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Studies on oil contents and oil yield of mustard (*Brassica juncea* L.) following foliar application of sulphur and micronutrients

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Abstract

A field study was conducted at Crop Research Farm of Samhigginbottom University of Agriculture, Technology and Science, Prayagraj, Uttar Pradesh during rabi seasons of 2022-23 and 2023-24 with the objective to assess the effect of sulphur and micronutrients foliar application on oil contents and oil yield of mustard under semi-arid conditions of Prayagraj, Uttar Pradesh. The Crop Research Farm is situated at 25.57°N latitude, 87.19°E longitude at an altitude of 98 m above mean sea level. The soil is sandy loam in texture, low in organic carbon, potassium and medium in available nitrogen, phosphorus. The experiment consists of 16 treatments with three replications in Randomized Block Design. Foliar application of sulphur and micronutrients in various concentrations was done at 45 and 65 DAS. Treatment RDF + Sulphur @ 1.0% had statistically higher oil content in both the years (39.60% and 39.80%, respectively) which was at par with treatment RDF + Sulphur @ 0.5% (38.60% and 38.80%, respectively). Both the treatments with the foliar spray of sulphur were found to enhance the oil content of mustard seeds amongst other treatments. Significantly higher oil yield was recorded in treatment RDF + Sulphur @ 1.0% in both the years (713.80 kg ha⁻¹ and 733.90 kg ha⁻¹, respectively) which was at par with all other foliar nutrient application treatments except T₁(RDF), T₈(RDF + FeSO₄ @ 0.2%) and T₁₆ (control) in both the years and T₁₄(RDF + CuSO₄ @ 0.2%) and T₁₅(RDF + CuSO₄ @ 0.4%) in first year. Pooled analysis indicated that RDF + Sulphur @ 1.0% recorded significantly more oil yield (723.8 kg ha⁻¹) than RDF and control by 42.7% and 183.3%, respectively. Thus, it can be concluded that application of sulphur@1% with RDF will result into higher oil content and well as oil yield which could be beneficial for the farmers' under field conditions.

Keywords: Foliar application, sulphur, oil content, oil yield, mustard growth

Introduction

India's oilseeds production in marketing year (MY) 2024/2025 (October-September) is forecast to reach 41.9 million metric tons (MMT), a marginal change of 1.8 percent from MY 2023/2024 estimate of 42.7 MMT and (GAIN,2024) [7] India's edible oil production for MY 2024/25 is forecast at 9.1 MMT, compared to 9.3 MMT for the current MY. This is based on the estimated availability of oilseeds for "crush-to-oil", which is expected to reach 35 MMT. Mustard seed is the third leading source of vegetable oil in the world after Soya bean oil and palm oil. It is world's second-leading source of protein meal after soybean meal. Mustard seeds oil content varies from 33% to 46% and average oil recovery is around 32% to 38%. After oil extraction, the remaining part of the seed is used to produce a rapeseed/mustard meal, an important source of cattle and poultry feed. It is basically a winter crop and it requires a temperate climate to grow. The planting season or the sowing period in India is during the Rabi season i.e. October to November. The crop starts flowering in the months of December, January, and February. The harvesting period is from February to March. Mustard seeds typically contain 33-46% oil, with an average oil recovery rate of 32-38%. The remaining seed material after oil extraction is used to produce mustard cake, a valuable byproduct for animal feed.

Present research work was designed to study the effect of foliar application of sulphur and micronutrients during growth phase of Pioneer hybrid 45S46 variety of mustard on oil contents and oil yield under semi arid conditions, sandy loam soil during 2022-23 and 2023-24.

Materials and Methods

The study was conducted at Crop Research Farm, Samhigginbottom University of Agriculture, Technology and Science, Prayagraj, Uttar Pradesh during Rabi season, 2022-23 and 2023-24. The soil was sandy loam in texture, low in organic carbon and potassium and medium in available nitrogen and phosphorus. Hybrid variety; Pioneer hybrid 45S46 was sown with spacing of 45 cm × 20 cm, plot size of 4m×3m=12 m²; gross experimental area of 586.5 m² (72.5×18m=length x width including 0.5 m bunds and 1.5 m channels); net experimental area of 432 m². Micronutrients were sprayed at 45 and 65 days after sowing (DAS), spray volume was 1000 l ha⁻¹.

