Effect of Sulphur, Potassium and PSB on Growth Parameters, Root Architecture and Quality of Mustard (*Brassica juncea* L.)

Abstract

Field experiments were conducted to Studies effect of sulphur, potassium and PSB on growth parameters, root characterstics and quality of mustard during rabi season of 2019-20 and 2020-21 at students instructional farm, Chandra Shekhar Azad University of Agriculture & Technology, Kanpur. The experiment consists of 9 treatments combinations in randomized block design with three replications.Mustard variety *Varuna (T-59)*was grown with the recommended agronomic practices. On the basis of results emanated from investigation it can be concluded that among the growth parameters viz. The maximum plant height (137.72 cm) and number of leaves (8.62) were recorded in the treatment T_9 [K_{60} + S_{40} + PSB] during the second year (2020-21) of experimentation. Similarly among the root characterstics, maximum root depth (72.49 cm), no. of roots plant^{-1}(14.92) and dry weight of roots (28.37 g) were associated with the treatment T_9 [K_{60} + S_{40} + PSB] during the second year (2020-21) of experimentation. Maximum oil content (38.65 %) and oil yield (841.80 kg ha^{-1}) were recorded in the treatment T_9 [K_{60} + S_{40} + PSB] during the second year (2020-21) of experimentation.

Key Words: Growth, Mustard, Potassium, Protein, PSB, Root and Sulphur

Introduction

Mustard is an important oil seed crop in India. It secures unique position in Indian farming system with an impressive acreage next to food crops. Despite the fact that nearly 33.8 per cent of the total cropped area in world (7.49 million ha) is under oil seeds, India is still facing a severe shortage of edible oils because the average productivity and yield in India is about 697.9 kg ha^{-1} as against 917 kg ha^{-1} yield of world **(Ikisan, 2018).**

In India oilseeds are the second largest agricultural commodity after cereals, occupying about 13.5 % of the gross cropped area in the country and according for 5 % of GNP and 10 % value of all agricultural products **(Rai *et al.*, 2002).**

Mustard (*Brassica juncea* L.) crops are the major *rabi* oil seeds in India and stand next to groundnut in the oilseed economy. Rapeseed and mustard oil the most important edible oil of northern and eastern parts of India.

Rapeseed and mustard crop belongs to Cruciferae family which is preferentially need sulphur (S) for their growth and development. Sulphur is called as the fourth major essential element for plant. Sulphur plays a multiple role for better productivity as well as quality of

oilseeds **(Biswas *et al.,* 1995).** Each unit of fertilizer S generates 3-5 units of edible oil. It is the major constituent of important amino acids like cystine, cysteine and methionine and helps in the formation of chlorophyll. Sulphur application also has marked effect on soil properties and is used as soil amendment such as gypsum and pyrite to improve the availability of other nutrients in soil. Between the two common sources of S, gypsum is available in India and is a cheaper source of S which may be used for oilseed crops **(Rathore *et al.,* 2015).**

The lack of potassium is responsible for low yields and poor crop quality because, apart from other major physiological and biochemical requirements in growth, K is a key nutrient element in the biosynthesis of oil in oilseeds and protein.

Biofertilizers are known to play a vital role in soil fertility and crop productivity and considered as eco-friendly which can reduce the cost of chemical fertilizers to substantial amount.They supplement chemical fertilizers towards meeting the integrated nutrient demand of the crops. Phosphate solubilizing bacteria (PSB) promote seed germination and initial vigour of the plants by producing growth promoting substances. Application of PSB results in increased mineral and water uptake, root development, vegetative growth and nitrogen (N) fixation **(Gangwal *et al.,* 2011)**

Material and Methods

Experimental Site

The experiment was conducted during *rabi*season of 2019-20 and 2020-21 at student's Instructional farm, C.S.A. University of Agriculture and Technology, Kanpur Nagar (U.P.). The field was well leveled and irrigated by tube well. The farm is situated at main campus of the university, in the west northern part of Kanpur city under sub-tropical zone in v^{th} agroclimatic zone (central plain zone).

EdaphicCondition

The soil was moist, well drained with uniform plane topography. The soil of the experimental field was alluvial in origin, sandy loam in texture and slightly alkaline in reaction having pH 7.8 and 7.7 (1:2.5 soil: water suspension method given by **Jackson, 1973**), electrical conductivity 0.35 and 0.34 dSm^{-1} (1:2.5 soil: water suspension method given by **Jackson, 1973**), Organic carbon percentage in soil is 0.38 and 0.37 per cent (Walkley and Black's rapid titration method given by **Walkley and Black, 1934**), with available nitrogen 167.4 and 168.4 kg ha^{-1} (Alkaline permanganate method given by **Subbiah and Asija, 1956**), available phosphorus as sodium bicarbonate-extractable P was 16.8 and 17.8 kg ha^{-1}, Olsen's

calorimetrically method**(Olsen *et al.,* 1954**), available potassium was 155.7 and 156.7 kg ha^{-1} (Flame photometer method given by **Hanwey and Heidel (1952**) and available sulphur was 9.1 and 9.2 mg ka^{-1}, Turbidimetric method given by **Chesnin and Yien (1951)**during before sowing of the crop first and second year, respectively.

