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Effect of INM and planting date on dry herbage yield and nutrient uptake of mint (*Mentha arvensis* L.)

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Abstract
The present investigation entitled "Effect of INM and planting date on dry herbage yield and nutrient uptake of mint (*Mentha arvensis* L.) is carried out at COH, Parvathipuram, Dr. Y.S.R. Horticultural University, during *Summer* season 2021. The experiment was laid out in factorial randomized block design with combinations of four planting dates (first fortnight of February, second fortnight of February, first fortnight of March and second fortnight of March) and four nutrient doses (N_1 - 100% RDN, N_2 - 75% RDN+ (12.5% FYM + 12.5% Vermicompost) + Rhizobium + PSB + KMB, N_3 - 50% RDN + (25% FYM + 25% Vermicompost) + Rhizobium + PSB + KMB and N_4 - 100% organic (50% FYM + 50% Vermicompost). The results revealed that the conjunctive use of organic, inorganic fertilizer along with biofertilizers increased the dry herbage yield and nutrient uptake of mint. Application of 75% RDN+ (12.5% FYM + 12.5% Vermicompost) + Rhizobium + PSB + KMB, registered the highest dry herbage yield (7.16 and 2.74 q ha^{-1}) at first and final harvest and maximum uptake of nutrient at final harvest as N (21.13 kg ha^{-1}), P (6.93 kg ha^{-1}) and K (41.53 kg ha^{-1}).

Keywords: Japanese mint, dry herbage yield, FYM, vermicompost, bio-fertilizers, INM (Integrated nutrient management)

Introduction
Mint (*Mentha arvensis* L.) is an important essential oil bearing crop; known as japanese mint, menthol mint, grown as an aromatic plant belongs to the family *Lamiaceae*. Over the years, the essential oils extracted from japanese mint have become precious and indispensable ingredients of the fragrance, pharmaceuticals and flavour industry. The high economic value of essential oil is due to the presence of a complex mixture of volatile substances, monoterpenes, sesquiterpenes and their oxygenated analogs present at low concentrations in plants (Taie *et al*., 2010) [18]. The oil yield may vary under different agro climates, soil conditions and nutrient application (Duhan and Gulati, 1977) [5]. Congenial climatic conditions with ample sunshine hours, rainfall and humidity plays an important role in growth and yield of the crop. Among the plant nutrients, nitrogen phosphorus and potassium are the most important macro nutrient elements that decide the yield level. The nature and the characteristics of nutrient release of chemical, organic and biofertilizers are different, and each type of fertilizer has its advantages and disadvantages in the context of nutrient supply, crop growth and environmental quality. The advantages need to be integrated in order to make optimum use of each type of fertilizer and achieve balanced nutrient management for crop growth. Applying of organic manures and biofertilizers has led to a decrease in the use of chemical fertilizers and has provided high quality products free of harmful agrochemicals for human safety (Mahfouz and Sharaf Eldin, 2007) [10]. The rigorous management of fertilization must try to ensure both an improved and safeguarded environment; so, a balanced fertilization strategy that combines the use of chemical, organic or biofertilizers must be developed and evaluated. In this context, the present study aimed to show the effect of integrated nutrient management and planting dates on dry herbage yield, nutrient uptake of mint (*Mentha arvensis* L.).

Material and Methods
Field experiment was conducted in a factorial randomized complete block design with three replications in the experimental field of COH, Parvathipuram, Dr. YSRHU, during the Summer season of 2021-22. The experimental fields were located at $18^0 47'$ N latitude, $83^0 26'$ E longitude and $18^0 48'$N latitude, $83^0 30'$ E longitude respectively. Soil of the experimental field belongs to Visakhapatnam soil series, taxonomically typic haplustept, fine, mixed,