The experiment was conducted using a Randomized Block Design (RBD) with 16 treatments, repeated thrice at 20, 40, 60, 80, 100 days after sowing and at harvest from each plot. The treatments were as follows:

- **T1:** Recommended Dose of Fertilizer (RDF) - 80:40:40 kg N:P₂O₅:K₂O ha⁻¹
- **T2:** RDF + Zinc sulfate (ZnSO₄·7H₂O) at 0.25%
- **T3:** RDF + Zinc sulfate (ZnSO₄·7H₂O) at 0.5%
- **T4:** RDF + Molybdenum (Mo) at 0.05%
- **T5:** RDF + Molybdenum (Mo) at 0.1%
- **T6:** RDF + Boron (B) at 0.05%
- **T7:** RDF + Boron (B) at 0.1%
- **T8:** RDF + Ferrous sulfate (FeSO₄·5H₂O) at 0.2%
- **T9:** RDF + Ferrous sulfate (FeSO₄·5H₂O) at 0.4%
- **T10:** RDF + Sulphur (S) at 0.5%
- **T11:** RDF + Sulphur (S) at 1.0%
- **T12:** RDF + Manganese sulfate (MnSO₄) at 0.2%
- **T13:** RDF + Manganese sulfate (MnSO₄) at 0.4%
- **T14:** RDF + Copper sulfate (CuSO₄·5H₂O) at 0.2%
- **T15:** RDF + Copper sulfate (CuSO₄·5H₂O) at 0.4%
- **T16:** Control (no fertilizer or micronutrient application)

The data generated following 2 years of experimentation was analyzed using ANOVA for interpretation.

Oil content (%) and Oil yield (kg/ha): The oil content (%) in mustard seeds was estimated after harvest by Soxhlet apparatus method; 10g of mustard seeds were taken in a bowl, after crushing they were put in a filter paper then mixed with 100 ml distilled water in a flask and then added diethyl ether solution about 50 ml and heated the water continuously for one hour then after the cycle is completed when the dipping temperature of solvent comes down then it is repeated 2 or more times when the cycle finishes, it is left for one hour to cool down. When the solvent cool down, it is taken to the digestion chamber and then it is heated till it vaporizes and left about 5ml approximately then sample was weight. Oil yield was calculated by using following formula:

$$\text{Oil yield (kg/ha)} = \frac{\text{Seed yield (kg/ha)}}{\text{Oil content (\%)}} \times 100$$

Results and Discussion:

Oil content (%) and Oil yield (kg ha⁻¹)

The data representing the effect of various nutrient treatments on oil content (%) and oil yield (kg/ha) is presented in Table-1.

Oil content (%):

The oil content (%) in mustard seeds was estimated after harvest. The data revealed that there were significant differences in oil content (%) of mustard seeds from different treatments in both the years.

Treatment-11(RDF + Sulphur @ 1.0%) had statistically higher oil content in both the years (39.60% and 39.80%, respectively) which was at par with treatment-10(RDF + Sulphur @ 0.5%) (38.60% and 38.80%, respectively). Both the treatments with the foliar spray of sulphur were found to enhance the oil content of mustard seeds significantly followed by Treatment-7 (RDF+Boron 0.1%). Oil content was significantly lower in control treatment. Bharose *et al* (2025) [3] have reported 36.84,37.86 and 38.21% oil content in mustard in three conditions; farmers practice, RDF and RDF+Boron (2kg ha⁻¹), respectively which is at par with our findings. Kumar *et al*. (2024) [9] have reported similar findings i.e. 39.35% following use of sulphur @ 60 kg h⁻¹. They reported that oil content increased with increasing levels of sulphur and maximum oil content was recorded with application of 60 kg h⁻¹ which was significantly higher over 20 kg S h⁻¹. Ghosh and Nath (2024) [6] found significantly higher oil contents of 42% in Pusa Mustard 31 amongst 7 varieties. According to Sharief *et al*. (2017) [12], variation in oil contents among different mustard varieties are attributed to biological and environmental factors, soil composition and crop management practices. Beenesh and Lal (2018) [2] also recorded 37.47-38.07% oil content in 2016 and 37.45-37.75 in 2017 in different varietal trials of Indian mustard. Chaudhary *et al*. (2023) [4] revealed at par oil contents in their experiment as reported in this study. They found 39.8% oil content in 26th October sown crop.

Oil yield (kg ha⁻¹)

The experimental results of 2022 and 2023 revealed that there were significant differences in oil yield of treatments compared in both the years.

