Original Research Article

"Effect of the phosphorus and sulphur levels on growth and yield of mustard (*Brassica juncea L.*) crop under rainfed condition"

Abstract

Background – Phosphorus has been pointed out as one of most important in oilseed crop wich is responsible for vegetative growth,reproduction and consequently yield of mustard. Sulphur element is important for crop growth and development especially in oilseed. At present, 42% of Indian soil have been found to the sulphur deficient, sulphur is essential for synthesis of oil percentage, protein, vitamins, in oilseed crops.

Methods – The field investigation was carried out at the Rajaula Research Farm, Faculty of Agricultural Science ,Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalay, Chitrakoot- Satna (M.P.) during Ravi season 2019-20. The treatment comprised three levels of phosphorus and three levels of sulphur along with absolute control.

Result – The result revealed that application of 30kg phosphorus/ha significantly increase the plant height , plant leaves, primary branches, secondary branches and yield indices vis number of siliqua/plant, number of seed/siliqua, 1000 seed weigh and seed yield than 20kg phosphrus/ha and 0kg phosphorus/ha . Sulphur levels also hed significantly influereced on these growth and yield indices and reconded higher values 20kg sulphur/ha found at per 10kg sulphur/ha and significantly higher over 0kh sulphur/ha. Thefinding that application of 30kg phosphorus with 20kg sulphur/ha proved the most optimum and beneficial fertility management for the **Pusa Mahak** veriety mustard for the Bundelkhand/ chitrakoot region of M.P.

Key word: Mustard, Sulphur, Phosphorus

INTRODUCTION

Comment [M1]: It is better not to use the words used in the title in the keywords. Use related or synonymous words.

Comment [M2]: It is better to use images and diagrams in this section to better present the content.

India is the fourth largest oilseed economy in the world . Rapeseed - mustard contributes 28.6 % in the total oilseeds production among the seven edible oilseeds cultivated in India and ranks second after groundnut sharing 27.8 % in the India's oilseed economy [1] . Indian mustard (Brassica juncea L.) is predominantly cultivated in the states of Rajasthan , Uttar Pradesh Haryana , Madhya Pradesh and Gujarat and some non - traditional areas of South India including Karnataka , Tamil Nadu , and Andhra Pradesh . Indian mustard (Brassica juncea L.) commonly known as raya , rai or lahi is an important oilseed crop among the Brassica group of oilseed in India . Rapeseed - mustard is an important group of edible oil seed crops and contributes about 26.1 % of the total oil seed production and contributes about 85 % of the total rapeseed- mustard produced in India **(Meena et al . , 2011)** . The first position in area and second position in Production after China (Anonymous , 2009) . In India 2016-17 the production of oilseed crops was 32. 10 million tones.

Quality of the oil in the rapeseeds and mustard possess a adequate amount of erucic acid 40 60 % together with Linolinic up to 4.5 to 13 % . The oleic acid and linoleic acid which have a higher nutritive value together constituent only about 25 30 % . It is desirable to increase the quality of oleic acid and linoleic acid by reducing the linolinic and erucic acid , a lower proportion of erucic acid will make the oil more palatable , nutritive , besides reducing metabolic disorders . The oil content in mustard about 35-40 % and protein content ranges from 25-30 % . But the presence of toxic glucosinolate in mustard render it unavailable as a source of human protein and is present used as a manures and a animal feed. Among the primary nutrients, phosphorus is the most important constrint for increasing oilseed production because of the nutrients requirement of oilseeds, in general is high. The p compound (ADP and ATP) in fact as energy currency with in the plant. It plays a vital role in plant metabolism . Thus, phosphorus influence the vigor of plants and root growth. It also encourage the development of nitrogen fixing bacteria, pod formation and hastens the maturity of pods (Tisdal et al. 1984). Phosphorus applied in combination with sulphur and potassium, increased the yield significantly has been reported **by Maini and Nag(2003)**. Sulphur in creases the oil content and gives pungency to oil as it forms certain disulphide linkages **(Khan et al; 2002).** Among the soureces, application of gypsum increased the seed yield of mustard as compared with single supper phosphate. Application of S in combination with balanced quantities of other nutrients significantly increased the oil content of mustard (5-6%)**(Verma et al;2018).** Kumar et al. reported that the sources of sulphur (Gypsum, bentonites pyrite) did not influence significantly the yield attributes and yield of Indian mustard (Brassica juncea L.) in the experiment by (**Kumar et al; 2011).** Sulphur is constituent of three S containing amino acid (Cystine, cysteine and methionine) wich are buiding blocks of protein. Sulphur deficiency is becoming more critical with each passing year wich is severely restricting crop yield, produce quality and nutrient use efficiency. Oilseed in general need more S as compared to other crops dua to its pivotal role in synthesis of oil. Sulphur is now recognized as the founth major plant.

