Influence of Potassium and Spacing on Growth and Yield of Mustard (*Brassica juncea* L.)

ABSTRACT

A field experiment was conducted during *Rabi* of 2022-23 at the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology And Sciences, Prayagraj (U.P.) India. To study the Response of potassium and spacing on the growth and yield of Mustard. The treatments consist of potassium 30,40,50 kg/ha and spacing 25 x 10 cm, 35 x 10 cm, and 45 x 10 cm. There were 9 treatments each replicated thrice. The soil of the experimental plot was sandy loamy in texture, nearly neutral in soil reaction (pH 7.8), low in organic carbon (0.35%) available N (163.42 kg/ha), available P (21.96 kg/ha) and available K (256.48 kg/ha). Results revealed that the significantly the higher plant height (181.74 cm), the higher plant dry weight (24.88 g/plant), the higher crop growth rate (11.6 g/m^2 /day), the higher number of siliqua per plant (276), the higher seeds/siliqua (16.54), the higher oil content (44.03%), the higher seed yield (2.33 t/ha) and the higher stover yield (3.53 t/ha) were significantly influenced with the application of potassium 50 kg/ha + spacing 45 x 10 cm.

Keywords: *Mustard, Potassium, Spacing, growth parameters, and yield attributes.*

INTRODUCTION

Oilseeds occupy a prestigious place in Indian agriculture due to their vital role in the sustainable economy of the country. Vegetable oil (edible) plays a significant role in human nutrition. As a high energy element of food, edible oil is important for meeting the calorific requirements of human beings. There are two major sources of Oilseeds i.e., Primaryand Secondary. Primary sources of oilseeds are made by combining the edible group [Groundnut, Rapeseed (Toria, Mustard and Sarson), Soybean, Sunflower, Sesame, Safflower and Niger)]and non-edible group (Castor and Linseed). Almost 72% of the total oilseeds area is confined to rainfed farming cultivated mostly by marginal and small farmers. Lack of appropriate technologies, cultivation under input-starved conditions, combating the biotic and abiotic stresses are some of the major causes for poor productivity of oilseeds. The huge drain on the import bill coupled with the above factors led to establishment of Technology Mission on Oilseeds (TMO) in 1986, a key breakthrough in increasing oilseeds production was attained through an integrated approach by introducing innovative crop production technologies, improved supply of inputs and extension services support for marketing, post-harvest technologies and excellent coordination between various concerned organizations/ departments and Ministries. As a result of concerted efforts by the TMOP, the production of oilseeds increased from 108.3 lakh tonnes in 1985-86 to 361.009 lakh tonnes in 2020-21. **(Anonymous, 2021)**

Mustard has a primary center of its origin in central Asia with secondary centers in central and western China, Eastern India, Burma and through Iran to near east cultivated for centuries in many parts of Eurasia. However, the principle growing countries are Bangladesh, Central Africa, China, India, Japan, Nepal and Pakistan as well as Southern Russia in north of the Caspian Sea. In India, rapeseed-mustard occupy 6.23million hectare area with production and productivity of 9.34 million tonnes and 1499 kg ha respectively **(India starts, 2020-21).** Major growing areas are Rajasthan, Uttar Pradesh, and Haryana. Rajasthan and Uttar Pradesh are the major mustard producing states in our country. Together, they contribute to about 50% of the total production. In Uttar Pradesh rapeseed and mustard is one of the major grown crops occupying 0.56 million hectares of area with production and productivity of 0.699 million tonnes and 1,248 kg/ha, respectively **(GOI,2021).**

There is a lot of opportunity for maximizing mustard's output in terms of both productivity and area expansion. The productivity of mustard crops is greatly influenced by effective crop management techniques, which include choosing high yielding, disease and pest resistant varieties and adopting proper crop rotation, timely planting, adequate plant stand, balanced plant nutrition, need-based plant protection, irrigation, and weed control.

Among the mineral cations needed by plants, potassium is one of the primary nutrients found in soil. 2.4% of the earth's crust is potassium. Potassium is mostly found in complex silicate components, while some of it is also found in soil's organic matter and clay fraction. The amount of potassium in soil can range from 0.1% to 3.0% or even higher. The quality of agricultural output is enhanced, pest and disease resistance is added, and tolerance to cold and frost is imparted thanks to potassium, which also plays a significant role in metabolic processes and grain formation. Lack of potassium lowers yield and oil content and has a detrimental impact on the ratio of unsaturated to saturated fatty acids **(Brar et al., 2010).**

The amount of space that plants have to grow, develop, and produce their final product is a major factor; nevertheless, the precise and exact reaction will depend on the species and cultivar. Therefore, it is essential to manage plant populations by planting techniques that may aid in preventing overcrowding and so enable the plants to utilise these resources more effectively and efficiently, leading to greater output. Beyond an ideal level, higher plant densities per unit area led to competition for natural resources among the plants, weaker plants, and perhaps severe lodging **(Kumar *et al*., 2004)**. Up until other production parameters become limiting, a linear rise in grain output has been seen with increased plant density **(Norsworthy and Emerson, 2005).** While fewer branches are produced by low population density carry fertile pods, thus prolonging the seed development phase.

