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*Research Article*

# Effect of Potassium and Sulphur Application on Growth Parameters of Indian Mustard (*Brassica juncea* L.) Genotypes at Vegetative Stage under Water Deficit Conditions

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**ABSTRACT**

*The experiment was conducted with two genotypes of Indian mustard (Brassica juncea L ) viz RH 725 and RH 749 to study the effect of potassium and sulphur at vegetative stages under water deficit conditions in randomized block design during rabi season of 2018- 2019 at nursery of Kurukshetra University , Kurukshetra ( Haryana). The main plots were treated with potassium and sulphur at different concentrations of potassium (control) $K_1$=10 kg/acre, $K_2$=20 kg/acre, $K_3$= 30 kg/acre and $K_2S$= ( 20+60 kg/acre) to study various growth parameters including Leaf area index ( LAI ), Leaf area duration ( LAD ), crop growth rate (CGR), relative growth rate (RGR), and net assimilation rate (NAR). Growth and development parameters were computed and experimental results showed that combine treatment of potassium and sulphur were pragmatic in improving Brassica performance. Maximum LAI ( 0.37) , LAD ( 5.62 days) CGR (0.86 g $m^{-2}$ $d^{-1}$), RGR ( 0.05 mg $g^{-1}day^{-1}$) and NAR (0.319 g $m^{-2}$ $d^{-1}$) noted in plots where sulphur was applied along with increased level potassium while least LAI (0.14) , LAD (2.15 days), CGR (0.024 g $m^{-2}$ $d^{-1}$), RGR ( 0.03 mg $g^{-1}day^{-1}$) and NAR (0.003 g $m^{-2}$ $d^{-1}$) was in control treatment. Overall performance of genotype RH-749 was comparatively higher in all fertilizer treatment as compared to RH- 725 genotype.*

***Keywords:*** *Mustard, Growth, Vegetative stage, LAI, Drought*

## INTRODUCTION

Indian mustard is a winter oilseed crop largely grown in semi arid regions of northern India. It is generally grown under rain fed condition and drought plays vital role in determining the yield of the crop. Indian mustard is an important oilseed crop of the Indian subcontinent and contributes more than 80% of the total rapeseed-mustard production of the country. It is the second important oilseed crop at national level and contributes nearly 27% of edible oil pool of the country (Singh et al., 2013).

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In India, rapeseed-mustard occupy 5.99 million ha area with production and productivity of 6.31 million tones and 1053 kg/ha respectively (India stat 2018-19). Indian mustard (*Brassica juncea* L.) is an important *rabi* crop of Haryana. In Haryana, rapeseed and mustard is one of the major growing crop occupying 0.56 million ha of area, with production and productivity of 0.699 million tones and 1248 kg/ha respectively (India stat 2018-19).

Drought is one of the environmental factors, which influence the growth in every phenophase of the crop cycle. Its impact on morphology, development, biomass production and days to attain the phenophase is well established. The full genetic potential of the cultivar is only obtained when an optimum climatic condition including other environmental factors is available. The drought conditions during early and later stages caused by higher temperatures coupled with moisture stress adversely affect growth and yield of mustard crop (Sapalika el al., 2018). Growth and seed yield production of *Brassica* species have greatly decreased owing to drought conditions. Like other crop, mustard suffers from stringent drought with fluctuating and un-predicting intensities, so there is an urgent need for drought proofing of mustard crop (Singh et al., 2018).

The LAI, LAD, NAR, CGR and RGR are the important growth parameters influencing yield which are dependent not only on the genotypes but also on the environmental and fertility management practices.

The functional leaves, dry matter production and leaf area index are the main growth factor which may directly reflect to grain yield. Growth analysis parameters like crop growth rate (CGR) are product of LAI. Relative growth rate (RGR) measures the increase in dry matter with a given amount of assimilatory material at a given point of time and net assimilation rate (NAR) is the net gain in total dry matter per unit leaf area per unit time Moaveni et al. (2010) studied that drought stress has negative effects on physiological growth indices of winter rape seed. Drought stress causes an increase in solute concentration in the soil and root-zone of the plant leading to an osmotic flow of water out of plant cells. This in turn causes the solute concentration inside plant cells to increase, thus lowering water potential and disrupting membranes along with essential processes like photosynthesis. These drought-stressed plants consequently exhibit poor growth and yield. According to Lessani and Mojthaedi (2006), one of the main aspects of drought tolerance is the ability of plant cells to survive severe water loss without being affected by deleterious damages. When the plant cell dries up, usually the vacuole crumples more than the cell wall and thus results in tearing up of the protoplasm. Plant yield losses under insufficient water have always been an important issue for plant breeders to improve using drought tolerance indices to select genotypes (Mitra, 2001).

