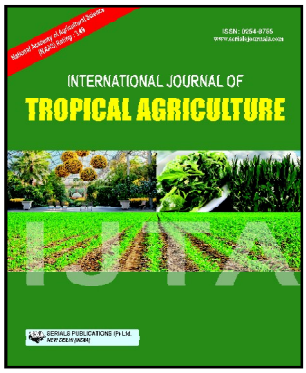

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Integrated Nutrient Management for Higher Essential Oil Yield of Menthol mint (*Mentha arvensis* L.).

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Abstract: A field experiment were conducted during 2017 to ascertain the response of primary integrated nutrient management (foliar spray of sulphur and zinc with recommended dose of NPK, alone and in conjunction) on yield contributing character, oil yield and quality of Menthol mint (*Mentha arvensis* L.). The results revealed that, application of NPK @ 100:60:40 kg ha^{-1} + Sulphur- 2.0 kg ha^{-1} foliar spray at 25 & 45 DAT + Zinc- 2.0 kg ha^{-1} 25 & 45 DAT recorded highest plant height (95.0 cm), fresh herb yield (225.70 q ha^{-1}), oil content (0.98%), and oil yield (221.19 kg ha^{-1}) of of menthol-mint as compared to other treatments.

INTRODUCTION

Menthol mint (*Mentha arvensis* L.) is a potential source of natural menthol and dementholized oil and is cultivated in the tropics and subtropical countries worldwide. Mints are aromatic, almost exclusively perennial herbs. They have wide-spreading underground and overground stolons and erect, square branched stems. The leaves are arranged in opposite pairs, from oblong to lanceolate, often downy, and with a serrated margin (Aflatuni *et. al.* 2005, Brickell *et. al.* 1997). Leaf colors range from dark green and gray-green to purple, blue, and sometimes pale yellow. The flowers are white to purple and produced in false whorls called verticillasters. The corolla is two-lipped with four subequal lobes, the upper lobe usually the largest. The area under menthol mint cultivation in India is estimated to be 0.20 million hectares with annual production of 20,000-25,000 tons of essential oil. The crop is commercially cultivated in tarai and central part of Uttar Pradesh (Barabanki, Bareli, Rampur, Badaun, Raebareli, Moradabad, Rudrapur Bilaspur Amroha,), Punjab, Bihar and Haryana (Singh

et al, 1998). The plant on hydro distillation yields essential oil containing about 75-80 % menthol, which is used in various pharmaceutical industries, food, medicines, and cosmetic preparations. Besides China and USA, India is a major producer of mint oil mostly exported to USA and European countries. Due to huge amount application agrochemicals as N, P, K soil facing problem of nutrient imbalance, agrochemical pollutions, nutritional imbalance, because less number of farmers apply good agricultural practices (GAP) practices in menthol-mint cultivation. Hence, nowadays soil productivity declining is major issues at national and international level. The present research experiment was undertaken to develop appropriate and good agro technology for mint crop which may be improve nutrient balance as well and provide higher return with minimum risk to environment, soil health, quality and quantity of the produce.

MATERIALS AND METHODS

A field experiment was conducted during summer season 2017 with an object to ascertain the response of primary and secondary nutrient in conjunction with Zinc on yield contributing character, oil yield and quality of Menthol mint (*Mentha arvensis* L.). The experimental site is located between 29° N latitude and 79.38° E longitude and at an altitude of 243 m above mean sea level. The maximum temperature ranges between 35 to 45°C, and minimum between 2 to 5°C. At proper tilth, field was ploughed once with soil turning plough by tractor followed by cross-harrowing with the help of disk harrow. After well filed preparation harrowing, planking was done to level the field and obtain fine tilth which is necessary for proper plant growth. The experimental soil in field up to furrow slice level (15-20 cm depth) was sandy-loam in texture, neutral in reaction (7.4 pH), medium in organic carbon (0.51%), low in available nitrogen (131 kg ha-1), and medium in available phosphorus (12 kg ha-1) as well as in potassium (135 kg ha-1). The field experiment was laid out in a Randomized Block Design with three replication keeping 5 treatments as T_{-1}- Control (without fertilizer); $T-_{2}$- Recommended dose of NPK @ 100:60:40 kg ha^{-1}; $T-_{3}$- R.D. + Sulphur (S) @ 2.0 kg ha^{-1} foliar spray at 25 and 45 DAT; $T-_{4}$- RD + Zn @ 2.0 kg ha^{-1} foliar spray at 25 and 45 DAT; T_5- RD + S + Zn.

