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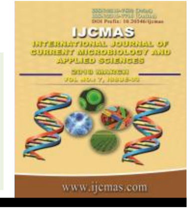

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Effect of Different Doses of Sulphur and Zinc with NPK on Different Growth Parameters and Yield Attribute of Yellow Mustard (*Brassica compestris* L.) cv. Sunanda

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A B S T R A C T

The experiment was carried out at Soil Science *and agricultural chemistry* research farm SHUATS, Allahabad during rabi season 2016-17. The experiment was laid out in 3×3 factorial randomized block design with three replications, consisting of nine treatments. It was observed that the best yield attributes characters in treatment T_7 (@ 30 kg Sulphur ha^{-1} + 1.35 kg Zinc ha^{-1}) in respect to different day's intervals i.e. 25, 50, 75, 100 and 125 days after sowing (DAS). Plant height was 30.53, 85.56, 113.53, 135.53, and 154.46 cm found to be significant at 50, 75, 100 and 125 DAS but non-significant at 25 DAS, No. of leaves plant^{-1} were 4.46, 11.4, 61.93, 74.2 and 49.33 found to be non-significant at 25, 75, 100 DAS but significant at 50 and 125 DAS. No. of Branches plant^{-1} were 3, 15.2, 26.73 and 32.33 found to be non-significant at 50, 75 DAS but significant at 100 and 125 DAS. No. of siliqua plant^{-1} was 143.2 found to be significant, T_8 (@ 30 kg Sulphur ha^{-1} + 2.75 kg Zinc ha^{-1}) found highest Seed yield (q ha^{-1}) and Test weight (g) which were 11.13 and 3.81 respectively found to be significant. Highest Stover yield (q ha^{-1}) found in T_8 (@ 30 kg Sulphur ha^{-1} + 2.75 kg Zinc ha^{-1}) which was 15.70 found to be non- significant. Highest B: C (1.57) was recorded in T_8 (@ 30 kg Sulphur ha^{-1} + 2.75 kg Zinc ha^{-1}). However, since these findings are based on one year experiment and therefore, further research may be conducted to substantiate it under Allahabad agro climatic conditions.

Keywords

Sulphur, Zinc, Different Growth Parameter, Yellow Mustard

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Introduction

Mustard is the second most important edible oil-seed crop after groundnut. It plays an important role in the oil-seed economy of the country. India occupies the third position in mustard production in World after China and Canada. In India, during 2009-2010, the mustard crop had production of about 6.40 mt. from an area of 6.45 m ha with an average productivity of 1184 kg ha^{-1}. However, in U.P it is grown in 0.82 m ha with production of 0.90 mt. The average productivity in U.P is 1141 kg ha^{-1}, which is 3.6% lower than the national average productivity Indian mustard markedly responded to sulphur fertilization in oilseeds, sulphur plays a vital role in quality and development of seed. The importance of sulphur fertilization for increasing yield and quality of Indian mustard is being increasingly recognized. However, the information regarding optimum level of sulphur and its influences on seed yield and quality of different varieties of mustard is meagre. Probably for these reasons mustard crop needs comparatively higher amount of sulphur for proper growth and development and higher yields. Sulphur is considered to occupy fourth place among major plant nutrient after nitrogen, phosphorus and potassium. It increases phosphorus uptake by plant and nitrogen in protein synthesis and is indispensable for the synthesis of essential amino acid like cysteine and methionine. Besides, sulphur is also involved in various metabolic processes of plants. It is a constituent of glutathione, a compound supposed to be associated with the plant respiration and the synthesis of essential oils. Sulphur also plays a vital role in chlorophyll formation (Yadav *et al.,* 2016).

The term “mustard” is used to describe several plants in the *Brassica* and *Sinapis* genera which are used as sources of food. There are a number of different types of mustard which are cultivated for different products, including greens and leaves. The incredible diversity and flexibility of mustard plants can cause them to pop up in a wide variety of places, from traditional American Southern cuisine to fiery Indian curries. *B. nigra* produces black seeds with a very strong and distinctive flavour. Black mustard is often used in Indian and Southeast Asian cooking, where it is incredibly popular; you may have encountered whole mustard seeds in marinades and curries if you eat a lot of Southeast Asian food. Black mustard can also be ground into condiment form. As a condiment, mustard is incredibly diverse. Mustard can be ground into a smooth puree or mixed with whole seeds for more texture. It can also be blended with things like horseradish for spicy mustard, which can be quite fiery, or sugar, for sweet mustard. Some cultures have a tradition of making mustard with beer or wine, creating a very distinctive, complex flavour which complements a range of foods (Piri, 2012).

