



International Journal of Research in Agronomy

E-ISSN: 2618-0618

P-ISSN: 2618-060X

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www.agronomyjournals.com

2024; 7(11): 43-46

Received: 26-07-2024

Accepted: 05-09-2024

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Impact of sulphur and zinc on yield & oil content of mustard (*Brassica juncea*) in Chitrakoot area

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DOI: <https://doi.org/10.33545/2618060X.2024.v7.i11a.1920>

Abstract

This experiment was carried out during Rabi season 2022-23 at Rajaula Agriculture Farm of Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya Chitrakoot Satna M.P. The experiment having 10 treatments T₁-(Control), T₂-(100%NP RD), T₃-(100%NP+2.5 Kg Zinc), T₄-(100%NP+5.0 Kg.Zinc), T₅-(100%+30 Kg.Sulphur), T₆-(100%NP+15 Kg.Sulphur), T₇-(100%NP+15 Kg.Sulphur+2.5 Kg.Zinc), T₈-(100%NP+15 KgSulphu+5.0 Kg.Zinc), T₉-(100%NP+30 Kg.Sulphur+2.5 Kg.Zinc) and T₁₀. (100%NP+30 Kg.Sulphur+5.0 Kg.Zinc) laid out in Randomized Block Design. (RBD) with three replication. Pusha Mahak, a mustard varietal, was collected for research. The findings showed that distinct treatment combinations had a substantial impact on Mustard's quality characteristics. T₁₀- (100%NP+30 Kg.Sulphur+5.0 Kg.Zinc) had the most oil content (38.87). Compared to the control treatment, the Treatment T₁₀ had an seed yield and oil content that was 29.64 and 24.78% greater.

Keywords: Mustard, sulphur, zinc seed yield oil content oil yield Pusha Mahak

Introduction

The Mustard is known by many as Sarson, Rai, or Laha, mustard is one of the most significant edible oilseeds and rabi crops in North India. It is a member of the genus *Brassica* and family Brassicaceae. It consists of a number of traditionally grown indigenous species that are grown throughout the nation, including Taramira (*Eruca sativa/vesicaria* Mill.), Black mustard (*Brassica nigra*), Yellow sarson (*Sinapis alba* L. var. yellow sarson), Brown sarson (*Brassica juncea* L. var. brown sarson), and Toria (*Brassica campestris* L. var. toria). Mustard plants are thin herbaceous annuals with yellow flowers and red to brown seeds.

Mustard The thin, annual mustard plants have yellow flowers and reddish-brown seeds. For use as a vegetable, animal feed, condiment, and edible oil, mustard is grown. 35–40% of mustard's oil is unsaturated fatty acid (SFA) rich in linolenic and linoleic acid, two essential fatty acids (EFA). Pickles, cooking, frying, and using leaves as a vegetable all require the use of oil. Because mustard oil cake has a high protein and nitrogen content, it is used as an organic manure and as cattle feed. Pharmaceuticals are made using mustard and its byproducts. is cultivated for edible oil, condiment, vegetable and animal feed. Mustard contains 35-40% oil which is low in saturated fatty acids and is good source of essential fatty acids (EFA) viz. linolenic acid and linoleic acid. Oil is used for the purpose of cooking, frying, preserving pickles and leaves are used as vegetable.

Because mustard oil cake has a high protein and nitrogen content, it is used as an organic manure and as cattle feed. Pharmaceuticals are made using mustard and its byproducts. Because of the presence of antioxidants (tocopherol) in oil and glucosinolates (such as indolyl glucosinolate) in seed meal, it is used as an emetic, diuretic, and in the treatment of inflammatory infections like rheumatism and arthritis. It also has anti-cancer properties (Kumar, 2012) [7, 8].

After China and Canada, India comes in third place in terms of rapeseed-mustard producing area and yield. Rapeseed-mustard production spans 36.81 million hectares and 72.61 million tonnes worldwide, respectively.