Detail of treatments and design

The experiment comprising nine treatment laid out in a randomized block design (RBD) with three replications. The treatment details are as under:

Table -1: detail of the treatment combinations:

Symbol (s)	Treatments
T_1	Control
T_2	$K_0 + S_{20}$ (RDF)
T_3	$K_0 + S_{40}$ (RDF)
T_4	$K_{40} + S_0$
T_5	$K_{40} + S_{20}$ + PSB
T_6	$K_{40} + S_{40}$
T_7	$K_{60} + S_0$
T_8	$K_{60} + S_{20}$ + PSB
T_9	$K_{60} + S_{40}$ + PSB

Where, K_0: 0 kg K ha^{-1}, K_{20}: 20 kg K ha^{-1} and K_{60}: 60 kg K ha^{-1}

S_{20}: 20 kg S ha^{-1} andS_{40}: 20 kg S ha^{-1}

PSB: Phosphate solubilizing bacteria

Crop Husbandry

A pre-sowing irrigation (Paleva) was done in the experimental field with an object to get optimum moisture conditions for attaining good germination. At proper tilth, one ploughing with tractor drawn mould bold plough was done followed by two ploughings by cultivator. Nitrogen @ 100 kg ha^{-1} and phosphorous @ 60 kg ha^{-1} applied uniformly through urea and DAP, respectively. Sulphur, potassium and PSB were apply through elemental sulphur and murate of potash as per treatment in the furrows, 5 cm below the seed at the time of sowing through single super phosphate. The sowing of mustard crop was done using a seed rate of 5 kg ha^{-1} in shallow furrows opened by plough in the furrows spaced at 45 cm apart. Planking was done to cover the seeds with fine soil after sowing.

Data Collection

Depth of root (cm)

Roots of each plants were measured from ground level till the deepest root tip in cm with the help of meter scale. The total of two plant roots of each plant were taken and value so obtained was recorded as depth in cm.

Number of roots plant^{-1}

After measuring the root depth, each plant roots were cleared with the help of fine hair brush. The number of each plant roots were counted and mean of 2 plant roots in each plot was recorded as the number of roots plant^{-1}.

Dry weight of roots plant^{-1} (g)

After counting the number of roots for each and crop, those were kept separately in Bamboo paper bags which were sun dried for few days and then transferred to oven at 50^0C ± 1 for 2 hours. Then their weight was taken on electronic balance. The mean of 2 plants was computed in each case and recorded as dry weight of root plant (g^{-1})

Oil content

The oil content of oven dried seeds was estimated by extracting oil using petroleum ether (60-80^0C) as solvent and Soxhlet apparatus as given by Sadasivum and Manickam(1992). The oil yield (kg ha^{-1}) was calculated by using following formulae:

Oil yield (kg ha^{-1}) = Seed oil content (%) × Seed yield (kg ha^{-1})

Statistical analysis: The growth parameters and yields were recorded and analyzed as per Gomez and Gomez (1984) the tested at 5% level of significance to interpret the significant differences.

Result and discussion

Growth parameters

It is visualized from the data given in Table-2 clearly indicate that among the growth parameters viz. plant height (cm) at harvest stage and number of leaves at harvest significantly increase due to the application of sulphur, potassium and PSB. Plant height at harvest stage varied from 107.75 to 135.28 cm and number of leaves at harvest stage varied from 6.65 to 8.45 during the first year of experimentation and plant height at harvest stage varied from 108.45 to 137.72 cm and number of leaves at harvest stage varied from 6.80 to 8.62 during the second year (2020-21) of experimentation. The maximum plant height (137.72 cm) and number of leaves (8.62) were recorded in the treatment T_9 [K_{60} + S_{40} + PSB] during the second year (2020-21) of experimentation. The minimum plant height (107.75 cm) and number of leaves (6.65) were recorded in the treatment T_1 [Control] during the first year (2019-20) of experimentation. These results also confirms the findings of**Jamal *et al.* (2010), Rajput *et al.* (2018), Upadhyay*et al.* (2018) and Singh *et al.* (2018)**