India is amongst the largest vegetable oil economic in the world. Mustard is rich in minerals like calcium, manganese, copper, iron, selenium, zinc, vitamin A, B, C and proteins. 100 g mustard seed contains 508 kcal energy, 28.09 g carbohydrates, 26.08 g proteins, 36.24 g total fat and 12.2 g dietary fiber. The physical properties of soil play an important role in determining its suitability for crop production. The characteristics like support in power and bearing capacity, tillage practices, moisture storage capacity, drainage, ease of penetration by roots, aeration, retention of plant nutrient and its availability to plant. It includes bulk density, particle density, porosity, soil texture and soil colour too. Sulphur plays a significant role in increasing production especially in oilseeds (Upadhyay *et al.,* 2016).

The nutrient elements of major significance for yield and quality of yellow mustard are nitrogen, phosphorus and sulphur. Nitrogen is an important constituent of protein for which the plants take inorganic nitrogen in the form of ammonium or nitrate. Higher the nitrogen greater would be the protein and protoplasm which would increase, in turn greater cell size, leaf area index resulting into greater photosynthetic activity. Thus, the nitrogen help in formation in of a larger frame on which more flowers and eventually more pods can develop. This shows a positive link between larger nitrogen supply and higher seed yield. In case of nitrogen deficiency the leaves and stems become light green in colour. In case of acute shortage the leaves may become chlorotic associated with purple coloration and older leaves may wither. The plants have poor growth with thin and short stems having few or practically no branches (Bharose *et al.,* 2010).

Materials and Methods

The experiment was conducted in the research farm of Department of Soil Science, Department of Soil Science and Agricultural Chemistry, Sam Higginbottom University of Agriculture, Technology and Sciences Allahabad which situated six km away from Allahabad city on the right bank of Yamuna river. The experimental site is located in the sub – tropical region with 25^0 22'45.14" N *latitude* 81^0 54'49.95" E *longitudes* and 98 meter the sea level *altitudes.* The experiment was laid out in a 3^2 RBD factorial design with three levels of each Sulphur and Zinc with nine treatments, each consisting of three replicates.

The total number of plots was 27. Yellow Mustard (*Brassica compestris* L.) "Cv. Sunanda" were sown in *rabi* season plots of size 2 x 2 m with row spacing 30 cm and plant to plant distance 10 cm. The Soil of experimental area falls in order of Inception and is alluvial in nature; both the mechanical and chemical analysis of soil was done before starting of the experiment to ascertain the initial fertility status (Table 1 and 2). The soil samples were randomly collected from 0-15cm depths prior to tillage operations. The treatment consisted of nine combination of inorganic source of fertilizers T_0 (@ 0 S kg ha^{-1} + 0 Zn kg ha-1), T_1 (@ 0 S kg ha^{-1} + 1.35 Zn kg ha^{-1}), T_2 (@ 0 S kg ha^{-1} + 2.75 Zn kg ha^{-1}), T_3 (@ 15 S kg ha^{-1} + 0 Zn kg ha^{-1}), T_4 (@ 15 S kg ha^{-1} + 1.35 Zn kg ha^{-1}), T_5 (@ 30 S kg ha^{-1} + 2.75 Zn kg ha^{-1}), T_6 (@ 30 S kg ha^{-1} + 0 Zn kg ha^{-1}), T_7 (@ 30 S kg ha^{-1} + 1.35 Zn kg ha^{-1}), T_8 (@ 30 S kg ha^{-1} + 2.75 Zn kg ha^{-1}). The source of sulphur and zinc as milvet sulphur and zinc sulphate respectively.

Results and Discussion

Different growth parameters

Effect of different doses of Sulphur and Znic with NPK the important growth parameters of Yellow Mustard crop

Plant height

Plant height (cm) $plant^{-1}$ was significantly increased according to table 3 by the application of different treatment of S and Zn (sulphur and zinc) interaction. 125 DAS, the maximum plant height of 154.53 cm was recorded in T_8- S_2Zn_2 (@ 30 kg ha^{-1} + 2.75 kg ha^{-1}), which was significantly higher than other treatment. The minimum plant height was 152.2 cm. was recorded in T_0- S_0Zn_0 (@ 0 kg ha^{-1} + 0 kg ha^{-1}). Similar results have also been recorded by Dubey *et al.,* (2013) (Fig. 1).