semiactive, iso-hyperthermic, non-calcareous and sandy loam texture. Initial experimental soil samples (0-30 cm depth) were taken for the nutrient analysis prior to land preparation and analyzed using standard procedures (Piper, 1966; Jackson, 1973; Subbaiah and Asija, 1956) [13, 7, 17]. Physical and chemical properties of the initial experimental soil are presented in Table 1. The nutrients were supplied in the form of straight fertilizers like urea, single super phosphate and muriate of potash. The land was brought to a fine tilth by ploughing and harrowing. The experimental site was divided into plots having dimensions of 4 m long and 3m wide. Healthy and disease free plant saplings were collected from the nursery and planted at 15 cm spacing, at a depth of 2.5 to 4.0 cm and later covered with soil. The seed rate followed was 400 kg stolons ha^{-1}. Five plants were randomly selected from each plot and the observations were recorded. Dried plant samples were ground to a fine powder and analyzed for determination of total nutrients content by adopting standard methods. The total nitrogen (%) was determined by Micro-kjeldhal method as outlined by Piper (1966) [13], total phosphorus was estimated from di-acid extract by Vanadomolybdate phosphoric acid yellow colour method (Kitson and Mellon, 1944) [8] using spectrophotometer. Total potassium was estimated from di-acid extract by using flame photometer (Piper, 1966) [13]. Total plant nutrient uptake was calculated by following the equation:

$$\text{Nutrient uptake (kg ha}^{-1}\text{)} = \frac{\text{Nutrient content (\%) x Dry matter yield (kg ha}^{-1}\text{)}}{100}$$

Statistical Analysis

Statistical analysis for the data recorded was done by following the analysis of variance for randomized block design with factorial concept as suggested by Gomez and Gomez (1984) [6]. The significance was tested by applying F-test at 0.05 level of probability and critical differences were calculated for those parameters which turned to the significant (p<0.05) in order to compare the effects of different treatments.

Results and Discussion

Dry herbage yield (q ha^{-1})

The data on dry herbage yield of mint as influenced by planting dates, different levels of N, organic fertilizers and with bio-fertilizers is given in Table 2. Significant difference for dry herbage yield per hectare at different planting dates was recorded at 100 DAP (First harvest) and 150 DAP (Final harvest). Among the dates of planting, the highest dry herbage yield per hectare of 3.04 for S_2 followed by S_1 of 2.82 and lowest dry herbage yield per hectare of 2.26 was recorded in S_4 at 100 DAP. At final harvest the highest dry herbage yield per hectare of 3.06 for S_1 followed by S_2 of 2.76 and lowest dry herbage yield per hectare of 1.48 was recorded in S at 150 DAP.

Significant difference for dry herbage yield per hectare among different levels of nutrients was recorded at 100 DAP (First harvest) and 150 DAP (Final harvest) for dry herbage yield per hectare. The highest dry herbage yield per hectare of 3.41 for N_2 followed by N_3 (2.93) and lowest dry herbage yield per hectare of 2.12 was recorded in N_4 at 100 DAP. At final harvest the highest dry herbage yield per hectare of 3.53 for N_2 followed by N_3 of 2.45 and lowest dry herbage yield per hectare of 1.75 was recorded in N_1 at 150 DAP.

Significant difference for interaction effects was recorded at 100 DAP (First harvest) and 150 DAP (Final harvest). Among the interaction effects the highest dry herbage yield per hectare of 4.66 in S_2N_2 whereas the lowest dry herbage yield per hectare of 1.27 was recorded in S_4N_4 at 100 DAP. At final harvest the highest dry herbage yield per hectare of 4.50 in S_2N_2 whereas the lowest dry herbage yield per hectare of 0.80 was recorded in S_3N_1.

Nitrogen played a positive role in growth and metabolism of plants which increases dry matter accumulation in plants. Along with congenial climatic conditions use of organic, inorganic and biofertilizers and increased growth parameters might be the reason for better dry matter partitioning which resulted in corresponding high dry herbage yield per hectare in the above treatments of the experiment. These findings are in accordance with Arularasu *et al*. (2008) [2], Befrozfar *et al.* (2013) [3], Brar *et al*. (2014) [4], Nilofer *et al*. (2015) [12], Kumar *et al.* (2017) [9] and Amir and Mensure (2021) [1].

NPK uptake in plant (kg ha^{-1})

NPK uptake in plant was recorded at 150 DAP (Final harvest) for the effect of planting dates, nutrients and their interaction effects were recorded and presented in (Table 3).

