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# Effect of NPK, zinc and sulphur levels on oil yield of Japanese mint (*Mentha arvensis* L.) var. Kosi

**Deepak BR, Dr. M Padma, Dr. B Neeraja Prabhakarand and Dr. D Vijaya**

**Abstract**
A field experiment was conducted at PG Vegetable Block, College of Horticulture, Rajendranagar, Hyderabad during 2017-18 to study the "effect of different NPK, zinc and sulphur levels on oil yield of Japanese mint (*Mentha arvensis* L.) Var. Kosi." The treatments comprised RDF of 100% and 75%, with and without combinations of sulphur and/or zinc. Experiment was carried out under randomized block design (RBD) with three replications. The study revealed that Japanese mint plants treated with $T_9$ (RDF 100% + Zn 25 kg + S 25 kg ha $^{-1}$) showed maximum oil yield of (12.73 ml/kg, 0.08 l/plot and 93.15 l/ha) with maximum benefit: cost ratio where as minimum was recorded with control (Without fertilizer) treatment.

**Keywords:** NPK, zinc, sulphur levels, oil yield, Japanese mint, *Mentha arvensis* L. var. Kosi

## Introduction
Japanese Mint (*Mentha arvensis*), belongs to the family Lamiaceae (Labiatae). The genus *Mentha* includes 25 to 30 species that grow commonly called as corn mint, field mint and wild mint is found to be native to the temperate regions of Europe, Western and Central Asia, East to the Himalaya. India grows Japanese mint in around 60,000 ha in Tarai districts (Rudrapur and Bilaspur) of Uttaranchal and Central U.P. (Barabanki, Moradabad, Bareily, Badaun and Lucknow) besides smaller area in parts of Punjab (Ludhiana and Jallandhar).

It is divided into two varieties namely, *M. arvensis* var. *glabrata* which refers to North American plants such as American Wild Mint and *M. arvensis* var. *piperascens* which refers to Eastern Asian plants such as Japanese mint (Dorman *et al*., 2003) [3].

The commonly grown Japanese mint varieties are MAS-1, MAS-2, Hybrid-77, Shivalik, Kosi, EC-41911 etc. The variety Kosi, matures in 90-120 days having the oil content of 75-80% menthol. It is resistant to rust, blight, mildew and leaf spot diseases. Approximately 150 kg of oil per hectare during the first year and subsequently 200-250 kg per hectare can be obtained under good management. Present investigation is undertaken to study the effect of different NPK, zinc and sulphur levels on growth, yield and quality parameters of Japanese mint

## Material and Methods
Experiment was conducted to study the "effect of different NPK, zinc and sulphur levels onyield of Japanese mint (*Mentha arvensis* L.) Var. Kosi.", PG Vegetable Block, College of Horticulture, Rajendranagar, Hyderabad. The experiment was carried out during 2017 to 2018. The experimental site is situated at an altitude of 538.3 m above mean sea level with a geographical bearing of 17º23' North latitude and 78º42' East longitude.

The experiment was laid out in a Randomized Block Design (RBD) with nineteen treatments, replicated thrice. The treatments are viz, RDF 100% (150:60:40), RDF 100% + Zn @ 20 kg ha$^{-1}$, RDF 100% +Zn @ 25 kg ha $^{-1}$, RDF 100% + S 20 kg ha $^{-1}$, RDF 100% +S @ 25 kg ha $^{-1}$, RDF 100% Zn @ 20 +S @ 20 kg ha $^{-1}$. RDF 100% + Zn @ 20kg +S @ 25 kg ha $^{-1}$, RDF 100% +Zn 25 kg +S @ 20 kg ha $^{-1}$, RDF 100% +Zn @ 25 kg +S @ 25 kg ha $^{-1}$, RDF 75% ( 112.5: 45:30 ), RDF 75% + Zn @ 20 kg ha $^{-1}$, RDF 75% +Zn@ 25 kg ha $^{-1}$, RDF 75% +S @ 20 kg ha $^{-1}$, RDF 75% +S @ 25 kg ha $^{-1}$, RDF 75% +Zn @ 20 kg +S @ 20 kg ha $^{-1}$, RDF75% +Zn @ 20 +S @ 25 kg ha $^{-1}$, RDF 75% +Zn @ 25 kg + S @ 20 kg ha $^{-1}$, RDF 75% + Zn @ 25 kg +S @ 25 kg ha $^{-1}$ and Control.