Number of leaves $plant^{-1}$

The number of leaves $plant^{-1}$ was significantly increased according to table 3 by the application of different treatment of S and Zn (sulphur and zinc) interaction. At 125 DAS, the maximum number of leaves 49.4 was recorded in T_8- S_2Zn_2 (@ 30 kg ha^{-1} + 2.75 kg ha^{-1}). The minimum number of leaves was 46.4 recorded at 125 DAS in T_0- S_0Zn_0 (@ 0 kg ha^{-1} + 0 kg ha^{-1}). Similar results have also been recorded by Dubey *et al.,* (2013) (Fig. 2).

Number of branches $plant^{-1}$

The number of branches $plant^{-1}$ was significantly increased according to table 3 by the application of different treatment of S and Zn (sulphur and zinc) interaction.

At 125 DAS, the maximum plant branches of 32.06 cm was recorded in T_8- S_2Zn_2 (@ 30 kg ha^{-1} + 2.75 kg ha^{-1}), which was significantly higher than other treatment (Fig. 3).

Table.1 Physical analysis of soil

Sand (%)	**Bouyoucous Hydrometer method (Bouyoucous, 1927)**	**62.71**
Silt (%)		23.10
Clay (%)		14.19
Textural class		Sandy loam
Bulk density (g cm^{-3})	Graduated measuring cylinder **Muthuval (1992)**	1.22
Particle density (g cm^{-3})	Graduated measuring cylinder **Muthuval (1992)**	2.21
Pore Space (%)	Graduated measuring cylinder **Muthuval (1992)**	53.17
Solid space (%)	Graduated measuring cylinder **Muthuval (1992)**	46.83

Table.2 Chemical Analysis of Soil Particulars Method Employed Results

pH (1:2)	**Digital pH meter (Jackson, 1958)**	**7.18**
EC (dSm^{-1})	EC meter (Digital Conductivity Meter) **(Wilcox, 1950)**	0.53
Organic Carbon (%)	Rapid titration method **(Walkley and Black's** method **1947)**	0.5
Available Nitrogen (kg ha^{-1})	Alkaline potassium permanganate method (**Subbaih and Asija (1956)**	251.63
Available Phosphorus (kg ha^{-1})	Colorimetric method **(Olsen *et al.*, 1954)**	20.41
Available Potassium (kg ha^{-1})	Flame photometric method **(Toth and Prince, 1949)**	130.64
Available Sulphur (ppm)	Turbidemetric **(Bardsley and Lancaster 1960**)	9.82
Available Zinc (ppm)	Spectrophotometer **(Shaw & Dean 1952**)	0.72

Table.3 Plant growth parameter

Treatment	**Plant height (cm)**					**Number of leaves**					**Number of branches**			
	25 DAS	**50 DAS**	**75 DAS**	**100 DAS**	**125 DAS**	**25 DAS**	**50 DAS**	**75 DAS**	**100 DAS**	**125 DAS**	**50 DAS**	**75 DAS**	**100 DAS**	**125 DAS**
T_0	29.53	70	80.8	76	152.2	3.93	10.6	11	73.4	45.4	2.53	12.8	25.06	31.6
T_1	29.86	81.8	82.8	81.4	153.66	4.06	9.6	10.2	73.46	49	2.66	13.6	25.33	30
T_2	29.86	83.4	84.6	82.2	153.06	4.26	11.6	10.8	73.66	46.8	2.26	14	25.33	32.6
T_3	30.06	78.4	91.2	83.8	153.33	4.33	10.6	10.8	74	45.4	2.73	14.2	25.4	31.8
T_4	30.86	83	89.2	81.6	153.4	4.36	11.6	10.6	74	45.6	2.73	14.6	25.73	31
T_5	30.2	84.4	89	81.4	153.93	4.4	12.6	10.2	74.06	48.4	2.93	14.4	26.2	31.6
T_6	30.46	85.2	89.6	81.8	154.26	4.43	10.8	10.6	74.13	49.2	3	14.6	26.46	35
T_7	30.53	86	84.3	86.4	154.46	4.46	10.4	12.4	74.2	49.4	3	14.8	26.73	33
T_8	31	85.6	89	83.8	154.53	4.5	11.4	10.6	74.46	49.4	3.13	16	26.8	32.8
F-test	NS	S	S	S	S	NS	S	NS	NS	S	NS	NS	S	S
S.Ed. (±)	1.126	1.297	0.299	0.164	0.127	0.194	0.031	0.466	0.125	0.679	0.287	0.292	0.114	0.086
C.D. (at 5%)	2.388	2.750	0.635	0.347	0.270	0.411	0.066	0.988	0.266	0.144	0.609	0.620	0.243	0.183