Table-2: Effect of different treatment combinations on growth parameters

Treatments	Plant height at harvest		Number of leaves at harvest	
	2019-20	2020-21	2019-20	2020-21
T_1	107.75	108.45	6.65	6.80
T_2	109.30	115.78	7.06	7.25
T_3	110.93	118.48	7.22	7.42
T_4	114.26	121.41	7.45	7.60
T_5	132.33	129.01	8.90	8.08
T_6	114.35	116.67	7.26	7.30
T_7	120.89	119.18	7.90	7.47
T_8	128.09	128.68	8.21	8.06
T_9	135.28	137.72	8.45	8.62
S.Ed±	3.46	4.06	0.44	0.21
C.D. at 5 %	7.35	8.61	0.95	0.46

Root characteristics

It is observed from the data given in Table-3 clearly indicate that among the root characteristics viz. root depth (cm), no. of roots plant^{-1} and dry weight of roots (g) significantly increase due to the application of sulphur, potassium and PSB. Root depth varied from 56.43 to 70.83 cm, no. of roots plant^{-1}varied from 11.61 to 16.15 and dry weight of roots varied from 22.15 to 28.30 g during the first year of experimentation and root depth varied from 57.15 to 72.49 cm, no. of roots plant^{-1}varied from 11.75 to 14.92 and dry weight of roots varied from 22.35 to 28.37 g during the second year (2020-21) of experimentation. The maximum root depth (72.49 cm), no. of roots plant^{-1}(14.92) and dry weight of roots (28.37 g) were recorded in the treatment T_9 [K_{60} + S_{40} + PSB] during the second year (2020-21) of experimentation. The minimum maximum root depth (56.43 cm), no. of roots plant^{-1}(11.61) and dry weight of roots (22.15 g) were recorded in the treatment T_1 [Control] during the first year (2019-20) of experimentation. These results also confirms the findings of**Ray *et al.* (2015), Dhruw*et al.* (2017) and Masum *et al.* (2019)**

Table-3: Effect of different treatment combinations on root characteristics

Treatments	Root depth (cm)		No. of roots plant^{-1}		Dry weight of roots (g)	
	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21
T_1	56.43	57.15	11.61	11.75	22.15	22.35
T_2	61.54	60.98	13.15	12.53	23.05	23.84
T_3	64.05	62.39	13.65	12.84	23.95	24.41
T_4	66.71	63.93	14.15	13.15	24.83	25.01
T_5	68.80	68.01	14.75	13.96	25.85	26.58
T_6	62.65	61.37	13.25	12.63	23.25	24.04
T_7	63.45	62.77	13.65	12.90	23.95	25.56

T_8	69.45	67.76	14.80	13.95	26.15	26.51
T_9	70.83	72.49	16.15	14.92	28.30	28.37
S.Ed±	1.35	1.62	0.69	0.47	1.48	0.81
C.D. at 5 %	2.88	3.44	1.48	1.00	3.15	1.71

Quality parameters

Oil content (%)

It is observed from the data given in Table-4 clearly indicate that among the quality parameters viz. oil content (%)and oil yield (kg ha^{-1}) significantly increase due to the application of sulphur, potassium and PSB. Oil content varied from 37.15 to 38.45 % and oil yield varied from 611.12 to 805.91 kg ha^{-1} during the first year of experimentation and oil content varied from 37.35 to 38.65 % and oil yield varied from 640.55 to 841.80 kg ha^{-1} during the second year (2020-21) of experimentation. The maximum oil content (38.65 %) and oil yield (841.80 kg ha^{-1}) were recorded in the treatment T_9 [K_{60} + S_{40} + PSB] during the second year (2020-21) of experimentation. The minimum oil content (37.15 %) and oil yield (611.12 kg ha^{-1}) were recorded in the treatment T_1 [Control] during the first year (2019-20) of experimentation. These results also confirms the findings of**Reddy*et al.* (2009), Singh *et al.* (2017), Sahoo *et al.* (2017) and Rathore *et al.* (2015)**

Table-4: Effect of different treatment combinations on quality parameters

Treatments	**Oil content (%)**		**Oil yield (kg ha^{-1})**	
	2019-20	**2020-21**	**2019-20**	**2020-21**
T_1	37.15	37.35	611.12	640.55
T_2	37.41	37.61	641.58	688.26
T_3	37.75	37.95	673.84	711.56
T_4	37.95	38.15	702.08	732.48
T_5	38.12	38.32	734.19	781.73
T_6	37.80	38.00	652.48	701.10
T_7	37.93	38.13	578.95	718.75
T_8	38.15	38.35	742.02	780.42
T_9	38.45	38.65	805.91	841.80
S.Ed±	0.11	0.21	44.06	10.80
C.D. at 5 %	0.23	0.26	115.89	22.91

Conclusion

The study showed that the application of sulphur and potassium along with PSB resulted in higher growth parameters, root characteristics and quality traits of mustard. It will help in uplifting the socioeconomic status of the farmers. Application of sulphur, potassium along with PSBdeserves a special attention for increasing of production and quality of mustard.

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