The planting material was available at Kittur Rani Channama, college of Horticulture, Arabhavi and the runners were collected from the mother plant of two year old mint plant. Stem cuttings of length 10-12 cm with three to five nodes were taken and were planted to the depth of five cm by inserting one node beneath the soil. Nitrogen, phosphorus and potash were applied in the form of urea, di ammonium phosphate and murate of potash respectively.

They were applied immediately after planting and nitrogen was given in two split doses *i.e* after planting and 30 days after planting. zinc and sulphur were supplied in the form of zinc sulphate and elemental sulphur respectively.
The crop was harvested at 120 days after planting when the shoots attained maximum size. Light irrigation was given one day before harvesting for easy lifting up of roots. Harvesting was done manually by cutting at the base of the plant.

**Extraction of oil from Japanese mint by Clevenger's Apparatus**

Oil from fresh herbage was extracted by using Clevenger's apparatus. Apparatus consist of one round bottom flask of 1000 ml which is connected with another two way round flask which holds raw material. The top flask is connected with condenser through the connecter. The separating funnel is used for the separation of essential oil and water

**Oil extraction Procedure**

Fresh shoots of Japanese mint along with leaves are cut into pieces within half a day after collection. The cut herbage of 250-500 g boiled with 1000 ml of distilled water in a Clevenger apparatus until oil distillation ceased after 5-6 h. The volume of essential oil (ml) was determined from a calibrated trap. The essential oil in the distillate was dried over anhydrous $Na_2SO_4$ and kept in the freezer.

**Benefit Cost ratio**

The data pertaining to the cost benefit ratio of Japanese mint cuttings at 120 days after planting as influenced bylevels of NPK, zinc and sulphurare presented in (Table 2.)

**Results and Discussion**

**Oil yield (ml kg$^{-1}$)**

The oil yield (ml kg$^{-1}$) at the end of 120 days after planting as influenced by different of NPK, zinc and sulphur levels are presented in (Table 1). Significant differences were observed among the treatments.
The present investigation reveals that oil yield ml kg$^{-1}$ of sample was highest in $T_9$ (RDF 100% + Zn @ 25 kg + S @ 25 kg ha$^{-1}$) with oil yield of about 12.73 ml kg$^{-1}$. This was followed by $T_8$ (RDF 100% + Zn @ 25 kg + S @ 20 kg ha$^{-1}$) of 11.33 ml kg$^{-1}$, $T_7$ (RDF 100% + Zn @ 20 kg + S @ 25 kg ha$^{-1}$) of 10.86 ml kg$^{-1}$ and $T_6$ (RDF 100% + Zn @ 20 kg + S @ 20 kg ha$^{-1}$) 10.80 ml kg$^{-1}$. The treatment unfertilized plants showed the lowest value for oil yield *i.e*. 6.67 ml kg$^{-1}$.

**Oil yield (l plot$^{-1}$)**

The oil yield (l plot-1) at the end of 120 days after planting as influenced by different levels of NPK, zinc and Sulphur are presented in (Table 1). Significant differences were observed among the treatments.
The present investigation revealed that oil yield ml/ kg of sample was highest in $T_9$ (RDF 100% + Zn @ 25 kg +S @ 25 kg ha$^{-1}$) with oil yield of 0.08 l plot$^{-1}$. This was followed by $T_8$ (RDF 100% + Zn @ 25 kg + S @ 20 kg ha$^{-1}$), $T_7$ (RDF 100% + Zn @ 20kg + S @ 25 kg ha-1), $T_6$ (RDF 100% + Zn @ 20 kg + S @ 20 kg ha$^{-1}$) of 0.07 l plot$^{-1}$ each. The untreated plants showed the lowest value for oil yield i.e. 0.03 l plot$^{-1}$.