Table.4 Plant yield attributes parameter

Treatment	Siliquae plant^{-1}	Number of seed Siliquae^{-1}	Test weight (g/1000 seed)	Total seed yield (t. ha^{-1})	Total stover yield (t. ha^{-1})	B:C ratio
T_0	73.4	45.4	2.53	12.8	25.06	31.6
T_1	73.46	49	2.66	13.6	25.33	30
T_2	73.66	46.8	2.26	14	25.33	32.6
T_3	74	45.4	2.73	14.2	25.4	31.8
T_4	74	45.6	2.73	14.6	25.73	31
T_5	74.06	48.4	2.93	14.4	26.2	31.6
T_6	74.13	49.2	3	14.6	26.46	35
T_7	74.2	49.4	3	14.8	26.73	33
T_8	74.46	49.4	3.13	16	26.8	32.8
F-test	NS	S	NS	NS	S	S
S.Ed. (±)	0.125	0.679	0.287	0.292	0.114	0.086
C.D. (at 5%)	0.266	0.144	0.609	0.620	0.243	0.183

Fig.1 Interaction effect of different doses of sulphur and zinc with NPK on plant height (cm plant^{-1}) of yellow mustard at 25, 50, 75, 100 and 125 DAS

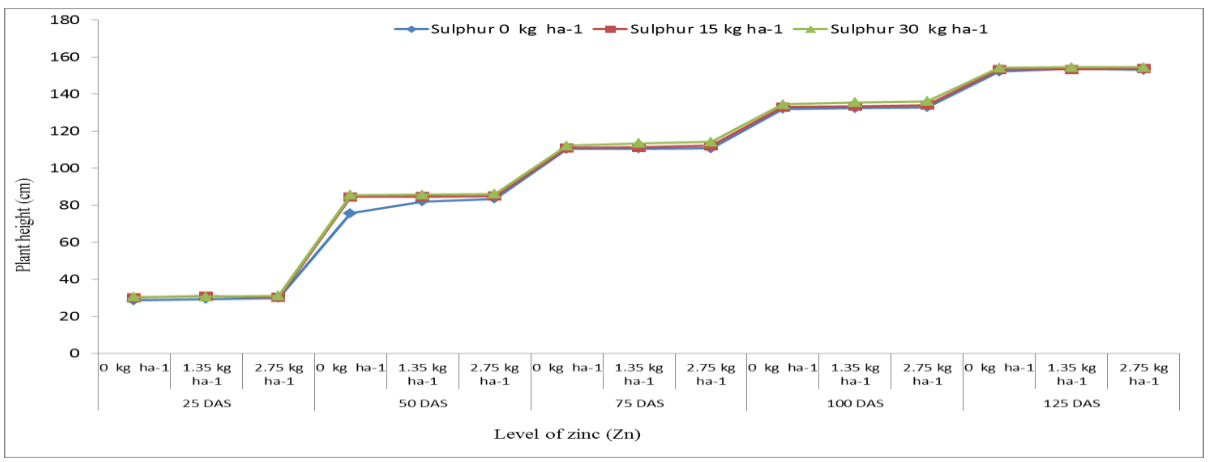


Fig.2 Interaction effect of different doses of sulphur and zinc with NPK on number of leaves plant^{-1} of yellow mustard at 25, 50, 75, 100 and 125 DAS