After soybeans, rapeseed mustard is the second most popular edible oilseed crop in India. With

an average yield of 1499 kg ha⁻¹, or around three-fourths of the global average productivity of 1960 kg ha⁻¹, India produces 9.34 million tonnes of rapeseed mustard on 6.23 million hectares of land (DAC & FW, 2020). Over 74% of the land covered by oilseeds is planted with mustard, the predominant oilseed crop during the Rabi season. The states with the greatest mustard seed planting rates are Rajasthan, Uttar Pradesh, Madhya Pradesh, Haryana, and Gujarat, which together account for about 70% of the nation's total mustard acreage.

In India, 10.11 MTs of mustard and 1511 kg ha⁻¹ of productivity were produced in 2020–21 (Economic Survey, 2021–2022) over an area of around 6.69 mha. Nonetheless, it is cultivated on around 7.7 lakh hectares of land in Madhya Pradesh, where it produces and is productive on the order of 13.1 lakh tonnes and 1713 kg ha⁻¹, respectively. (Economic Survey, 2021–2022).

After N, P, and K, sulphur is a crucial secondary plant nutrient and the fourth most important ingredient in crop development to improve mustard quality and productivity. Since these amino acids contain around 90% of the element sulphur, it is a necessary component of S-containing amino acids and aids in the production of cystine (27% S), cysteine (26% S), and methionine (21% S). (Havlin *et al.*, 2013) [11].

Chlorophyll, a component of the vitamins biotin and thiamine (B1), and iron-sulfur proteins known as ferredoxins, are all formed with sulphur. It also contributes to the creation of protein and oil, sulphhydryl (SH) bonds, and the activation of several vitamins and enzymes. (Rathore *et al.*, 2015) [1] It is also a constituent of glucosinolate and glycosidase enzymes, which contribute to the aroma and pungency found in mustard oil. (Thompson *et al.*, 1986) [4]. Mustard exhibits a higher sensitivity to sulfur compared to other crops. Consequently, ensuring sufficient sulfur availability is essential for optimizing its productivity. Research has demonstrated that the application of sulfur fertilizer enhances the growth, yield, and quality of Indian mustard. (Singh *et al.*, 2015) [2], (Piri *et al.*, 2011) [5]. The application of sulfur notably influences the levels of oil, fatty acids, and glucosinolate in mustard seeds. The application of sulfur significantly influences soil characteristics and serves as a soil amendment to enhance the accessibility of other nutrients within the soil.

Zinc is a vital micronutrient that significantly contributes to numerous enzymatic and physiological processes within plants. Although it is needed in minimal yet crucial amounts, it is essential for the proper functioning of several important physiological pathways in plants. Photosynthesis and nitrogen metabolism are also critically dependent on this element, which plays a significant role in maintaining the stability of cytoplasmic ribosomes and facilitating cell division. Additionally, it serves as a co-factor for enzymes such as dehydrogenase, proteinase, and peptidase, which are involved in the synthesis of tryptophan. Tryptophan is a vital component of certain proteins and is necessary for the production of growth hormones, including auxin, specifically indole acetic acid. (Brown *et al.*, 1993) [12]. In plants production zinc is one of the most important elements in the carbohydrate metabolism, most enzymes that play a role in carbohydrates metabolism are activated by zinc. In addition, Carbonic anhydrase, Fructose- 1, 6- biphosphate and Aldolase enzymes are activated by zinc. These enzymes are active in the chloroplasts and cytoplasm, six-carbon sugar molecule are separated between chloroplasts and cytoplasm by Fructose- 1, 6-bisphosphate and three-carbon sugars molecule in photosynthesis are transported from cytoplasm to chloroplasts by Aldolase. The activity of these enzymes decreased in zinc deficiency condition, resulting

carbohydrate accumulated in plants leaves (Taheri *et al.*, 2011) [3].

Macronutrients include Nitrogen, Phosphorus, and Potassium, while Sulfur serves as a secondary nutrient, and Zinc is classified as a micronutrient. These elements are crucial for enhancing crop yield. Numerous studies have demonstrated that higher nutrient levels correlate with increased yields in mustard cultivation. The application of Sulfur and Zinc contributes to greater plant height and results in higher grain and Stover production.