**Oil yield (l ha$^{-1}$)**

The oil yield (l ha$^{-1}$) at the end of 120 days after planting as influenced by different levels of NPK, zinc and sulphur are presented in (Table1). Significant differences were observed among the treatments.
The present investigation revealed that oil yield l ha$^{-1}$ of sample was the highest in $T_9$ (RDF 100% + Zn @ 25 kg + S @ 25 kg ha$^{-1}$) with oil yield of 93.15 l ha$^{-1}$. This was followed by $T_8$ (RDF 100% + Zn @ 25 kg + S @ 20 kg ha$_{-1}$) of 82.34 l ha$^{-1}$, $T_7$ (RDF 100% + Zn @ 20 kg + S @ 25 kg ha$^{-1}$) of 78.77 l ha$^{-1}$ and $T_6$ (RDF 100% + Zn @ 20 kg + S @ 20 kg$^{-1}$) of 77.41 l ha$^{-1}$. The unfertilized plants showed lowest value for oil yield *i.e.* 28.77 l ha$^{-1}$.
Oil yield has been influenced by the both growth and yield parameters. More the growth and yield obtained, more is the oil yield. According to the present investigation, plants treated with more nutrients gave more vegetative yield and hence it lead to more oil yield. Vegetative growth is more influenced by nitrogen and it is believed to indirectly effect the yield paramaters. The increasing trend of oil and oleoresin with the application of nitrogen is close to the findings of Thasiama, 1991 [7] in Ginger, Mridula and Jayachandran, 1998 [4] in Mango-ginger and Pariari and Bhattacharya, 2001 [5] in Ginger.
RDF with combination of higher concentrations have resulted in more oil yield compared to alone application of RDF. This may be because of nitrogen and sulfur play an important role in enhancing the carbohydrate and protein synthesis, potassium to enhance the translocation and proper utilization of amino acids into protein synthesis and zinc by way of its action as activator of various enzymes involved in essential oil synthesis, the combined effect of the sufficient availability of these input factor might have led to higher essential oil content in plant as reported by Kumar *et al.,* 2010 [6] in Japanese mint. Combined applications of fertilizers have greater affect on improved mint oil yield (Patra *et al*., 2002; Chand *et al*., 2001) [6, 1]

**Table 1:** Effect of NPK, zinc and sulphur levels on herb yield of Japanese mint (*Mentha arvensis* L.) var. Kosi

| Treatment | Treatment details | Quality parameters after 120 days after planting | | |
|---|---|---|---|---|
| | | Oil yield (ml/kg) | Oil yield (l/plot) | Oil yield (l/ha) |
| $T_1$ | RDF 100% (150:60:40 ) | 8.80 | 0.05 | 59.71 |
| $T_2$ | RDF 100% + Zn @ 20 kg ha$^{-1}$ | 9.07 | 0.06 | 61.73 |
| $T_3$ | RDF 100% +Zn @ 25 kg ha $^{-1}$ | 9.47 | 0.06 | 65.45 |
| $T_4$ | RDF 100% +S @20 kg ha $^{-1}$ | 9.00 | 0.06 | 62.88 |
| $T_5$ | RDF 100% +S @ 25 kg ha $^{-1}$ | 10.27 | 0.07 | 73.11 |
| $T_6$ | RDF 100% Zn @ 20kg +S @ 20 kg ha $^{-1}$ | 10.80 | 0.07 | 77.41 |
| $T_7$ | RDF 100% + Zn @ 20kg +S @ 25 kg ha $^{-1}$ | 10.86 | 0.07 | 78.77 |
| $T_8$ | RDF 100% +Zn @25 kg +S @ 20 kg ha $^{-1}$ | 11.33 | 0.07 | 82.34 |
| $T_9$ | RDF 100% +Zn @ 25 kg +S @ 25 kg ha $^{-1}$ | 12.73 | 0.08 | 93.15 |
| $T_{10}$ | RDF 75% (112.5: 45:30) | 7.93 | 0.04 | 49.60 |
| $T_{11}$ | RDF 75% + Zn @ 20 kg ha $^{-1}$ | 8.13 | 0.05 | 51.10 |
| $T_{12}$ | RDF 75% +Zn @ 25 kg ha $^{-1}$ | 8.07 | 0.05 | 51.32 |
| $T_{13}$ | RDF 75% +S @2 0 kg ha $^{-1}$ | 8.27 | 0.05 | 52.58 |
| $T_{14}$ | RDF 75% +S @ 25 kg ha $^{-1}$ | 8.47 | 0.05 | 54.10 |