METHODS AND METERIALS

Find experiment was conducted to study the effect of different levels of phosphorus and sulphur on growth and yield of mustard (brassica juncea L.) at the experimental farm of rajola the faculty of agriculture science and technology at mahatma Gandhi chitrakoot gramodaya Vishwavidyalaya chitrakoot satna mp located from 24° 31' N latitude and 81° 15' E latitude. The climate of the district is semi arid with hot summer and cold winter. The rainfall very scantly less than 300 mm/year and mean annual temperature varies from 32.6 to 45.02 °C the humidity is about 60%.

The physio-chemical properties of experimental field were determined in composite soil sample taken before sowing. The value are given below in the table A.

Table 1. Physio-chemical properties of experimental field

SN	Soil properties	Value
1	Ph	7.4
2	EC (ds/ma at 25 oC)	0.29
3	CEC (c mol/kg (p+)	20.80
4	Organic matter %	0.21
5	Total Nitrogen %	0.090
6	Available Nitrogen %	0.003
7	Total phosphorus %	0.085
8	Available phosphorus %	0.028
9	Available potassium %	0.005
10	Available sulphur %	0.016
11	Sand %	51.0
12	Silt%	21.6
13	Clay %	27.0
14	Taxture class	Sandy loam

The experiment was laid out in medium plot of (3*5M2) consisting 9 treatment with three replication. Phosphorus and Sulphur were supplied through diammonium phosphate (46% P2O5 & 18% N) and gypsum (29.4% ca & 23.5% S), respectively. The Phosphorus is applied in 0,20,30 kg/ha and Sulphur is applied in 0,10,20 kg/ha respectively. Land preparation was started before 20 days of sowing and layout was carefully done as per need of experiment. Phosphorus was supplied through DAP in calculated amount on the basis of Phosphorus Penta Oxide (P2O5 46%) and applied before 2 days of sowing mustard crop at field capacity. After 2 days ,it was mixed with the soil. Sulphur was supplied through gypsum. The required amount of gypsum calculated on the basis of their sulphur 23.5% and applied at the time of sowing according to

plan of layout in experimental period. The Nitrogen and potassium is applied in recommended amount in all plots.

The mustard variety PUSA MAHAK was sown in recommended manner, thinning, weeding carried out in two phases. To check the damage by mustard aphid indosulphan 35 EC spraying has be done at the rate of 1.25 lit/ha.

Table 2. Experimental details

SN	Particulars	Details
1	Variety	PUSA MAHAK
2	Germination %	85
3	Physical purity %	80
4	Genetical purity %	85
5	Seed rate kg/ha	6
6	Test weight (g)	4.2
7	Planting distance (cm)	30 x10
8	Depth of seed sowing (cm)	3.5
9	Season of seed sowing	Winter
10	Crop length (in days)	130
11	No. of treatment	9
12	No. of replication	3
13	Total no. of plots	27
14	Design	RBD

The crop was harvested after 130 days of sowing, when it becomes mature as judged by visual observation. The production of net plot is weighted individually and recorded after threshing. Threshing is done by wooden stick and seed weight. Plant samples were taken randomly from each treatment at maturity stage. These plant samples were taken for the analysis of growth parameters and biochemical analysis, Plant height, number of primary and secondary branches, no. of siliqua/plant, no. of seed/siliqua, seed yield, straw yield recorded at pre fix time and interval.

RESULTS AN DISCUSSION

Growth attributes

Application of 30kg phosphorus/ha although recorded maximum plant height than 20kg phosphorus/ha and 0kg phosphorus/ha. Similarly plant height recorded 20kg sulphur/ha

