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# Effect of gibberellic acid and sulphur on growth and yield of mustard (*Brassica juncea* L.)

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**Abstract**
A field experiment entitled **"**Effect of Gibberellic Acid and Sulphur on Growth and Yield of Mustard (*Brassica juncea* L.)" was conducted during *rabi* season of 2020-21 at the research farm of Rajasthan College of Agriculture, Udaipur. The experiment consisting of four levels (control, 20, 40 and 60 kg $ha^{-1}$) of sulphur and four levels (control, 25, 50 and 75 ppm) of gibberellic acid there by making 16 treatment combinations, were laid out in Factorial Randomized Block Design and replicated three times. The significant increase in plant height, dry weight, number of branches $plant^{-1}$, number of siliqua $plant^{-1}$, number of seeds $siliqua^{-1}$, test weight, seed yield, stover yield and biological yield of mustard was observed with the application of $T_{11}$ (40 kg S $ha^{-1}$ +50 ppm $GA_3$), as compared to control.

**Keywords:** Gibberellic, sulphur, mustard, *Brassica juncea* L.

## 1. Introduction

Indian mustard (*Brassica juncea* L.) is one of the most important oil seed crop belongs to the family Brassicaceae and the genus *Brassica*. Among the edible oilseeds cultivated, mustard ranks second after groundnut in India and contribution to the total oil seed acreage and production is 23.7 and 26.0% respectively. The unbalanced use of fertilizers is the main cause for low productivity of mustard. Compared to other crops mustard is more responsive to sulphur. The oil content in mustard seed is increased after the application of sulphur (Singh *et al.*, 2015) [20]. The sulphur containing glucosinolates are responsible for the aroma and pungent flavour. The consumption of sulphur fertilizer increases the yield in Indian mustard (Piri *et al.*, 2011) [11]. Application of sulphur has a significant effect on oil, fatty acids and glucosinate content in mustard seeds (Ahmad and Abdin, 2000 and Falk *et al.*, 2007) [1, 3]. Sulphur levels has beneficial effect on sulphur uptake, stover and seed yield (Sharma *et al.*, 2009) [16].

Plant growth regulators play an important role in plant development, improving yield and enhancing quality of seeds. Gibberellic acid is a PGR that improves seed germination, growth, stem elongation, photosynthesis, flowering and cell expansion because of its phytohormonic function (Taiz and Zeiger, 2010; Yuan and Xu, 2011) [21, 25]. The hydrolytic enzymes are coded by mRNA of gibberellic acid accumulated in dry matter, minerals and carbohydrates. Studies revealed that gibberellic acid has the capability to improve growth, flowering, photosynthesis, nutrient transport and yield of mustard (Hayat *et al*., 2001; Khan *et al*., 2005) [5, 7]. The present study was under taken to evaluate the effect of gibberellic acid and sulphur on growth and yield of mustard.

## 2. Materials and Methods

The experiment was conducted during *rabi* season of 2020-21 at the research farm of Rajasthan College of Agriculture, Udaipur. The experimental site is situated at South–Eastern part of Rajasthan at 24˚34' N latitude and 73˚42' E longitude at an altitude of 582.17 m above mean sea level. The region falls under the agro-climatic zone Ⅳ-a of Rajasthan. The maximum and minimum temperature ranged between 32.3˚C and 4.1˚C. Mean weekly maximum and minimum relative humidity ranged between 90.6% and 22.7% respectively and the total rainfall received during the crop period is 12.6 mm. The soil analysis confirmed that soil of experimental field was clay loam belongs to *Typic Haplustepts*, neutral alkaline in reaction, medium in available nitrogen and phosphorus and high in available potassium and low in sulphur.

The experiment consisting of four levels (control, 20, 40 and 60 kg $ha^{-1}$) of sulphur and four levels (control, 25, 50 and 75 ppm) of gibberellic acid there by making 16 treatment combinations, were laid out in Factorial Randomized Block Design and replicated three times. The seed was sown manually on 23 October 2020 by placing 2 seeds at a depth of 3–4 cm. Thinning was done after 25-30 days after sowing maintaining row to row and plant to plant distance 30 x 10 cm. In order to minimise weed competition, a hand weeding was done on the same day of thinning. Three irrigations were given to mustard crop. First irrigation was given after sowing, second irrigation was done at 20-25 days after sowing and third irrigation was given at pod filling stage of the crop. Recommended dose of NP *viz.*, 60 kg N, 40 kg $P_2O_5$ was applied uniformly through urea and DAP respectively. Half dose of nitrogen and full dose of phosphorous was applied as basal dressing at the time of sowing and remaining half dose of nitrogen was top dressed after second irrigation. Growth, yield attributes and yield were recorded and statistically analysed to find out the best treatment combination.