It is widely recognized that Sulphur ranks just after Nitrogen and Phosphorus in terms of its significance for the nutrition of Mustard, as it is essential for its fundamental requirements. Oilseed varieties demand a higher quantity of Sulphur compared to other crops. This study aims to investigate the effects of Sulphur and Zinc in conjunction with varying levels of Nitrogen, Phosphorus, and Potassium, in order to determine the optimal combination of NPK along with Sulphur and Zinc for superior crop response.

Materials and Methods

The current study titled “Impact of Sulphur and Zinc on Oil Content of Mustard (*Brassica juncea*) in the Chitrakoot Area” was conducted as a field experiment at the Rajaula Agriculture Farm, part of Mahatma Gandhi Chitrakoot Gramoday Vishwavidyalaya, located in Chitrakoot, Satna (M.P.) during the Rabi season of 2022-23. This chapter provides comprehensive details regarding the experimental site, including soil characteristics and climatic conditions, along with the experimental design, layout, cultural practices, treatment specifics, planting materials, and methodologies utilized for the various parameters. The experiment took place at Rajaula Agriculture Farm, situated in the semi-arid and sub-tropical region of Madhya Pradesh, positioned at a latitude of 25.148° North and a longitude of 80.855° The town is situated at an elevation of approximately 190 to 210 meters above mean sea level. It experiences severe temperature variations during both winter and summer, with average maximum and minimum temperatures recorded at 46.9°C and 4.8°C, respectively. The primary period for precipitation occurs from October to January. Over the past year, the average rainfall in the Chitrakoot region has been less than 300 mm, indicating a significant scarcity of rainfall. Mustard Variety Pusha Mahak was taken for study. In the present research work 10 treatments T₁–Control, T₂–100%NP(RD), T₃–100%NP +2.5 KgZinc, T₄–100%NP+5.0 Kg.Zinc T₅–100% NP+30 Kg.Sulphur, T₆–100%NP+15 KgSulphur, T₇–100%NP+15 Kg.Sulphur+2.5 Kg.Zinc, T₈–100%NP+15 KgSulphur+5.0 Kg.Zinc, T₉–100%NP+30 Kg.Sulphur+2.5 Kg. Zinc and T₁₀–(100%NP+30 Kg.Sulphur+5.0 Kg.Zinc) laid out in Randomized Block Design.(RBD) with three replication having plot size 5×4meter square. Doses of fertilizers are applied@ 80 Kg. N 40 Kg. P₂O₅, 40 Kg. 40 Kg. K₂O/ha. 30 Kg. S/ha, 5 Kg Zn/ha. Through Urea, D.A.P. and Muriate of Potash, Elemental sulphur, Zinc Oxide. Sowing is done @ 6 kg. Seed ha⁻¹Mustard variety Pusha Mahak was used and sown on 19 Oct 2022. Row to Row and Plant to Plant distance remains 45×20 respectively. Seeds were sown about 1to 2 cm deep.

Results and Discussion

Results

To study the impact of different treatments on quality of Mustard crop.

Seed yield Kg/ha⁻¹

The research data in (Table) revealed that application of different nutrients had significant impact on seed yield of mustard crop comparison to control during the year-2022-23. The application different nutrient supplementation at increasing levels individually and in combination significantly increased seed yield at harvest of the crop during 2022-23 and in mean analysis. The application of different nutrient the seed yield of Mustard ranged between 1499.04 Kg. to 1943.42 Kg /ha⁻¹ in 2022-23. Under the treatment of nutrients the significantly maximum seed yield was recorded as 1943.42 Kg. under the treatment combination T₁₀-(100%NP+30 Kg.Sulphur+5.0 Kg. Zinc).Which was 29.64 percent higher and significantly superior over control (T₁) in the years 2022-23 and analysis mean. The lowest seed yield found was 1499.04 Kg./ha⁻¹.(T₁) recorded in the control.

Oil content (%) in seed

The research data in (Table-1) revealed that application of different increasing level of mineral had significant impact on the oil content of seed of Mustard comparison to control during the year 2022-23. The application of different nutrients supplementation at increasing levels individually and in combination significantly increased oil content at harvest of the crop during the year 2022-23 and in mean analysis. The application of nutrients the oil content in seed of Mustard ranged

between 31.15 to 38.87% in 2022-23. Under the treatment of nutrients, the significantly maximum oil content in seed was recorded as 38.87% under the treatment T₁₀-(100%NP +30 Kg. Sulphur +5.0 Kg.Zinc) which was 7.72 percent higher and significantly superior over control (T₁) in the years 2022-23 and analysis mean. The lowest oil content in mustard seed was 31.15% (T₁) recorded in the control.