| | | | | |
|---|---|---|---|---|
| $T_{15}$ | RDF 75% +Zn @ 20 kg + S @ 20 kg ha $^{-1}$ | 8.33 | 0.05 | 53.43 |
| $T_{16}$ | RDF75% +Zn @ 20 +S @ 25 kg ha $^{-1}$ | 8.60 | 0.05 | 55.52 |
| $T_{17}$ | RDF 75% +Zn@ 25 kg + S @20 kg ha $^{-1}$ | 8.80 | 0.05 | 57.20 |
| $T_{18}$ | RDF 75% + Zn @ 25 kg +S@ 25 kg ha $^{-1}$ | 8.87 | 0.05 | 57.82 |
| $T_{19}$ | CONTROL | 6.67 | 0.03 | 28.77 |
| Mean | | 9.18 | 0.054 | 61.36 |
| S. Em ± | | 0.16 | 0.00165 | 1.87 |
| CD (P=0.05) | | 0.47 | 0.00467 | 5.30 |

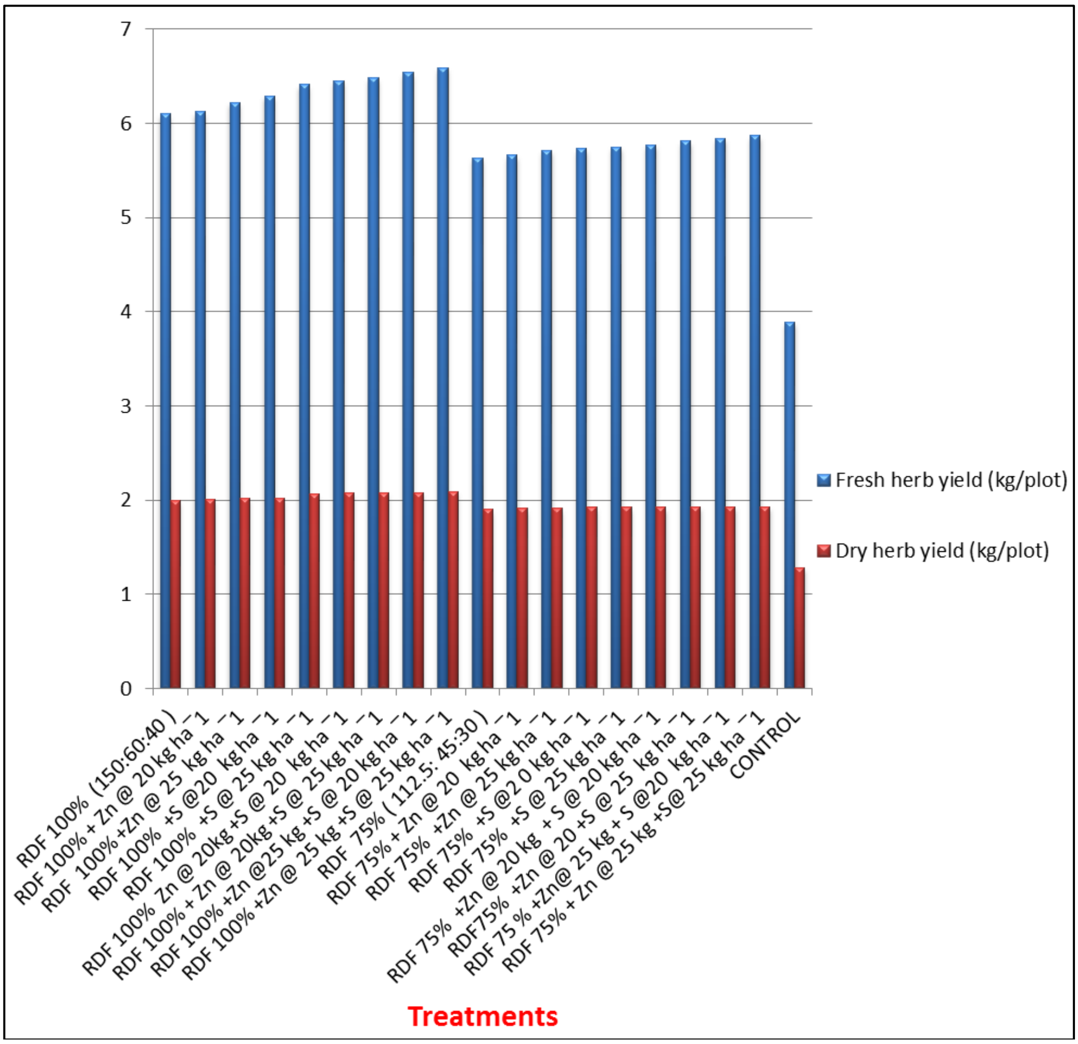


**Fig 1:** Herb Yield (kg/plot)

**Table 2:** The data pertaining to the cost benefit ratio of Japanese mint cuttings at 120 days after planting as influenced bylevels of NPK, zinc and sulphurare

| Sl. No | Treatment details | RS/ha | Fixed Cost | Total Cost | lit/ha | Gross returns in lakh | Net returns in lakh | B:C |
|---|---|---|---|---|---|---|---|---|
| T1 | RDF100% | 4160 | 97600 | 1,01,760 | 59.71 | 1,21,808 | 20,048.4 | 0.19 |
| T2 | RDF 100%+Zn 20 | 5220 | 97600 | 1,02,820 | 61.73 | 1,25,929 | 23,109 | 0.22 |
| T3 | RDF 100%+Zn 25 | 5485 | 97600 | 1,03,085 | 65.45 | 1,33,518 | 30,433 | 0.29 |
| T4 | RDF 100%+S 20 | 4920 | 97600 | 1,02,520 | 62.88 | 1,28,275 | 25,755 | 0.25 |
| T5 | RDF 100%+S 25 | 5110 | 97600 | 1,02,710 | 73.11 | 1,49,144 | 46,434 | 0.45 |