Keeping these points in view, the present study entitled "**Influence of Potassium and spacing on growth and yield of Mustard (*Brassica juncea* L.)",** was conducted at Crop Research Farm, Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh during *Rabi* season of 2022-23.

Materials and Methods

The experiment was conducted during *Rabi* of 2022-23, Crop Research Farm, Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture Technology And Sciences, Prayagraj, Uttar Pradesh. Which is located at 25.24' 42'' N latitude, 81·50' 56" E longitude and 98m altitude above the mean sea level (SL).

The experiment was conducted in Randomized Block Design with 9 treatments each replicated thrice. The plot size of each treatment was 3m x 3m. Factors are three levels of Potassium (30,40,50 kg/ha) and the spacing 25×10 cm, 35×10 cm, 45×10 cm. The Mustard crop was sown on 15 October 2022. Harvesting was done by taking 1m^2 area from each plot. And fromit five plants were randomly selected for recording growth and yield parameters. The treatment details are as follows, T_1 -(Potassium 30 kg/ha + Spacing 25 x 10 cm), T_2 -(Potassium 30 kg/ha + Spacing 35 x 10 cm), T_3 – (Potassium 30 kg/ha + Spacing 45 x 10 cm), T_4 -(Potassium 40 kg/ha + Spacing 25 x 10 cm), T_5 -(Potassium 40 kg/ha + Spacing 35 x 10 cm), T_6 -(Potassium 40 kg/ha + Spacing 45 x 10 cm), T_7 -(Potassium 50 kg/ha + Spacing 25 x 10 cm), T_8 -(Potassium 50 kg/ha + Spacing 35 x 10 cm), and T_9 -(Potassium 50 kg/ha + Spacing 45 x 10 cm). The observations were recorded for plant height, dry weight, Crop growth rate, number of siliqua per plant, number of seeds per siliqua, test weight, see yield and stover yield. The data was subjected to statistical analysis by analysis of variance method **(Gomez and Gomez, 1976).**

Results and Discussion

Growth parameters:

Plant Height- At 100 DAS The significantly higher plant height (181.74 cm) was observed in treatment-9 (Potassium 50 kg/ha + Spacing 45 x 10 cm) However, treatment-8 (Potassium 50 kg/ha + Spacing 35 x 10 cm) was found to be statistically at par with treatment- 9 (Potassium 50 kg/ha + Spacing 45 x 10 cm). With the application of K, a noticeably greater plant height (181.74 cm) was observed. The K strengthens plant cell walls and helps lignifysclerenchyma tissues. An Increase in plant height brought on by an increase in K may also be the result of adequate nutrition, which helps plants grow vigorously during their vegetative stages and ultimately results in an increase in plant height through cell elongation, cell division, photosynthesis, assimilation, and turgidity of plant cells. These findings closely match those of **Dhruw et al. (2017).** Likewise, the additional growth in plant height may bea result of plant spacing. Row spacing for mustard varies widely around the globe depending on the cultivar, production method, and local climatic circumstances. To enhance crop growth and the amount of time needed for canopy closure, maintaining optimum row spacing is crucial. **Svecnjak et al. (2006)** observed similar findings.

Dry weight/plant- The significantly higher plant dry weight (24.88 gm) was observed in treatment-9 (Potassium 50 kg/ha + Spacing 45 x 10 cm) However, treatment-8 (Potassium 50 kg/ha + Spacing 35 x 10 cm) was found to be statistically at par with treatment- 9 (Potassium 50 kg/ha + Spacing 45 x 10 cm). With potassium management, a considerably increased plant dry weight (24.88 gm) was seen. This might be as a result of increased nutrient availability in the soil and their higher absorption, which causes an increase in height that results in an increase in the number of branches, increasing the accumulation of dry matter in the plant. These findings were shown to be comparable to those published by **Amanullah (2016).** and also, better growth observed under wide row spacing compared to closer spacing might be due to efficient use of light, soil moisture and nutrients under wider spacing. Results are in conformity with findings of **Pandey *et al.* (2015).**

