Original Research Article

Effect of Zinc and Sulphur elements on growth performance and productivity of Yellow Mustard (*Sinapis alba*) grown under Prayagraj conditions.

ABSTRACT

The field experiment was conducted during *Rabi* season, 2021 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (U.P) under sandy loam soil conditions. The experiment was laid out in Randomized Block Design with nine treatments each replicated thrice comprising three levels of Zinc (6, 8 and 10 kg/ha) and three sulphur levels (20 kg S/ha, 40 kg S/ha and 60 kg S/ha). The experiment results showed that the growth parameters and yield parameters such as plant height (55.3 cm), plant dry weight (8.8 g/plant), number of siliqua per plant (132.0), number of seeds per siliqua (31.7), test weight (3.9 g), seed yield (2.12 t/ha), stover yield (3.5 t/ha) and harvest index (35.8 %) recorded significantly higher in the treatment with the application of zinc 10 kg/ha + 60 kg/ha sulphur as compared to other treatment combinations. Generally it can be concluded that both zinc and sulphur are bifacial for yellow mustard grown on sandy loam soil.

Keywords: Mustard, Zinc, Sulphur, growth and yield.

Introduction

"Yellow mustard (***Sinapis alba***) crops are important for the Indian economy, since India imports large quantities of edible oils despite having the largest area of cultivated oilseeds in the world. The estimated area, production and yield of rapeseed-mustard in the world was 36.59 million hectares, 72.37 million tonnes (mt) and 1980 kg/ha, respectively, during 2018-19. Globally, India account for 19.8 % and 9.8% of the total acreage and production (USDA). During the last eight years, there has been a considerable increase in productivity from 1840 kg/ha in 2010-11 to 1980 kg/ha in 2018-19 and production has also increased from 61.64 mt in 2010-11 to 72.42 mt in 2018-19" **(DRMR 2019).**

"Oil seeds play an important role in Indian Agriculture and industries. Besides, immense value in our diet, oils and fats are used in cosmetics, soaps, lubricants, paints and

varnish industries and their medicinal and therapeutic value. The requirement of vegetable oils and fats will be much higher in coming years in view of ever increasing population" (Kumar *et al.* 2016). "The mustard seed is rich in protein. The protein is of excellent nutritional quality, being rich in lysine with adequate amounts of sulfur-containing amino acids-limiting amino acids in most of the cereals and oilseed proteins" (Sadeghi, M.A. and S. Bhagya, 2008).

"Micronutrients are also essential for plant growth. Zinc influences the formation of growth hormones and it plays a helpful role in reproduction of certain plants" (Patel *et al.* 2017). "Zinc is necessary to activate many enzymes like Tryptophan synthetase, superoxide dismutase and dehydrogenases. Lack of zinc causes deficiency in formation of RNA and protein. Therefore, the plant with lack of zinc is poor in amount of protein" (Singh *et al.* 2018).

"In oilseed, sulphur plays a vital role in quality, production and plays an important role in protein synthesis of essential amino acids like cysteine, cystine and methionine which are the building blocks of protein and about 90% of plant Sulphur is present in these amino acids" (Ahmad and Abdin 2000). However, the information regarding optimum dose of sulphur and its influence on mustard is necessary to augment the productivity and quality of Indian mustard.

"Sulphur and Zinc are most vital nutrients for growth and development. Sulphur is considered to be the fourth important essential nutrient after Nitrogen, Phosphorus and Potassium for plant growth. Sulphur performs many physiological functions like synthesis of Cystein, methionine, chlorophyll and oil content of oilseed crops. It also responsible for synthesis of certain vitamins (B, Biotin and Thiomine) metabolism of carbohydrate, protein and its oil formation of flavor compounds in crucifers. Sulphur increase the seed yield of mustard by 12-48% under irrigated and 17 to 124% under rainfed condition" (Rathore et al., 2015) . "The Zinc application in mustard may be attributed to various enzymatic reactions, merit" (Nayak *et al.* 2020).

Sulfur element is a building block of protein as well as it plays an important role in the synthesis of chlorophyll.in other words, without the sulfur optimum level in the soil, the different crops cannot reach their full potential yield and protein content **(Ghazi *et al,* 2022).**

Therefore, the aim of this study was to assess the effect of Zinc and Sulphur elements on growth performance and productivity of Yellow Mustard grown under Prayagraj conditions.

Materials and Methods

The experiment carried out during *Rabi* season of 2021 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (U.P.). which is located at 25^{o} 39’ 42’’N latitude, 81^{o} 67’ 56” E longitude and 98 m altitude above the mean sea level (MSL).

The soil texture in the experimental plot was sandy loam, with a practically neutral soil reaction (pH 7.1), low in organic Carbon (0.36%) available Nitrogen (171.49 kg ha^{-1}), available Phosphorus (15.3 kg ha^{-1}) and available Potassium (232.4 kg ha^{-1}) (**Sparks et al.,2020 and Dane et al.,2020**).