Significant difference for NPK uptake in plant at different planting dates was recorded at 150 DAP (Final harvest). Among the planting dates, the highest uptake N in plant is of 14.86 for S_1 and lowest uptake of N in plant is of 8.18 was recorded in S_4. The highest uptake of P in plant is of 4.02 for S_1 and lowest uptake of P in plant is of 2.69 was recorded in S_4. The highest uptake of K in plant is of 30.38 for S_2 and lowest uptake of K in plant is of 27.93 was recorded in S_3.

Significant difference for NPK uptake in plant among different levels of nutrients was recorded at 150 DAP (Final harvest). The highest uptake of N in plant is of 15.95 for N_2 followed by N_3 of 12.95 and lowest uptake of N in plant is of 6.32 was recorded in N_1. The highest uptake of P in plant is of 4.18 for N_2 followed by N_3 of 3.78 and lowest uptake of P in plant is of 1.82 was recorded in N_1. The highest uptake of K in plant is of 37.04 for N_2 followed by N_3 of 33.35 and lowest uptake of K in plant is of 16.52 was recorded in N_1.

Significant difference for interaction effects for N, P and K was recorded at 150 DAP (Final harvest). Among the interaction effects the highest uptake of N is of 19.33 in S_1N_2 whereas the lowest uptake of N is of 2.80 was recorded in S_4N_1. The highest uptake of P is of 5.13 in S_1N_2 whereas the lowest uptake of P is of 1.07 was recorded in S_4N_1. The highest uptake of K is of 38.73 in S_2N_2 whereas the lowest uptake of K is of 14.33 was recorded in S_4N_1.

Highest uptake of NPK by plant might be due to favourable soil conditions, comparatively low rains, less leaching losses and application of organic, inorganic, and biofertilizers which not only gives additional dose of nitrogen to the plant but also increases the availability and uptake by plants. The plants treated by bio-fertilizers can absorb nutrients from soil easily resulting in accumulation of more N, P and K in the leaves (Rai, 2006) [15] that lead to increase the yield. There might be better relative proportion between N and P leading to higher uptake and also due to synergestic interaction between N and K triggers the absorption of nutrients to maintain better NPK uptake by plants. These reports were in line with Prakasa Rao *et al*. (2007) [14] and Arularasu *et al*. (2008) [2] and Saif *et al*. (2018) [16].

Table 1: Physical-chemical properties of the initial experimental soil

S. No.	Properties	Value	Method of Analysis
I	**Physical properties**		
	Sand (%)	34.77	Bouyoucos Hydrometer method (Piper, 1966) [13]
	Silt (%)	14.04	
	Clay (%)	19.02	
	Textural class	Sandy loam	
II	**Physico-chemical properties**		
	pH	7.38	Glass Electrode method (Jackson, 1973) [7]
	EC (dS m^{-1})	0.35	Digital conductivity meter (Jackson, 1973) [7]
III	**Chemical properties**		
	Organic carbon (g Kg^{-1})	0.41	Modified Walkley and Black Method (Walkley and Black, 1934)
	Available N (Kg ha^{-1})	212.0	Alkaline Permanganate method (Subbiah and Asija, 1956) [17]
	Available P_2O_5 (Kg ha^{-1})	22.6	Olsen's method (Olsen *et al.*, 1954)
	Available K_2O (Kg ha^{-1})	238.0	Neutral Normal Ammonium Acetate method (Muhr *et al.*, 1963) [11]

Table 2: Effect of planting date and nutrients on dry herbage yield (q $hectare^{-1}$) during summer season in mint (*Mentha arvensis* L.)

Treatments	100 DAP	150 DAP
Planting dates		
R_1 - First fortnight of October	2.82	3.06
R_2 - Second fortnight of October	3.04	2.76
R_3 - First fortnight of November	2.57	2.03
R_4 - Second fortnight of November	2.26	1.48
S.Em±	0.17	0.17
CD (P = 0.05)	0.51	0.49
Nutrients (Kg ha^{-1})		
N_1 - 100% RDN	2.23	1.75
N_2 - 75% RDN+ (12.5% FYM + 12.5% Vermicompost) + Rhizobium + PSB + KMB	3.41	3.33
N_3 - 50% RDN + (25% FYM + 25% Vermicompost) + Rhizobium + PSB + KMB	2.93	2.45
N_4 - 100% organic (50% FYM + 50% Vermicompost)	2.12	1.80
S.Em±	0.17	0.17
CD (P = 0.05)	0.51	0.49

Table 3: Interaction effects of planting date and nutrients on dry herbage yield (q $hectare^{-1}$) at 100 and 150 DAP during summer season in mint (*Mentha arvensis* L.)