Crop growth rate - The maximum crop growth rate (11.66 g/m^2 /day) was observed in treatment-9 (Potassium 50 kg/ha + Spacing 45 x 10 cm) However, treatment-8 (Potassium 50 kg/ha + Spacing 35 x 10 cm) was found to be statistically at par with treatment- 9 (Potassium 50 kg/ha + Spacing 45 x 10 cm). The treatment of potassium at a rate of 50 kg per ha resulted in the highest crop growth rate (11.6 g/m^2/day). This may be because one ofthe 17 elements required for plant growth and development is potassium. Because of its impact on photosynthesis, water usage efficiency, and plant resistance to diseases, drought,and cold, as well as for creating the balance between protein and carbs, it is for enhancing the production and quality of various crops **(Dhruw et al., 2017).**

Yield Attributes:

Number of siliqua/plant

The significantly higher number of siliquae per plant (276) were observed in treatment-9 (Potassium 50 kg/ha + Spacing 45 x 10 cm), which was significantly superior over rest of the treatments. However, treatment-8 (Potassium 50 kg/ha + Spacing 35 x 10 cm) was found to be statistically at par with treatment- 9 (Potassium 50 kg/ha + Spacing 45 x 10 cm). With the application of K 50kg/ha, a significantly larger number of siliquae/plant (276) was seen. The fact that K plays a crucial part in plant metabolism, which is a crucial necessity for plant growth and development, may be the cause of this improvement in growth and yield characteristics. These findings are consistent with those of **Lakhan *et al.* (2017)**. And also, this was possibly due to less competition between plants for nutrient, soil moisture, space and solar radiation etc. in wider spacing than closer spacing. This also confirms the results of **Kushwaha *et al.* (2006).**

Number of seeds/siliqua

The significant higher number of seeds per siliquae (16.54) were observed in treatment-9

(Potassium 50 kg/ha + Spacing 45 x 10 cm), which was significantly superior over rest of the treatments. However, treatment-8 (Potassium 50 kg/ha + Spacing 35 x 10 cm) was found to be statistically at par with treatment- 9 (Potassium 50 kg/ha + Spacing 45 x 10 cm). With the application of K 50kg/ha, a significantly larger number of seeds/siliquae (16.54) were seen. Increased transfer of photosynthates from source to sink and greater crop development can be linked to the more seeds per siliquae **(Tripathi *et al*., 2010).**

Test weight (g)

The maximum test weight (4.45 gm) was observed in treatment-9 (Potassium 50 kg/ha + Spacing 45 x 10 cm), and the minimum test weight (3.71 gm) was observed in treatment-2. However, there was no significant difference among the treatments. The potassium treatment of 50 kg/ha resulted in the highest test weight (4.45 gramme) being reported. According to Tripathi et al. (2010), increased photosynthate translocation from source to sink and improved crop growth are both responsible for the greater 1000-seed weight.

Oil Content (%)

The significant higher percentage of oil content (44.03%) was observed in treatment-9 (Potassium 50 kg/ha + Spacing 45 x 10 cm), which was significantly superior over rest of the treatments. However, treatment-8 (Potassium 50 kg/ha + Spacing 35 x 10 cm) was found to be statistically at par with treatment- 9 (Potassium 50 kg/ha + Spacing 45 x 10 cm). The significant higher percentage of oil content (44.03%) was observed with addition of K. might have activated the enzymes responsible for producing oil and caused higher oil content. Beneficial effect of K on oil content was also reported by **Singh *et al.* (2017)**.

Seed Yield (t/ha)

The significant higher seed yield (2.33 t/ha) was observed in treatment-9 (Potassium 50 kg/ha + Spacing 45 x 10 cm), which was significantly superior over rest of the treatments. However, treatment-8 (Potassium 50 kg/ha + Spacing 35 x 10 cm) was found to be statistically at par with treatment- 9 (Potassium 50 kg/ha + Spacing 45 x 10 cm). With the treatment of 50kg/ha potassium, a significantly increased seed output (2.33 t/ha) was noted. The fact that K is crucial for processes including photosynthesis, water interactions, protein synthesis, and at least 60 distinct enzyme systems inside the plant explains why there is an increase in seed production after K treatment. Similar findings are in agreement with **Rohit and Jitendra Singh (2020)**, and a further increase in seed output may be attributable to less competition, which led to more uniform dispersion of the roots and leaves. It encourages a more efficient use of light by improving the absorption of PAR during the blooming stage and radiation during the seed filling stage. Equivalent leaf spacing allowed for more sunlight absorption by each leaf. That might possibly be because mustard crops are better able to convert solar radiation into the generation of seeds because to larger leaf surfaces that can intercept sunlight and evenly spaced plants **(Beenish *et al*., 2019).**

Stover yield (t/ha)

The significant higher stover yield (3.53 t/ha) was observed in treatment-9 (Potassium 50 kg/ha + Spacing 45 x 10 cm), which was significantly superior over rest of the treatments. However, treatment-8 (Potassium 50 kg/ha + Spacing 35 x 10 cm) was found to be statistically at par with treatment- 9 (Potassium 50 kg/ha + Spacing 45 x 10 cm). The fact that K is the primary plant nutrient limiting yield in K deficient soils may be the cause of the rise in seed and stover yields brought on by K treatment. According to reports, applied K increases the plant's general growth and development as well as the uptake of important nutrients, leading to increased seed and stover output. Additionally, the role of K in numerous enzymatic reactions, growth processes, hormone production, protein synthesis, and the translocation of photosynthates to reproductive parts may be responsible for the beneficial effect of K application on the yield of mustard **Yadav *et al.*, (2013)**.