Oil yield (Kg. ha⁻¹) in seed

The research work data (Table-1) revealed that application of different increasing level of mineral had significant impact on the oil yield in seed of Mustard comparison to control during the year 2022-23. The application of different nutrients supplementation at increasing levels individually and in combination significantly increased oil yield at harvest of the crop during the year 2022-23 and in mean analysis. The application of nutrients the oil yield in seed of mustard ranged 466.95 Kg.ha⁻¹ to 755.40 Kg.ha⁻¹ in 2022-23 and in pooled mean. Under the treatment of nutrients the significantly maximum oil yield in seed was recorded as 755.40 Kg.ha⁻¹ under the treatment T₁₀ -(100%NP+30 Kg.Sulphur+5.0 Kg.Zinc). Which was 61.77 percent higher oil yield compare to control and significantly superior over control (T₁) in the years 2022-23 and analysis mean. The lowest oil yield in mustard seed between 466.95 Kg./ha. (T₁) recorded control.

Table 1: Effect of different treatments on oil yield Kg./ ha⁻¹ and oil content% and Total Seed yield Kg/ha⁻¹ in mustard grains. (Mean value)

Treatment	Treatment Combination	Total seed yield kg/ha.	Oil Content%	Total Oil Yield (Kg/ha)
T1	Control	1499.04	31.15	466.95
T2	100% NP (RD)	1533.54	31.69	485.97
T3	100% NP + 2.5 kg Zinc	1572.48	32.43	509.95
T4	100% NP + 5.0 kg Zinc	1583.70	34.43	545.26
T5	100% NP + 30 kg Sulphur	1653.96	34.45	569.78
T6	100% NP + 15 kg Sulphur	1672.38	34.67	579.81
T7	100% NP + 15 kg Sulphur + 2.5 kg Zinc	1703.49	35.67	607.63
T8	100% NP + 15 kg Sulphur + 5.0 kg Zinc	1823.47	36.33	662.46
T9	100% NP + 30 kg Sulphur + 2.5 kg Zinc	1852.27	36.87	682.93
T10	100% NP + 30 kg Sulphur + 5.0 kg Zinc	1943.42	38.87	755.40
S.Em ±		1.755	0.38	5.922
CD _{5%}		5.149	1.11	1.736

Discussion

To study the impact of different treatments on quality of Mustard crop.

The Seed yield, oil content of seed and oil yield was significantly influenced by the application of different increasing levels of nutrients over control the year and in mean analysis (Table-1). The significantly maximum Seed yield, oil content and oil yield were noticed with the application of 100%NP+30 Kg.Sulphur+5.0 Kg.Zincperha⁻¹. (T₁₀)over control during the year and in mean analysis. It is might due to fact that Sulphur is an essential component in the formation of chlorophyll, a constituent of vitamins biotin and thiamine (B1) and iron sulphur proteins called ferredoxins. It also plays a role in activation of various vitamins and enzymes, sulphydryl (SH) linkages, synthesis of oil. (Rathore *et al.*, 2015) [1]. It is also a component of glucosinolate and glycosidase enzyme, which are the source of aroma and pungency in mustard oil (Thompson *et al.*, 1986) [4]. Studies have confirmed that sulphur fertilizer increases the oil content and oil yield in grains of mustard (Singh *et al.*, 2015) [2] The oil yield is a function of oil content and seed yield and both the parameters increase with different levels of Sulphur & zinc, thus resulted in significant increase in

seed yield, oil content and oil yield of Mustard. Similar findings were reported by Deo and Khandelwal (2009) [15].

Conclusion

The current study suggests that the application of Sulphur and Zinc to the soil at rates of 30 Kg and 5.0 Kg/ha, respectively, is highly effective in enhancing the seed yield oil content and oil yields of the Mustard crop. Therefore, this treatment is practical for farmers.

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