Planting dates	Nutrients (Kg ha^{-1}) 100 DAP				Mean	Nutrients (Kg ha^{-1}) 150 DAP				Mean
	N_1	N_2	N_3	N_4		N_1	N_2	N_3	N_4	
R_1	2.68	3.97	2.87	1.76	2.82	2.81	3.90	3.46	2.08	3.06
R_2	2.61	4.66	3.06	1.85	3.04	2.49	4.50	2.10	1.95	2.76
R_3	1.74	2.27	2.69	3.60	2.57	0.80	2.64	2.43	2.28	2.03
R_4	1.90	2.74	3.11	1.27	2.26	0.92	2.30	1.82	0.90	1.48
Mean	2.23	3.41	2.93	2.12		1.75	3.33	2.45	1.80	
S.Em±	0.35					0.34				
CD (P=0.05)	1.01					0.97				

Table 4: Effect of planting date and nutrients on uptake of plant NPK (kg ha^{-1}) at final harvest during summer season in mint (*Mentha arvensis* L.).

Treatments	Nitrogen (N)	Phosphorus (P)	Potassium (K)
Planting dates			
R_1 - First fortnight of October	14.86	4.02	29.54
R_2 - Second fortnight of October	13.12	3.22	30.38
R_3 - First fortnight of November	11.52	2.73	27.93
R_4 - Second fortnight of November	8.18	2.69	28.86
S.Em±	0.30	0.08	0.30
CD (P = 0.05)	0.86	0.23	0.86
Nutrients (Kg ha^{-1})			
N_1 - 100% RDN	6.32	1.82	16.52
N_2 - 75% RDN+ (12.5% FYM + 12.5% Vermicompost) + Rhizobium + PSB + KMB	15.95	4.18	37.04
N_3 - 50% RDN + (25% FYM + 25% Vermicompost) + Rhizobium + PSB + KMB	12.95	3.78	33.35
N_4 - 100% organic (50% FYM + 50% Vermicompost)	12.46	2.88	29.80
S.Em±	0.30	0.08	0.30
CD (P = 0.05)	0.86	0.23	0.86

DAP- Days after transplanting

Table 5: Interaction effects of planting date and nutrients on uptake of plant (Kg ha^{-1}) at final harvest during summer season in mint (*Mentha arvensis* L).

N uptake					
Planting dates	Nutrients (Kg ha^{-1})				Mean
	N_1	N_2	N_3	N_4	
R_1	8.37	19.33	16.73	15.00	14.86
R_2	7.63	17.27	14.53	13.03	13.12
R_3	6.47	16.47	12.23	10.90	11.52
R_4	2.80	10.73	8.30	10.90	8.18
Mean	6.32	15.95	12.95	12.46	
S.Em±	0.59				
CD (P=0.05)	1.72				

P uptake					
Planting dates	Nutrients (Kg ha^{-1})				Mean
	N_1	N_2	N_3	N_4	
R_1	3.30	5.13	4.30	3.33	4.02
R_2	1.57	4.47	4.13	3.20	3.22
R_3	1.33	3.67	3.33	2.57	2.73
R_4	1.07	3.47	3.33	2.40	2.69
Mean	1.82	4.18	3.78	2.88	
S.Em±	0.16				
CD (P=0.05)	0.45				

K uptake					
Planting dates	Nutrients (Kg ha^{-1})				Mean
	N_1	N_2	N_3	N_4	
R_1	18.50	37.67	32.47	29.53	29.54
R_2	17.70	38.73	34.73	30.33	30.38
R_3	15.53	36.30	31.33	28.57	27.93
R_4	14.33	35.47	34.87	30.77	28.86
Mean	16.52	37.04	33.35	29.80	
S.Em±	0.59				
CD (P=0.05)	1.72				

Conclusion

The outcome of the present investigation revealed that the highest dry herbage yield and nutrient uptake was obtained with planting on first fortnight of February and application of N_2 - 75% RDN+ (12.5% FYM + 12.5% Vermicompost) + Rhizobium + PSB + KMB, followed by N_3 - 50% RDN + (25% FYM + 25% Vermicompost) + Rhizobium + PSB + KMB in mint crop during *summer* season.. Hence, the incorporation of 75% dose of recommended N along with organic source and biofertilizers may be recommended for mint crop to realize maximum dry herbage yield and nutrient uptake.