Harvest index (%)

The significant higher Harvest index (41.06 %) was observed in treatment-3 (Potassium 30 kg/ha + Spacing 45 x 10 cm), which was significantly superior over rest of the treatments. However, treatment-2 (Potassium 30 kg/ha + Spacing 35 x 10 cm) was found to be statistically at par with treatment- 3 (Potassium 30 kg/ha + Spacing 45 x 10 cm). The trend in the projected study under potash applied plants might be due to decrease in the transpiration rate which ultimately maximize the water retention and utilization **(Syrovy *et al.*, 2015).** The performance of potash in the plant growth and development might be due to trigger out the bio-chemical, morphological and physiological processes as a catalyst in the mustard crop plants **(Trivedi *et al.*, 2014).**

Conclusion

It revealed that with the application of Potassium 50 kg/ha along with the spacing 45 x 10 cm (Treatment-9), has performed positive performance was observed along with an improved growth and yield parameters. Higher grain yield, gross returns, net returns and benefit cost ratio were also recorded with application of with Potassium 50 kg/ha along with the spacing 45 x 10 cm (Treatment-9). These findings are based on one season therefore; further trials may be requiredfor further confirmation.

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Table 1. Influence of Potassium and Spacing on growth parameters of Mustard.

S. No.	Treatment combinations	Plant height(cm)	Plant Dry Weight(g)	Crop growth rate ($g/m^2/day$)
1.	Potassium 30 kg/ha + Spacing 25 x 10 cm	165.04	18.90	7.3
2.	Potassium 30 kg/ha + Spacing 35 x 10 cm	168.65	20.20	7.3
3.	Potassium 30 kg/ha + Spacing 45 x 10 cm	170.72	21.11	7.9
4.	Potassium 40 kg/ha + Spacing 25 x 10 cm	169.56	22.37	8.4
5.	Potassium 40 kg/ha + Spacing 35 x 10 cm	172.27	19.70	8.8
6.	Potassium 40 kg/ha + Spacing 45 x 10 cm	173.86	22.78	9.8
7.	Potassium 50 kg/ha + Spacing 25 x 10 cm	171.60	22.37	11.0
8.	Potassium 50 kg/ha + Spacing 35 x 10 cm	178.27	23.96	11.3
9.	Potassium 50 kg/ha + Spacing 45 x 10 cm	181.74	24.88	11.6
	F test	S	S	S
	SE m (±)	1.41	0.43	0.24
	CD (p=0.05)	4.22	1.30	0.73

Table 2. Influence of Potassium and Spacing on yield attributes of Mustard.

S. No.	Treatments	No of Siliquae/ plant	No of Seeds/ siliquae	Test weight (g)	Oil content (%)	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index (%)
1.	Potassium 30 kg/ha + Spacing 25 x 10 cm	242	14.11	3.74	38.24	1.54	2.57	37.38
2.	Potassium 30 kg/ha + Spacing 35 x 10 cm	248	14.84	3.71	39.31	1.81	2.69	40.20
3.	Potassium 30 kg/ha + Spacing 45 x 10 cm	252	15.36	3.80	40.71	1.89	2.71	41.06
4.	Potassium 40 kg/ha + Spacing 25 x 10 cm	256	14.96	3.92	39.54	1.81	2.84	38.96
5.	Potassium 40 kg/ha + Spacing 35 x 10 cm	264	15.38	4.05	41.66	1.92	2.92	39.63
6.	Potassium 40 kg/ha + Spacing 45 x 10 cm	266	15.79	4.21	42.63	2.04	3.08	39.81
7.	Potassium 50 kg/ha + Spacing 25 x 10 cm	263	15.27	4.13	39.80	2.10	3.21	39.53
8.	Potassium 50 kg/ha + Spacing 35 x 10 cm	270	16.11	4.31	43.61	2.23	3.41	39.52
9.	Potassium 50 kg/ha + Spacing 45 x 10 cm	276	16.54	4.45	44.03	2.33	3.53	39.76
	F-Test	S	S	NS	S	S	S	S
	S Em±	2.28	0.29	0.17	0.66	0.06	0.06	0.60
	CD (p=0.05)	6.85	0.86	--	1.98	0.17	0.17	1.80

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