| T6 | RDF 100%+Zn 20+ S 20 | 5980 | 97600 | 1,03,580 | 77.41 | 1,57,916 | 54,336 | 0.52 |
| T7 | RDF 100%+Zn 20+ S 25 | 6170 | 97600 | 1,03,770 | 78.77 | 1,60,690 | 56,920 | 0.54 |
| T8 | RDF 100%+Zn 25+ S 20 | 6245 | 97600 | 1,03,845 | 82.34 | 1,67,973 | 64,128 | 0.61 |
| T9 | RDF 100%+Zn 25+ S 25 | 6435 | 97600 | 1,04,035 | 93.15 | 1,90,026 | 85,991 | 0.82 |
| T10 | RDF 75% | 3131 | 97600 | 1,00,731 | 49.60 | 1,01,184 | 453 | 0.004 |
| T11 | RDF 75%+Zn 20 | 4191 | 97600 | 1,01,791 | 51.10 | 1,04,244 | 2,453 | 0.02 |
| T12 | RDF 75%+Zn 25 | 4456 | 97600 | 1,02,056 | 51.32 | 1,04,692 | 2,636 | 0.02 |
| T13 | RDF 75%+S 20 | 3891 | 97600 | 1,01,491 | 52.58 | 1,07,263 | 5,771 | 0.05 |
| T14 | RDF 75%+S 25 | 4081 | 97600 | 1,01,681 | 54.10 | 1,10,364 | 8683 | 0.08 |
| T15 | RDF75%+Zn20+S 20 | 4951 | 97600 | 1,02,551 | 53.43 | 1,08,997 | 6,446 | 0.06 |
| T16 | RDF75%+Zn20+S 25 | 5141 | 97600 | 1,02,741 | 55.52 | 1,13,260 | 10,519 | 0.10 |
| T17 | RDF75%+Zn25+S 20 | 5216 | 97600 | 1,02,816 | 57.20 | 1,16,688 | 13,872 | 0.13 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| T18 | RDF75%+Zn25+S 25 | 5406 | 97600 | 1,03,006 | 57.82 | 1,17,952 | 14946 | 0.14 |
| T19 | Control | --- | 97600 | 97600 | 28.77 | 58,690 | -38,909 | -0.39 |