Significantly higher oil yield was recorded in treatment RDF + Sulphur @ 1.0% in both the years (713.80 kg ha⁻¹ and 733.90 kg ha⁻¹, respectively) which was at par with all other foliar nutrient application treatments except T₁(RDF), T₈(RDF + FeSO₄ @ 0.2%) and T₁₆ (control) in both the years and T₁₄(RDF + CuSO₄ @ 0.2%) and T₁₅(RDF + CuSO₄ @ 0.4%) in first year. Pooled analysis indicated that RDF + Sulphur @ 1.0% recorded significantly more oil yield (723.8 kg ha⁻¹) than RDF and control by 42.7% and 183.3%, respectively.

The data revealed that oil content (%) and oil yield had significant difference under different nutrient management practices. The foliar spray of sulphur at 0.5% and 1% was found to enhance the oil content of mustard seeds significantly. Sulphur is a component of acetyl Co-A which is essential for synthesis of mustard oil. Application of sulphur might have aided the synthesis of Co-enzyme A and lipid acid resulting in increased oil content (Mathew and George, 2013). Oil yield is obtained by multiplying seed yield by oil percentage. Higher oil yield with the foliar application of micro nutrients and sulphur may be due to positive influence of S, Zn, B, and Cu on yield and higher seed yield recorded under these treatments. Lowest oil yield was reported in control during both the years. The results are in proximity with findings of Mekki *et al*. (2015) [11], Kumar *et al*. (2018) [10], Dadhich *et al*. (2021) [5] and Kour *et al*. (2017) [8]. Kumar *et al*. (2024) [9] also noted maximum oil yield of 7.81 q per hectare following application of sulphur @ 60 kg h⁻¹. The oil yield of mustard is influenced by both oil content and seed yield. They found that Pusa Mustard has demonstrated better amongst other varieties. Banga *et al*. (2007) [1] also noted significant differences in the oil yield of Indian mustard attributable to varietal effects. Beenesh and Lal (2018) [2] also reported oil yield 379.57-452.27 kg h⁻¹ in 2016 and 387.67-459.32 kg h⁻¹ in 2017. Chaudhary *et al*. (2023) [4] also noted 743.1 kg h⁻¹ oil yield which is similar to our study.

Table 1: Effect of foliar spray of micronutrients and sulphur on oil content and oil yield of mustard.

Sr. No.	Treatments	Oil content and Oil yield					
		Oil content (%)			Oil yield (kg ha ⁻¹)		
		2022	2023	Pooled	2022	2023	Pooled
1	RDF (80:40:40)	36.50	37.10	36.80	494.0	520.1	507.1
2	RDF + ZnSO ₄ @ 0.25%	36.70	37.10	36.90	623.1	631.6	627.3
3	RDF + ZnSO ₄ @ 0.5%	37.20	37.50	37.40	664.8	679.8	672.3
4	RDF + Molybdenum @ 0.05%	36.90	37.40	37.20	632.7	612.2	622.5
5	RDF + Molybdenum @ 0.10%	37.20	37.70	37.50	664.7	622.7	643.7
6	RDF + Boron @ 0.05%	37.00	37.30	37.10	625.9	682.7	654.3
7	RDF + Boron @ 0.1%	37.70	38.20	38.00	648.1	702.8	675.4
8	RDF + FeSO ₄ @ 0.2%	36.80	37.10	37.00	621.2	599.3	610.2
9	RDF + FeSO ₄ @ 0.4%	37.30	37.70	37.50	633.3	620.1	626.7
10	RDF + Sulphur @ 0.5%	38.60	38.80	38.70	679.0	715.2	697.1
11	RDF + Sulphur @ 1.0%	39.60	39.80	39.70	713.8	733.9	723.8
12	RDF + MnSO ₄ @ 0.2%	36.50	37.10	36.80	623.1	618.3	620.7
13	RDF + MnSO ₄ @ 0.4%	36.70	37.30	37.00	646.8	624.4	635.6
14	RDF + CuSO ₄ @ 0.2%	36.90	37.60	37.20	609.1	681.2	645.1
15	RDF + CuSO ₄ @ 0.4%	37.30	38.00	37.60	622.7	689.0	655.8
16	Control	33.20	33.70	33.50	309.9	201.0	255.5
	F-test	S	S	S	S	S	S
	S.Em (±)	0.50	0.40	0.30	31.4	46.4	36.3
	CD (p=0.05)	1.30	1.20	0.80	91.1	134.7	105.4

Conclusion

On the basis of two years experimentation and results obtained, it could be concluded that 1% sulphur application during growth phases of mustard results into higher oil contents as well as higher oil yield leading better economic viability to the farmers.

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