References

1. Amir S, Mensure O. Influence of planting date on growth, yield and volatile oil of menthol mint (*Mentha arvensis* L.) under marginal land conditions. Journal of Essential Oil Bearing Plants. 2021;24(2):360-73.
2. Arularasu P, Sambandamurthi S, Palanikumar M, Rajangam J. Response of nitrogen fertilisation on growth and herbage yield of sacred basil (*O. sanctum* L.). Journal of Indian Perfumery. 2008;52:56-60.
3. Befrozfar MR, Davood HA, Mehdi S, Tookallo MR. Vermicompost, plant growth promoting bacteria and humic acid can affect the growth and essence of basil (*Ocimum basilicum* L.). Journal of Annual Biological Research. 2013;4(2):8-12.
4. Brar SK, Gill BS, Brar AS, Kaur T. Straw mulch effect on biomass yield, oil yield and oil quality of Japanese mint (*Mentha arvensis* L.) harvested at successive intervals. Journal of Essential Oil Research. 2014;17(4):676-95.
5. Duhan SPS, Gulati BC. Chemical weed control studies in citronella, Java type (*Cymhopogan winterianus* Jowitt.) Effect of 2, 4-D on control of weeds, herb and oil yield. Indian Perfumer. 1977;17:77-82.
6. Gomez KA, Gomez AA. Statistical procedures in Agricultural Research. New York Chichester Wiley. 2nd edition. 1984. p. 680.
7. Jackson ML. Soil Chemical Analysis, Prentice Hall of India Pvt. Ltd., New Delhi. 1973. p. 498.
8. Kitson RE, Mellon MG. Colorimetric determination of phosphorus molybdophosphoric acid. Ind. Eng. Chem. Anal. Ed. 1944;16:379-83.
9. Kumar R, Neetu V, Singh R, Upadhyay RK, Tiwari AK. Effect of sowing dates and planting distance on growth, oil and seed yield of sweet basil (*Ocimum basilicum* L.). International Journal of Tropical Agriculture. 2017;35(1):165-69.
10. Mahfouz SA, Sharaf Eldin MA. Effect of mineral vs. biofertilizer on growth, yield, and essential oil content of fennel (*Foeniculum vulgare* Mill). *International Agrophisics*. 2007;21(4):361-66.
11. Muhr GR, Datta NP, Dever F, Lecy VK, Donahue RR. Soil testing in India. USDA, publication; c1963. p. 120.
12. Nilofer P, Singh S, Singh KA, Singh HN, Kalra A. Effect

of weather conditions on growth, yield and quality of Menthol mint (*Mentha arvensis* L.) cultivars transplanted in different years on different dates under sub-tropical climate of North India. Indian Journal of Agriculture Research. 2015;6(2):82-88.

13. Piper CS. Soil and Plant Analysis: Inter Sciences Publications, Inc., New York; c1966. p. 47-49.
14. Prakasa Rao, EVS, Puttanna K, Ganesha Rao RS, Ramesh S. Nitrogen and potassium nutrition of french basil (*Ocimum basilicum* L.). Journal of Spices and Aromatic Crops. 2007;16(2):99-105.
15. Rai MK. Handbook of microbial biofertilizers. Food Products Press. An Imprint of the Haworth Press, Inc, Binghamton, New York; c2006.
16. Saif AK. Effect of integrated nutrient management on growth, yield of French basil (*Ocimum basillicum*). M.Sc. Thesis. University of Agricultural and Horticultural Sciences. Shivamogga, India; c2018.
17. Subbaiah BV, Asija GL. A rapid procedure for the estimation of available nitrogen. Soil. Curr. Sci. 1956;5:259.
18. Taie HAA, Salama ZAER, Radwan S. Potential activity of basil plants as a source of antioxidants and anticancer agents as affected by organic and bioorganic fertilization. Not. Bot. Hort. Agrobot. Cluj. 2010;38:119.