Transplanting of mint (cv. CIM-Kranti) was done at 50x50 cm spacing on March 15, 2017 through seedling. The full dose Phosphorous (P) & Potash (K) were applied as basal, and Nitrogen was applied in three equal doses as 1/3 basal, 1/3 at 25 days after transplanting (DAT), and 1/3 at 45 DAT. Secondary nutrient and zinc were sprayed with the help of a manual operated knapsack sprayer fitted with flatfan nozzle using 500 litres water per hectare as per treatment. The observation on different parameters viz. plant height (cm), fresh herb yield (q ha^{-1}), oil content (%) by Clevenger apparatus (Clevenger, J.F. 1928) , and oil yield (kg ha^{-1}) were observed. The statistical analysis of data was done following standard procedures (Snedecor & Cochran, 1967).

RESULTS AND DISCUSSIONS

The data pertaining to plant height (cm), fresh herb yield (q ha^{-1}), oil content (%), and oil yield (kg ha^{-1}) is presented in Table 1. The detailed scrutiny of table 1, presented data indicated clearly that significantly highest plant height (95.0 cm), fresh herb yield of menhol mint (225.70 q ha^{-1}), oil content on fresh weight basis (0.95%), and essential oil yield (221.19 kg ha^{-1}) of menthol-mint was recorded in $T---_{5}$ (application of recommended dose NPK @ 100:60:40 kg ha^{-1} in conjunction with foliar application of Sulphur- 2.0 kg ha^{-1} and Zinc sulphate @ 2.0 kg ha^{-1} both at 25 & 45 DAT-days after transplanting) followed by application of application of recommended dose of NPK + Zinc @ 2.0 kg per ha (T_4) recorded plant height 82.00 cm, fresh herb yield 211.4 q ha^{-1}, essential oil content 0.90% and oil yield 190.26 kg ha^{-1} as compared to other

treatments; and lowest plant height (51.0 cm), fresh herb yield (62.4 q ha^{-1}), oil content fresh weight basis (0.78%), and oil yield (48.67 kg ha^{-1}) was recorded in T_1- control. The results obtained is also supported with results made by Patra *et al.* (1998), Patra *et al.* (2000) and Singh *et al.* (1989) who worked on fertilizer requirement of menthol mint on the basis of soil-test-crop response and under integrated nutrient management system.

Table 1
Effect of integrated nutrient management on yield attributes and essential oil yield of Menthol mint (*Mentha arvensis* L.)

Treatment	*Plant height (cm)*	*Fresh herb yield (quintal ha^{-1})*	*Oil content (%)*	*Oil yield (kg ha^{-1})*
T_1	51.0	62.4	0.78	48.67
T_2	75.0	202.3	0.85	171.96
T_5	80.0	209.1	0.90	188.19
T_6	87.00	211.4	0.90	190.26
T_{12}	95.0.0	225.7	0.98	221.19
$SEm_{\pm}$	1.20	2.10	0.008	2.40
$LSD_{(P=0.05)}$	3.61	6.32	0.02	7.30

T_{-1}- Control (without fertilizer); T_{-2}- Recommended dose of NPK @ 100:60:40 kg ha^{-1}; T_{-3}- R.D. + Sulphur (S) @ 2.0 kg ha^{-1} foliar spray at 25 and 45 DAT; T_{-4}- RD + Zn @ 2.0 kg ha^{-1} foliar spray at 25 and 45 DAT; T_5- RD + S + Zn.

CONCLUSION

Application of NPK @ 100:60:40 kg ha^{-1} + Sulphur-2.0 kg ha^{-1} foliar spray at 25 & 45 DAT + Zinc (Zn) – 2.0 kg ha^{-1} 25 & 45 DAT recommended as a good agricultural practices for the commercial scale cultivation of menthol-mint i.e. recorded the highest plant height (95.0 cm), fresh herb yield (225.70 q ha^{-1}), oil content (0.98%), and oil yield (221.19 kg ha^{-1}) of mint, to increase farmers income in sustainable manner as well as large scale societal impact to strengthen famers economic condition and national economy.

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