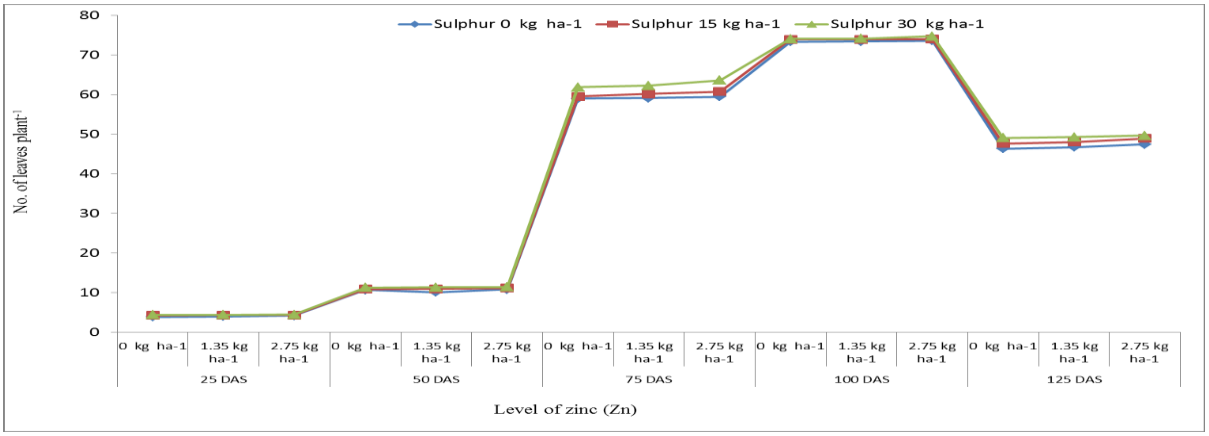


Fig.3 Interaction effect of different doses of sulphur and zinc with NPK on number of branches plant^{-1} of yellow mustard at 50, 75, 100 and 125 DAS

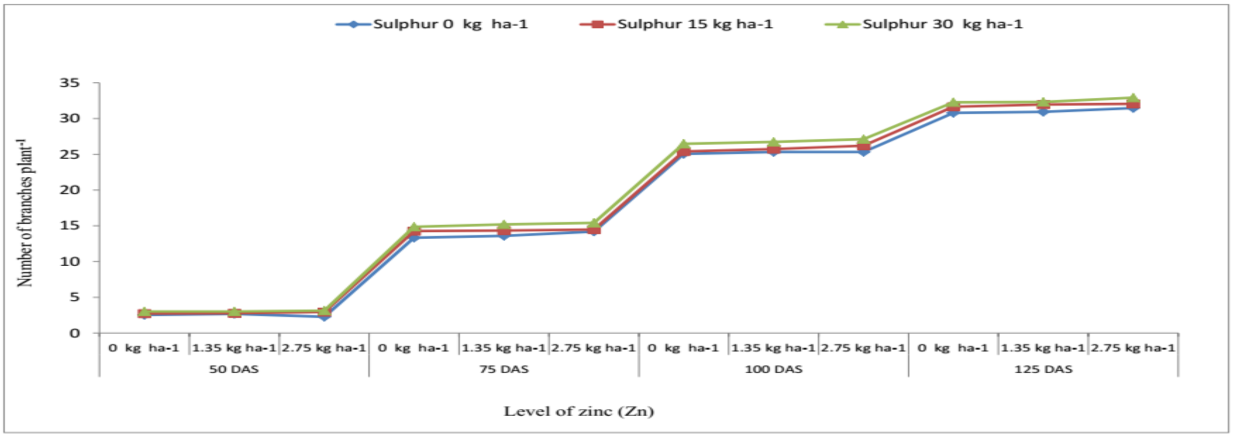


Fig.4 Interaction effect of different doses of sulphur and zinc with NPK on number of siliquae plant^{-1} of yellow mustard