The crop was sown on 22 October 2021 using Super goldy variety. The experiment was set up in a Randomized Block Design with three replications and nine treatments in total of 27 plots *Viz.*, T_1: Zinc 6 kg/ha + 20 kg/ha sulphur, T_2: Zinc 6 kg/ha + 40 kg/ha sulphur T_3: Zinc 6 kg/ha + 60 kg/ha sulphur, T_4: Zinc 8 kg/ha + 20 kg/ha sulphur, T_5: Zinc 8 kg/ha + 40 kg/ha sulphur, T_6: Zinc 8 kg/ha + 60 kg/ha sulphur, T_7: Zinc 8 kg/ha +20 kg/ha sulphur, T_8: Zinc 8 kg/ha +40 kg/ha sulphur and T_9: Zinc 8 kg/ha +60 kg/ha sulphur. Recommended dose of fertilizers were applied in the form of Urea (46.5%N), single super phosphate (SSP), and muriate of potash (MOP) as a basal dose in all plots, and the treatments Zinc and Sulphur were also applied as basal dose in the form of Zinc Sulphate in all corresponding plots. The growth Parameters were measured at 20, 40,60 and 80 DAS intervals, as well as at harvest stage, from randomly selected plants in each treatment. A statistical analysis was performed, and the mean was compared at a 5% probability level of significance Fisher, R. A. and Yates, F. (1963).

Results and Discussion

1. Effect of Zinc and Sulphur on growth attributes of yellow mustard.

Plant Height (cm)

The results showed that the maximum plant height was recorded application of Zinc 10 kg/ha + 60 kg/ha Sulphur (T_9) (76.22 cm) as compared with other treatments. however, application of Zinc 10 kg/ha + 40 kg/ha Sulphur (T_8) (75.84 cm) was statistically at par with treatment Zinc 10 kg/ha + 60 kg/ha Sulphur(T_9).

Application of Zinc as a basal dose was helpful for clearing the deficiencies in crop during vegetative growth which was responsible for the increased plant height. The presence of Sulphur plays vital role in increased metabolic uses of Sulphur in plants which seems to

have promoted meristematic activities resulting in higher apical growth and expansion of photosynthetic surface. Similar results were obtained by **(Negi *et al.* 2017)**.

Plant Dry weight (g/plant)

Significantly highest plant dry weight was recorded in treatment with application of zinc 10 kg/ha + 60 kg/ha sulphur (T_9) (17.79 g) as compared to other treatments and the treatment with application of zinc 10 kg/ha + 40 kg/ha sulphur (T_8) (17.58 g) was found to be statistically at par with zinc 10 kg/ha + 60 kg/ha sulphur (T_9).

Zinc and Sulphur helps for the production of organic acids, chelating oxoacids from sugars, and exchange reactions in growth environment, the results were found to similar with **Kumar *et al.* (2016).**

2. Effect of Zinc and Sulphur on yield and yield attributes of yellow mustard.

No. of Siliqua per plant

Number of Siliqua per plant (132.0) showed significant difference among all the treatments. whereas, maximum number of siliqua per plant was recorded in Zinc 10 kg/ha + 60 kg/ha (T_9) except Zinc 10 kg/ha and Sulphur 40 kg/ha (T_8) (130.0) siliqua per plant which was found to be statistically at par Zinc 10 kg/ha + 60 kg/ha Sulphur.

The increment in number of siliquae per plant and seed yield with increasing dose of Sulphur and Zinc application might be better for root growth, cell multiplication, elongation and cell expansion in the plant body by higher dose of sulphur application, which ultimately increased the seed yield **(Moinuddin *et al.* 2012)**.

No. of seeds per Siliquae

Significantly highest number of seeds per siliqaue was recorded with application of Zinc 10 kg/ha + 60 kg/ha Sulphur (T_9) as compared to other treatments. whereas, application of Zinc 10 kg/ha and Sulphur 40 kg/ha (T_8) recorded (31.3) seeds per siliquae was statistically at par Zinc 10 kg/ha + 60 kg/ha Sulphur(T_9).

Increase in value of these yield contributing characters might be due do the higher doses of Sulphur was due to the facts that the adequate Sulphur was available during the entire period of crop growth for better vegetative growth and development of mustard plants **(Singh *et al.*, 2016**).

Test weight (g)

From the observations, test weight (3.9 g) was recorded in Zinc 10 kg/ha + 60 kg/ha Sulphur (T_9) which was significantly highest than other treatments and the treatment with

application of Zinc 10 kg/ha and Sulphur 40 kg/ha recorded (T_8) (3.8 g) test weight which was statistically at par Zinc 10 kg/ha + 60 kg/ha Sulphur (T_9).

Application of zinc along with the sulphur improved the test weight due to better availability of nutrients, moisture, cell division and higher nutrient uptake.