K plays a vital role in photosynthesis, translocation of photosynthates, protein synthesis, control of ionic balance, regulation of plant stomata and water. It is not only an essential macronutrient for plant growth and development, but also is a primary osmoticum in maintaining low water potential of plant tissues use, activation of plant enzymes and many other processes (Reddya et al., 2004). Reduced K supply is known to reduce the translocation of nitrates, phosphates, calcium, magnesium, and amino acids. The process of photosynthetic carbon dioxide fixation and utilization of photo assimilates is strongly dependent on K supply (Cakmak et al., 2005). Numerous studies have shown that the application of K fertilizer mitigates the adverse effects of drought on plant growth (Sangakkara et al. 2001). In general, oilseed rape, and *Brassica* species have a characteristically high sulfur (S) demand during vegetative growth for the synthesis of proteins. For example, the production of 1 ton of rape seeds requires about 16 kg S (Blake-Kalff et al., 2001) compared with 2–3 kg of S per ton of wheat grain (Zhao et al., 1999).

The aim of the present experiment was to evaluate the effects of different levels of potassium and sulphur under water deficit condition on LAI, LAD, CGR, RGR and NAR.

## MATERIALS AND METHODS

Two genotype of Indian mustard, *Brassica juncea* L. *viz* RH-725 and RH-749 were grown during the spring season (October- April) of 2018-2019 at nursery of Kurukshetra University, Kurukshetra Haryana, India. Geographically the experimental field was located at $29^0$-95'N latitude and $75^0$.82' longitude at an elevation of 241 meters above the mean sea level. The average annual temperature is $24.4^0$C and variation in the precipitation between the driest and wettest months is 224 mm. The experimental soil having 44.37% sand, 32.68% silt and 22.95% clay particals, EC = 0.65 $dSm^{-1}$at $25^0$C, pH = 8.30, Organic carbon = 0.43%, Nitrogen = 109.65 kg/ha, Phosphorus = 7.60kg/ha, Potassium = 210 kg/ha. The crop was planted in rows spaced 10 inch with 30 cm plant to plant distance. The experiments were base on randomized complete block design with three replication. The main plots included potassium and sulphur treatment at 4 stages. $K_1$ (10kg/acre), $K_2$ ( 20 kg/acre) $K_3$ (30 kg/acre) , $K_2$ S (20kg/acre+60kg/acre). Data were collected on the vegetative stage (35 DAS) of the plant including (LAI) leaf area index, (LAD) leaf area duration, (CGR) crop growth rate , (RGR) relative growth rate and ( NAR) net assimilation rate.

LAI was calculated by using the formula as suggested by Watson (1947):

LAI = Leaf area / Land area

LAD ( leaf area duration ) was calculated using the formula given by Watson ( 1947) :

$LAD = ( LAI_1+ LAI_2) X ( t_2-t_1)/2$

where $LAI_1$and $LAI_2$ are leaf are indices recorded at times $t_1$ and $t_2$ respectively.

The dry weight per plant was calculated and used to estimate crop growth rate (CGR) as proposed by Hunt (1978): $CGR = W_2-W_1/t_2-t_1$ ( $g\ m^{-2}day^{-1}$) where,

$W_1$ and $W_2$ are dry weights ($g\ m^{-2}$) at first and second harvests taken at times $t_1$ and $t_2$ respectively. Mean values were calculated and the values of CGR and RGR were calculated by using the formulas given by Reddy and Reddy 2009 after achieving constant dry weight of the plants in the oven at $70^0$C.

The collected data were statistically analyzed by the OPSTAT software at the Computer Centre, Department of mathematics & Statistics, CCS HAU, Hisar.

## RESULT AND DISCUSSION

Overall mean performance of genotype RH-749 was comparatively higher in all fertilizer treatment as compared to RH- 725 genotype. The strength of the response of the two genotype to the all treatment, in terms of LAI, LAD, CGR, RGR and NAR, was in order of $K_1<K_2<K_3<K_2$ S (Table 1). LAI is a major factor which determines radiation interception, canopy photosynthesis at vegetative stage. Table 1 showed that leaf area index steadily increased in all treatments of potassium and reached at maximum in combined treatment of potassium and sulphur. In the beginning, differences in leaf area index among treatment were less visible, but with time these difference become progressively more visible. Maximum leaf area index (0.37) was observed in $K_2$ S treatment among RH-749 genotype while minimum LAI (0.14) was noted in $K_1$ treatment in RH-725 genotype. The progressive increase in LAI was due to increase K and S application which leads to increase the rate of photosynthesis which resulted in more LAI. Findings were supported by Daniela et al. (2008), they reported that LAI was significantly affected by the S application and showed highest value. As more LAI ensured the higher photosynthesis rate which further facilitates high dry matter accumulation, consequently more LAI could be attributed to significant development in leaf expansion. Moreover, the greater leaf expansion might be attributed to high rate of cell division and cell enlargement. As evidenced by Khan et al. (2005), reported that LAI is improved significantly due to S supplementation.