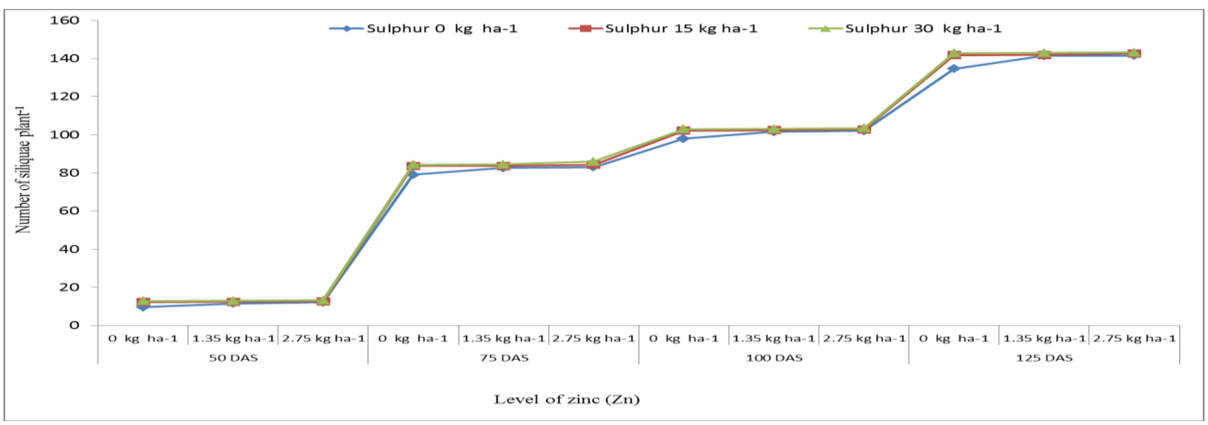


Fig.5 Interaction effect of different doses of sulphur and zinc with NPK on number of seeds siliquae^{-1} of yellow mustard

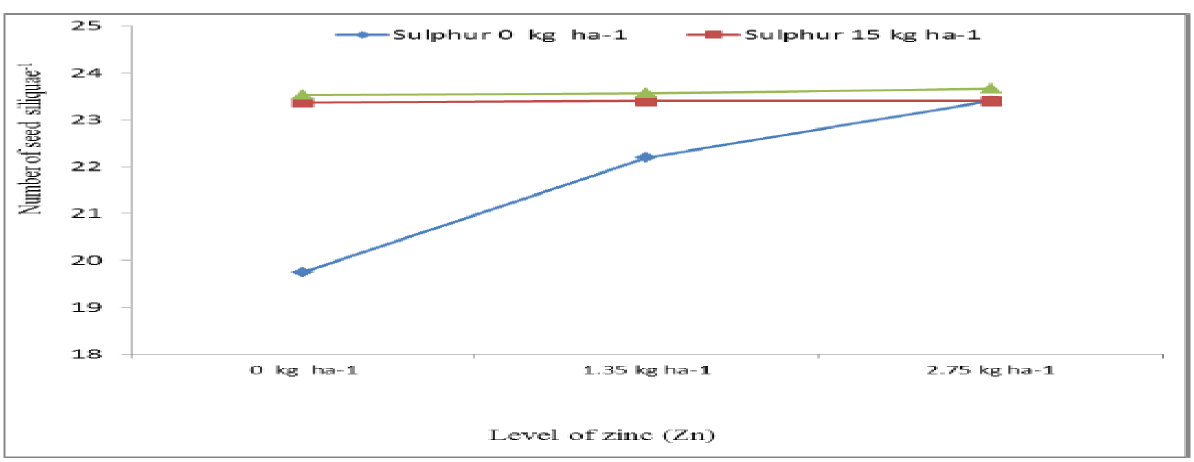


Fig.6 Interaction effect of different doses of sulphur and zinc with NPK on test weight of seeds (g/1000 seeds) of yellow mustard