**Benefit cost ratio on oil yield**

The benefit cost ratio was calculated for the oil yield per hectare and revealed that $T_9$ (RDF 100% + Zn @ 25 kg + S @ 25 kg $ha^{-1}$) reported the maximum gross income of rs 1,90,026 followed by $T_8$ (RDF 100% + Zn @ 25 kg + S @ 20 kg $ha^{-1}$) and $T_7$ (RDF 100% + Zn @ 20 kg + S @ 25 kg $ha^{-1}$) of rs1,67,973 and rs 1,60,690 respectively. The maximum net returns was recorded with $T_9$ (RDF 100% + Zn @ 25 kg + S @ 25 kg $ha^{-1}$) of rs 85,991 followed by $T_8$ (RDF 100% + Zn @ 25 kg + S @ 25 kg $ha^{-1}$) and $T_7$ (RDF 100% + Zn @ 25 kg + S @ 25 kg $ha^{-1}$) of rs 64,128 and rs 56,920. The highest benefit to cost ratio (0.82) was found in $T_9$ followed by $T_8$ (0.61). This is due to combined effect of NPK and also by the good uptake of nutrients by plants, which showed significantly increased the yield. However zinc and sulphur increased the oil content in shoots which lead to higher oil yield.

Oil yield has been influenced by the both growth and yield parameters. More the growth and yield obtained, more is the oil yield. According to the present investigation, plants treated with more nutrients gave more vegetative yield and hence it lead to more oil yield. Vegetative growth is more influenced by nitrogen and it is believed to indirectly effect the yield paramaters. The increasing trend of oil and oleoresin with the application of nitrogen is close to the findings of Thasiama1991 [7] in Ginger, Mridula and Jayachandran 1998 [4] in Mango-ginger and Pariari and Bhattacharya 2001 [5] in Ginger.

RDF with combination of higher concentrations have resulted in more oil yield compared to alone application of RDF. This may be because of nitrogen and sulphur play an important role in enhancing the carbohydrate and protein synthesis, potassium to enhance the translocation and proper utilization of amino acids into protein synthesis and zinc by way of its action as activator of various enzymes involved in essential oil synthesis, the combined effect of the sufficient availability of these input factor might have lead to higher essential oil content in plant as reported by Kumar *et al.* 2010 [6] in Japanese mint. Combined applications of fertilizers have greater affect on improved mint oil yield (Patra *et al*., 2002; Chand *et al*., 2001) [6, 1]

**Conclusion**

In the present investigation, the study revealed that Japanese mint treated treatments with $T_9$ (RDF 100% + Zn @ 25 kg $ha^{-1}$ + S @ 25 kg $ha^{-1}$) showed maximum oil yield parameters. Plants treated with 100% RDF proved better results compared to 75% RDF, with or without sulphur and/or zinc. Apart from this, RDF alone showed lowest performance in all parameters in almost all stages of plant growth when compared to RDF with zinc and/or sulphur combinations. And the lowest performance was found in control without any fertilizers.

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