Seed yield (t/ha)

Significantly highest seed yield (2.12 t/ha) was recorded in Zinc 10 kg/ha + 60 kg/ha Sulphur (T_9) which was superior over all other treatments except the treatment with application of Zinc 10 kg/ha and Sulphur 40 kg/ha(T_8) recorded (1.86) found to be statistically at par Zinc 10 kg/ha + 60 kg/ha Sulphur (T_9).

Due to the stimulatory effect in cell division, cell elongation and setting of cell structure and also higher dose may be responsible for increased leaf area and chlorophyll content causing higher photosynthesis and assimilation, metabolic activities responsible for overall reproductive phase and ultimately improved the seed yield of yellow mustard. Similar results were found with **(Sharma *et al.* 2018)**.

Stover yield (t/ha)

Significantly maximum stover yield (3.5 t/ha) was recorded in Zinc 10 kg/ha + 60 kg/ha Sulphur(T_9) as compared to the other treatments. whereas, treatment with application of Zinc 10 kg/ha and Sulphur 40 kg/ha (T_8) recorded (3.4 t/ha) was statistically at par Zinc 10 kg/ha + 60 kg/ha Sulphur (T_9).

Due to the application of increased levels of sulphur and zinc might be increased the number of branches per plant, plant height and good crop growth during the vegetative stage which was directly responsible for the increased stover yield.

Harvest Index (%)

From the observations harvest index (35.8%) was recorded in Zinc 10 kg/ha + 60 kg/ha Sulphur (T_9) which was significantly higher than other treatments and the treatment with application of Zinc 10 kg/ha and Sulphur 40 kg/ha (T_8) recorded (34.8 %) which was statistically at par Zinc 10 kg/ha + 60 kg/ha Sulphur (T_9).

Harvest index is directly co-related to the seed and stover yield. Maximum seed and Stover yield was responsible for increased harvest index in the treatment 9 with application of Zinc 10 kg/ha + 60 kg/ha Sulphur.

Fig 1. Experimental plot

CONCLUSION

It can be concluded that better production (2.12 t/ha) in yellow mustard were observed with the application of Zinc 10 kg/ha + 60 kg/ha Sulphur (treatment 9). Since the findings are based on one season, further trails are needed to confirm the results.

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Table 1. Effect of Zinc and Sulphur on growth parameters of yellow mustard

S.No.	Treatment Combinations	Plant Height (cm)	Plant Dry weight (g/plant)
1.	Zinc 6 kg/ha + 20 kg/ha sulphur	70.46	16.27
2.	Zinc 6 kg/ha + 40kg/ha sulphur	73.33	16.95
3.	Zinc 6 kg/ha + 60 kg/ha sulphur	73.58	17.08
4.	Zinc 8 kg/ha + 20 kg/ha sulphur	71.12	16.45
5.	Zinc 8 kg/ha + 40 kg/ha sulphur	74.77	17.25
6.	Zinc 8 kg/ha + 60 kg/ha sulphur	75.09	17.38
7.	Zinc 10 kg/ha + 20 kg/ha sulphur	71.75	16.52
8.	Zinc 10 kg/ha + 40 kg/ha sulphur	75.84	17.58
9.	Zinc 10 kg/ha + 60 kg/ha sulphur	76.22	17.79
	F-Test	S	S
	SEm (±)	0.19	0.06
	CD (P=0.05)	0.58	0.19

Table 2. Effect of Zinc and Sulphur on yield and yeild parameters of Yellow mustard.

S.No.	Treatment combinations	Number of Siliqua/plant	No. of seeds per siliqua	Test weight (g)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest Index (%)
1.	Zinc 6 kg/ha + 20 kg/ha sulphur	123.7	27.9	3.1	1.17	2.3	33.6
2.	Zinc 6 kg/ha + 40kg/ha sulphur	125.8	29.3	3.5	1.54	2.9	34.8
3.	Zinc 6 kg/ha + 60 kg/ha sulphur	126.6	29.5	3.6	1.62	3.1	33.9
4.	Zinc 8 kg/ha + 20 kg/ha sulphur	124.0	28.1	3.4	1.25	2.5	33.4
5.	Zinc 8 kg/ha + 40 kg/ha sulphur	127.1	30.4	3.7	1.61	3.2	34.4
6.	Zinc 8 kg/ha + 60 kg/ha sulphur	128.8	31.0	3.7	1.82	3.3	35.0
7.	Zinc 10 kg/ha + 20 kg/ha sulphur	124.9	28.4	3.4	1.39	2.6	34.9
8.	Zinc 10 kg/ha + 40 kg/ha sulphur	131.3	31.3	3.8	2.07	3.4	34.8
9.	Zinc 10 kg/ha + 60 kg/ha sulphur	132.0	31.7	3.9	2.12	3.5	35.8
	F-Test	S	S	S	S	S	S
	SEm (±)	0.27	0.18	0.06	0.02	0.04	0.39
	CD (P=0.05)	0.81	0.55	0.17	0.06	0.11	1.16