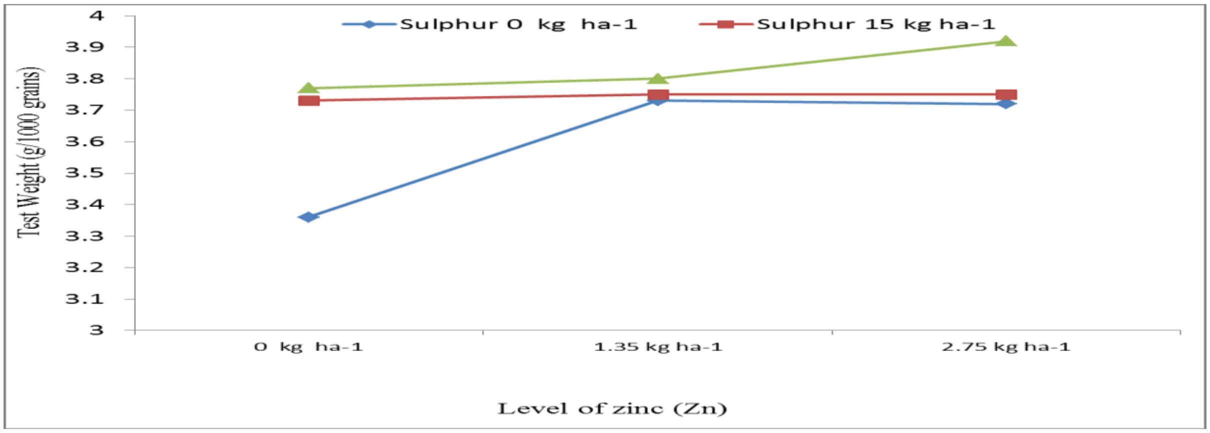


Fig.7 Interaction effect of different doses of sulphur and zinc with NPK on total seed yield (q ha^{-1}) of yellow mustard

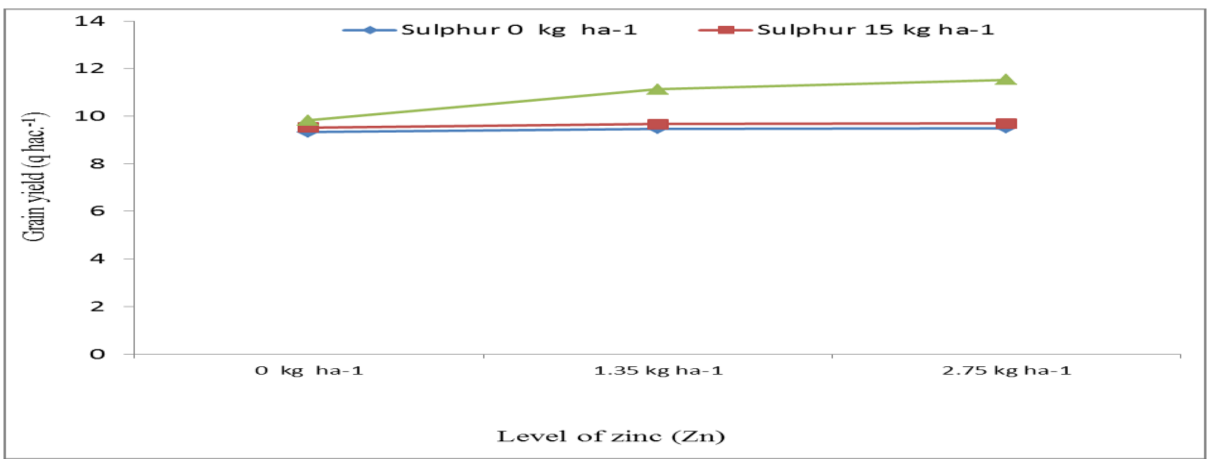
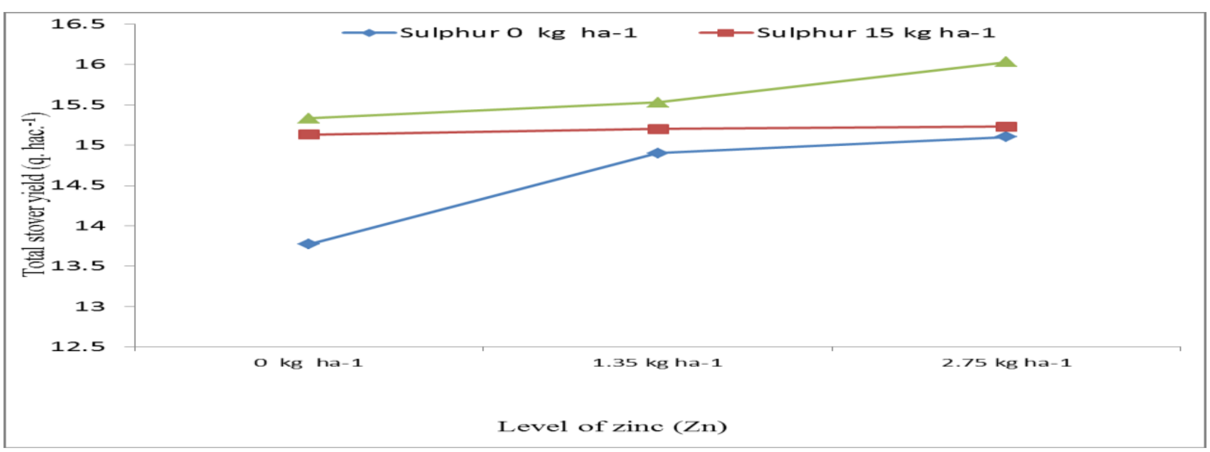


Fig.8 Interaction effect of different doses of sulphur and zinc with NPK on total stover yield (q ha^{-1}) of yellow mustard



The minimum plant branches was 30.8 cm. was recorded in T_0- S_0Zn_0 (@ 0 kg ha^{-1} + 0 kg ha^{-1}). Similar results have also been recorded by Baudh and Prasad**.** (2012).