Increase of K fertilizer give positive effect on LAD was for all treatments. Maximum LAD (3.80 days) was noted where S was applied with K in RH-749 genotype. The minimum LAD (2.15 days) was noted in $K_1$ treatment. The progressive increase in LAD was due to increase in S application which leads to increase the rate of photosynthesis, which resulted more LAI and LAD. High LAD depicts that plant developed their leaves for long time, associated with delayed leaf senescence. The substantial increase in LAD in potassium and sulphur might be ascribed to growth promontory effect of S, These results are in line with Khan et al. (2005) who reported S fertilization enhanced the LAD.

CGR is an important parameter which indicates how efficiently crop is using input resources and produces photosynthates which are used by plant for production of economic yield. Data related to CGR of *Brassica* are presented in table 1 showed that S application significantly affected CGR of *Brassica.* Maximum CGR (0.86 g $m^{-2}$ $d^{-1}$) was noted in the treatment where S was applied along with potassium in RH- 749 genotype and minimum CGR (0.024 g $m^{-2}$ $d^{-1}$ ) was noted in the $K_1$ treatment The increase in CGR was due to increase nutrients uptake which promoted better crop growth, gave maximum LAI and LAD with S application. Findings are quite similar with Daniela et al. (2008), they reported that CGR and RGR (relative growth rate) were significantly affected by the S application and showed the highest value.

The RGR of crop plants generally begins slowly just after germination. In the initial stages of plant growth the ratio between active and dead tissue is high and almost the entire cells of production organs are actively engaged in vegetative matter production. Maximum RGR noted in $K_2$ S treatment (0.05 mg $g^{-1}$ $day^{-1}$ ) in RH- 749 and minimum noted in $K_1$ treatment ( 0.03 mg $g^{-1}$ $day^{-1}$) in RH-725 genotype.

The average NAR of a crop represents the net photosynthetic production per unit LAD (Hunt, 1978). Maximum NAR (0.318 gm $^{-2}$ $d^{-1}$) was noted where Sulphur was applied along with potassium and minimum NAR (0.003 gm $^{-2}$ $d^{-1}$) was noted in treatment where no S was applied. The increase in NAR with application of S was due to better crop growth which gave the maximum plant height, LAI, and LAD. The improvement in NAR may be attributed to more vegetative growth due to increasing rate of S fertilizer.

**Table 1: Effect of potassium and sulphur application on growth parameters of Indian mustard (*Brassica juncea* L.) genotypes at vegetative stage**

| Treatments | LAI | | LAD (days) | | CGR (g $m^{-2}$ $d^{-1}$) | | RGR (mg $g^{-1}$ $day^{-1}$) | | NAR ($gm^{-1}day^{-1}$) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | RH 725 | RH 749 | RH 725 | RH 749 | RH 725 | RH 749 | RH 725 | RH 749 | RH 749 | RH 749 |
| $K_1$ (10kg/acre) | 0.14 | 0.16 | 2.15 | 2.45 | 0.024 | 0.37 | 0.03 | 0.03 | 0.003 | 0.060 |
| $K_2$ (20kg/acre) | 0.20 | 0.21 | 3.08 | 3.12 | 0.034 | 0.53 | 0.03 | 0.04 | 0.007 | 0.109 |
| $K_3$ (30kg/acre) | 0.25 | 0.25 | 3.76 | 3.80 | 0.102 | 0.63 | 0.04 | 0.04 | 0.025 | 0.159 |
| $K_2S$ (20+60kg/acre) | 0.33 | 0.37 | 5.02 | 5.62 | 0.196 | 0.86 | 0.04 | 0.05 | 0.067 | 0.319 |
| CD at 5% | T=0.06<br>G=1.84<br>TXG=0.008 | | T=0.112<br>G=0.079<br>TXG=0.159 | | T=0.002<br>G=0.002<br>TXG=0.003 | | T=0.001<br>G=0.001<br>TXG=0.001 | | T=0.006<br>G=0.004<br>TXG=0.008 | |

## CONCLUSION

Good growth and development of any plant results in better productivity. However, numerous factors affect productivity also. It is concluded that increased level of potassium significantly boosted vegetative growth of *Brassica juncea* under water deficit condition. However, application of elemental sulfur (S0) @ 60 kg/acre along with increased level of potassium @ 20kg/ acre has more influence on growth under water deficit condition rather beyond this rate, plant may get stressed. Further investigation particularly for *Brassica* should be related to depth of S application and method for improving S use efficiency.

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