## 3. Results and Discussion

### 3.1 Effect of sulphur

#### 3.1.1 Growth parameter

The results of the investigation presented in Table 3.1 showed that maximum plant height, number of branches plant$^{-1}$, dry matter accumulation was obtained with the treatment 40 kg S ha$^{-1}$. The profound influence of sulphur fertilization on plant height, branches and dry matter accumulation could be attributed to better nutritional environment for plant growth at active vegetative stages which seem to have promoted metabolic activities. Consequently, this improves the meristematic activities causing higher apical growth and improves the plant height by cell division, enlargement and elongation. Sulphur helps in the formation of chlorophyll, being a constituent of Succinyl Co-A that permits photosynthesis through which plants produce starch, sugar, oils, fats and vitamins. It is best known for its role in the synthesis of amino acids, namely methionine, cysteine and cystine as sulphate sulphur. Application of sulphur significantly affected the dry matter production up to maturity. Sulphur fertilization improves the nitrogen uptake, promote photosynthesis and synthesis of chloroplast protein which might lead to dry matter production (Reddy and Reddy, 2001) [15]. Plant height, number of branches and other growth parameters were enhanced with better sulphur nutrition which might have resulted in higher dry matter production (Kumar and Yadav, 2007) [8]. Similar findings also reported by Shivran *et al*. (2012) [17], Raja *et al*., (2007) [13], Vishwanath *et al*.,(2006) [24].

#### 3.1.2 Yield attributes and Yield

It is evinced from data (Table 3.2 and 3.3) that yield attributing characters and yield significantly influenced with the application of different doses of sulphur. Yield and yield attributes *viz.*, number of siliqua plant$^{-1}$, seeds siliqua$^{-1}$, test weight and seed, stover and biological yield were found maximum with the application of 40 kg S ha$^{-1}$. The balanced nutritional environment enhanced the nutrient assimilation which in turn accelerated the crop to put forth the maximum yield attributes and yield. Sulphur helps in the synthesis of protein, which in turn produce photosynthates and adequate partition and translocation of this metabolites to the reproductive organ might have lead to the production of high yield contributing characters and yield. Yield is a function of complex interrelationship of its several components and cumulative interaction between vegetative and reproductive growth of the crop. The availability of translocated metabolites and nutrients contributed towards stronger reproductive phase which finally lead to the accumulation of maximum grain yield. The increase in the yield attributing characters *viz.*, number of siliqua plant$^{-1}$, number of seeds siliqua$^{-1}$ and test weight contributed towards higher seed yield. Straw yield is chiefly a product of growth parameters like plant height, number of branches and dry matter accumulation. So the increase in these characters as a result of sulphur fertilization resulted in increase of straw yield of mustard. Biological yield is a function of seed and straw yield. The seed and straw yield together showed significant increase in biological yield of mustard with the application of 40 kg S ha$^{-1}$. These results are line with the findings of Verma *et al*., (2012) [23], Singh and Singh (2013) [19] and Tomar (2012) [22].

### 3.2 Effect of gibberellic acid

#### 3.2.1 Growth parameter

The results revealed that the foliar application of gibberellic acid shown a positive effect on growth attributes of mustard (Table 3.1). The maximum plant height, number of branches plant$^{-1}$, dry matter accumulation was obtained with the foliar application 50 ppm $GA_3$. It is due to the fact that gibberellic acid enhances internode extension, leaf growth and apical dominance. Ravat and Makani (2015) [14] reported that $GA_3$ increases cell division, cell elongation and cell wall plasticity which in turn increases intermodal length. It has also reported that axial elongation with the application of $GA_3$ might be due to the microtubule elongation. Potter and Fry (1994) [12] $GA_3$ enhances the activity of enzyme xyloglucan endotransglycosylase (XET). This enzyme catalyzes the bond breaking and reforming between xyloglucan residues, and hence increases in wall extensibility. This facts lead to the increment in growth attributes especially plant height. The number of branches plant$^{-1}$ increased with the applied $GA_3$ due to its function of cell division, multiplication and enlargement. It is reported that photosynthetic activity increases with the increased leaf growth due to gibberellic acid application and hence better dry matter accumulation. These findings confirm the earlier results of Jatav (2007) [6], Mukharjee and Roy (2006) [10] and Mithra and pathak (2005) [9].