Number of siliquae $plant^{-1}$

The number of siliquae $plant^{-1}$ was significant according to table 4 by the application of different treatment of S and Zn (sulphur and zinc) interaction. The maximum siliquae $plant^{-1}$ 143.2 was recorded in T_8- S_2Zn_2 (@ 30 kg ha^{-1} +2.75 kg ha^{-1}) and minimum siliquae $plant^{-1}$ 134.6 was recorded in T_0- S_0Zn_0 (@ 0 kg ha^{-1} + 0 kg ha^{-1}). Similar results have also been recorded by Baudh and Prasad. (2012) (Fig. 4).

Number of seeds $siliquae^{-1}$

The number of seeds $siliquae^{-1}$ was significant according to table 4 by the application of different treatment of S and Zn (sulphur and zinc) interaction. Maximum seeds $siliquae^{-1}$ 23.66 was recorded in T_8- S_2Zn_2 (@ 30 kg ha^{-1} + 2.75 kg ha^{-1}) and minimum seeds $siliquae^{-1}$ 19.26 was recorded in T_0- S_0Zn_0 (@ 0 kg ha^{-1} + 0 kg ha^{-1}). Similar results have also been recorded by Dubey *et al.*, (2013) (Fig. 5).

Test weight of seeds (g/1000 seed)

The test weight of seeds (g/1000 seed) was significant according to table 4 by the application of different treatment of S and Zn (sulphur and zinc) interaction. The maximum test weight of seeds 3.81 g was recorded in T_8- S_2Zn_2 (@ 30 kg ha^{-1} + 2.75 kg ha^{-1}) and minimum test weight of seeds was 3.36 g recorded in T_0- S_0Zn_0 (@ 0 kg ha^{-1} + 0 kg ha^{-1}). Similar results have also been recorded by Dubey *et al.*, (2013) (Fig. 6).

Seed yield (q ha^{-1})

The seed yield (q ha^{-1}) was non-significant according to table 4 by the application of different treatment of S and Zn (sulphur and zinc) interaction. The maximum seed yield 11.13 q ha^{-1} was recorded in T_8- S_2Zn_2 (@ 30 kg ha^{-1} + 2.75 kg ha^{-1}) and minimum seed yield 9.33 q ha^{-1} was recorded in T_0- S_0Zn_0 (@ 0 kg ha^{-1} + 0 kg ha^{-1}). Similar results have also been recorded by Dubey *et al.*, (2013) (Fig. 7).

Stover yield (q ha^{-1})

The stover yield (q ha^{-1}) was non-significant according to table 4 by the application of different treatment of S and Zn (sulphur and zinc) interaction. Stover yield was found maximum stover yield 15.70 q ha^{-1} was recorded in T_8- S_2Zn_2 (@ 30 kg ha^{-1} + 2.75 ha^{-1}) and minimum stover yield 13.77 q ha^{-1} was recorded in T_0- S_0Zn_0 (@ 0 kg ha^{-1} + 0 ha^{-1}). Similar results have also been recorded by Dubey *et al.*, (2013) (Fig. 8).

B: C ratio

The treatment combination of S and Zn (sulphur and zinc) T_8 S_2Zn_2 (@ 30 kg ha^{-1} + 2.75 kg ha^{-1}) was found the best combination. Highest net return ₹ 15540.12 ha^{-1} and B: C 1.57 was also recorded in this treatment. It is concluded that the best treatment was T_8 – S_2 + Zn_2 [@ 30 sulphur kg ha^{-1} + 2.75 zinc kg ha^{-1}] that showed the highest yield regarding, it gave the best results with respect to plant height 154.53 cm, number of leaves 74.46, number of branches 32.6, number of siliquae per plant 143.2, number of seed per siliquae 23.66, test weight of 1000 seed 3.81 gm, it gives highest yield 11.53 q ha^{-1} recorded.

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