2.59	8.30	8.64	8.96	8.63	14.26	14.62	14.85	14.57
N_2	2.30	3.00	3.01	2.77	9.01	10.31	9.63	9.65	15.01	16.31	15.64	15.65
N_3	2.48	2.89	3.62	2.99	9.01	10.02	11.02	10.01	15.01	16.01	17.01	16.01
N_4	2.64	3.57	3.02	3.07	12.02	12.02	13.02	12.35	18.02	18.02	19.02	18.35
N_5	2.39	3.00	3.25	2.88	11.01	10.64	11.29	10.98	17.02	16.64	17.31	16.99
Mean	2.44	3.06	3.08		9.87	10.32	10.78		15.86	16.32	16.76	
	S. Em±		**CD at 5%**		**S. Em±**		**CD at 5%**		**S. Em±**		**CD at 5%**	
N	0.27		NS		0.23		0.62		0.23		0.62	
P	0.19		NS		0.19		0.49		0.18		0.42	
NXP	0.43		NS		0.39		NS		0.38		NS	

N: Nitrogen levels N_1: 40 kg of N per ha N_2: 80 kg of N per ha N_3: 120 kg of N per ha N_4: 160 kg of N per ha N_5: 200 kg of N per ha
P: Phosphorus levels (P) P_1: 40 kg of P_2O_5per ha P_2: 60 kg of P_2O_5per ha P_3: 80 kg of P_2O_5 per ha
DAP: Days after planting
NS: Non-significant

Table 3: Effect of nitrogen and phosphorus levels on stem girth (mm) in Japanese mint (*Mentha arvensis* L.)

Treatments	Stem girth (mm)											
	30DAP				60DAP				90DAP			
	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean	P_1	P_2	P_3	Mean
N_1	3.52	3.67	3.70	3.63	5.56	5.67	5.80	5.67	8.26	8.54	8.93	8.57
N_2	3.62	3.64	3.74	3.66	5.72	5.81	6.05	5.76	8.74	8.93	9.09	8.92
N_3	3.62	3.95	3.78	3.85	5.77	5.80	6.01	5.86	9.19	9.39	9.56	9.04
N_4	3.83	3.76	4.19	3.92	6.01	6.09	6.22	6.10	10.46	10.61	11.28	10.78
N_5	3.75	3.54	3.84	3.71	5.85	6.01	6.07	5.97	9.88	10.29	10.30	10.15
Mean	3.67	3.71	3.85		5.78	5.88	6.03		9.31	9.55	9.83	

	30DAP S. Em±	30DAP CD at 5%	60DAP S. Em±	60DAP CD at 5%	90DAP S. Em±	90DAP CD at 5%
N	0.06	NS	0.03	0.8	0.06	0.21
P	0.05	NS	0.02	0.6	0.05	0.16
NXP	0.11	NS	0.04	NS	0.12	NS

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