#### 3.2.2 Yield attributes and Yield

Data Table 3.2 and 3.3 clearly indicates that yield and yield attributes *viz.*, number of siliqua plant$^{-1}$, seeds siliqua$^{-1}$, test weight and seed, stover and biological yield with application of 50 ppm $GA_3$ over control**.** Exogenous application of $GA_3$ has been shown to increase the number of siliqua per plant due to enhanced flowering. It has also reported that foliar nutrition increases the utilization of plant nutrients as the chance of loss for nutrients is very minimal. There is a positive correlation of yield with growth and yield attributes. The ultimate increase in grain yield is due to the improved siliqua plant$^{-1}$. The crop utilizes the nutrients supplied through foliar or soil application and these nutrients stimulate the metabolic process in the plant and synthesis photosynthate through photosynthesis. These photosynthate might be translocated to developing pods having greater demand for assimilate which ultimately lead to greater length, more number of seed and higher test weight. The significant and positive correlation of yield with plant growth and yield attributes further confirm with the findings of Ganapathi *et* *al*., (2008) [4], Dhariwal (2005) [2] and Singh and Rajodia (2001) [18].

## 4. Conclusion

On the basis of present study conducted during *rabi* 2020-2021, it can be concluded that there was significant response for application of sulphur and gibberellic acid on mustard crop. Mustard variety Giriraj should receive a sulphur dose of 40 kg S $ha^{-1}$ and GA3 @ 50 ppm under the agroclimatic condition prevalent at Udaipur for obtaining higher growth and yield.

**Table 1:** Effect of sulphur and gibberellic acid on growth attributing characters of mustard

| Treatments | Plant height (cm) | Number of Dry matter (g) | branches $plant^{-1}$ |
|---|---|---|---|
| Sulphur | | | |
| Control | 184.98 | 25.50 | 32.70 |
| 20 kg S $ha^{-1}$ | 199.41 | 29.58 | 34.10 |
| 40 kg S $ha^{-1}$ | 212.24 | 33.67 | 36.03 |
| 60 Kg S $ha^{-1}$ | 206.51 | 31.25 | 34.99 |
| S.Em.± | 0.93 | 0.19 | 0.15 |
| C.D. (P = 0.05) | 2.68 | 2.14 | 0.44 |
| Gibberellic acid | | | |
| Control | 189.94 | 21.67 | 31.12 |
| 25 ppm $GA_3$ | 204.84 | 31.58 | 35.00 |
| 50 ppm $GA_3$ | 215.60 | 34.25 | 36.15 |
| 75ppm $GA_3$ | 209.40 | 32.50 | 35.54 |
| S.Em.± | 0.93 | 0.19 | 0.15 |
| C.D. (P = 0.05) | 2.68 | 2.14 | 0.44 |

**Table 2:** Effect of sulphur and gibberellic acid on yield attributing characters of mustard

| Treatments | Number of siliqua | Number of seeds $plant^{-1}$ | Test weight (g) $siliqua^{-1}$ |
|---|---|---|---|
| **Sulphur** | | | |
| Control | 191.33 | 12.67 | 4.39 |
| 20 kg S $ha^{-1}$ | 227.00 | 13.33 | 4.64 |
| 40 kg S $ha^{-1}$ | 278.92 | 14.67 | 5.41 |
| 60 Kg S $ha^{-1}$ | 252.00 | 13.92 | 5.00 |
| S.Em.± | 1.58 | 0.22 | 0.02 |
| C.D. (P = 0.05) | 4.57 | 0.64 | 0.07 |
| Gibberellic acid Control | 170.67 | 12.33 | 4.25 |
| 25 ppm $GA_3$ | 245.83 | 13.50 | 4.95 |
| 50 ppm $GA_3$ | 271.75 | 14.75 | 5.18 |
| 75 ppm $GA_3$ | 261.00 | 14.00 | 5.06 |
| S.Em.± | 1.58 | 0.22 | 0.02 |
| C.D. (P = 0.05) | 4.57 | 0.64 | 0.07 |

**Table 3:** Effect of sulphur and gibberellic acid on yield of mustard

| Treatments | Seed | Straw | Yield (kg $ha^{-1}$) Biological |
|---|---|---|---|
| Sulphur | | | |
| Control | 1247 | 3065 | 4313 |
| 20 kg S $ha^{-1}$ | 1362 | 3637 | 4998. |
| 40 kg S $ha^{-1}$ | 1492 | 4101 | 5593. |
| 60 Kg S $ha^{-1}$ | 1431 | 3921 | 5352 |
| S.Em.± | 2.64 | 24.5 | 117.4 |
| C.D. (P = 0.05) | 7.62 | 110.5 | 325.6 |
| Gibberellic acid | | | |
| Control | 1156 | 2846 | 4003 |
| 25 ppm $GA_3$ | 1426 | 3831 | 5258 |
| 50 ppm $GA_3$ | 1504 | 4235 | 5739 |
| 75 ppm $GA_3$ | 1469 | 4079 | 5550 |
| S.Em.± | 2.64 | 24.5 | 117 |
| C.D. (P = 0.05) | 7.62 | 110.5 | 325.6 |

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