significantly then 10kg sulphur/ha and 0kg sulphur/ha. Both phosphorus and sulphur levels recorded significantly higher plant height over 0 kg phosphorus /ha and 0 kg sulphur/ha (Table-3).Plant leaves, trifoliate leaf, primary branches and secondry branches increased significantly higher values at 30kg phosphorus/ha. However, plant leaves, trifoliate leaf, primary branches and secondry branches increased significantly up to 20kg sulphur/ha. Phosphorus and sulphur leaves recorded significantly higher value of these indices than 0kh phosphorus/ha and 0kg sulphur/ha. Among the growth characters, plant height and were studied at 30, 60 and 90 days growth intervals. Leaves per plant were also counted. The plant height and number of branches were increased steadily with the advancement of plant growth up to 90 days of observation. This may be due to the fact that with the increase in the stage of the activity growing plants, the branches development.As regards with the influence of sulphur only up to 20kg/ha increased the plant height, leaves and branches significantly. This phenomenon was quite natural because of the greater availability of this element in the soil and its stimulating effect on the growth of the plants. The height of shoot was stimulated due to sulphur which may be attributed to its essentiality in cell division. Mover this nutrient plays an important role in the activity of shoots and meristematic tissues and development of shoots and leaf. The beneficial effect of sulphur was found to be limited only up to 20kg S/ha. It is as well as known fact that plants absorb all the essential plant nutrients from soil solution in a balanced requirement quantity, and even if certain nutrients are added in excess of the plants requirement, the plant growth is likely to sulphur supported by **Gangwal(2011)** and **Yadav(2010)**

The increasing levels phosphorus levels, all the above mentioned growth parameters including Trifoliate leaf per plant were increased significantly, only up to 30kg P_2O_5/ha the crop response of applied phosphorus only up to 30kg/ha indicate the fact that the existing available- P in the experimental field soil not much deficient and only 30kg applied P proved sufficient to meet out the complete requirement of the crop plants. The beneficial effect of applied P on the growth parameter under study may be attributed to the important role of phosphorus played in the branches development as well as in the translocation of photosynthesis, and being the constituent of nucleic acid, phytin and phospholipids its application increased the height and branches per plant. The differential response of phosphorus can be attributed to its efficiency and its

fertilization which in turn may be influenced by the environmental factors supported by **Gagwal(2011).**

Yield attributes

Phosphorus and sulphur levels recorded significantly higher number of siliua/plant, number of seed/siliqua and test weight than 0kg phosphorus/ha and 0kg sulphur/ha (Table 4). Application of 30 and 20 kg phosphorus was found at par with respect to number of siliqua/plant, number of seed/siliua and test weight and both recorded significantly higher values than 0 kg phosphorus/ha. Similarly, these indices recorded at 20 and 10 kg sulphur being at par and both recorded significantly higher valuesof these parameter than 0 kg sulphur/ha. The yield attributing parameters viz. Sulphur only up to 20kg/ha the number of Siliqua/plant, number of seeds/Siliqua and 1000-seed weight significantly. Further increase in sulphur application up to 20kg/ha brought about incurious influence. These parameters tended to increase which indicate the fact that this application rate of sulphur was in excess of the crop requirement. The increase in the number of Siliqua /plant may be due to the fact that number of trifoliate leaf were increased due to higher sulphur application only up to 20 kg/ha. Since the chlorophyll synthesis in greatly affected by sulphur content of the growing medium, therefore plants as well as supplied with sulphur would have naturally photosynthesis and accumulated move photosynthesis which Tran located to the sink supported by **Raman *et al* .(2012)**

The increasing levels of phosphorus up to Number of Siliqua/plant, number of seeds/Siliqua and 1000 seed weight were found to enhance significantly only up to 30 kg P_2O_5/ha Father increase in phosphorus level of this parameter.

The crop responded to its lower level (20kg/ha) may be attributed to the fact that mustard crop taken it's require quantity for its proper growth and development. Application of phosphorus up to 30kg/ha proved to be the excess among under the existing dauphin conditions. The higher number of Siliqua/plant, seeds/Siliqua and 1000 seed weight may be due to the fact that applied P enhanced the metabolic activities promoting chlorophyll formation and photosynthesis at one hand and branches development completed with accelerated microbial activities on the other supported by **Gagwal(2011)**

Grain yield

Application of phosphorus up to 30kg / ha the grain yield significantly up to 14.01q / ha as compared to 0 kg phosphorus/ha (8,80g / ha) . The increasing sulphur level only up to 20kg / ha the grain yield significantly up to 13.41q / ha as compared to 0 kg sulphur/ha (9.84q / ha)(Table 4). The increasing levels of sulphur only up to 20kg/ha increased the grain yield (13.41q/ha) significantly. Thus, 20kg/ha appeared to be the optimum dose for achieving the maximum productivity of mustard Verity. **"PUSA MAHAK"** under the existing agro-climatic conditions of Chitrakoot region. The increased grain and straw yields may be attributed to the accumulative effect of increased growth and yield attributing characters due to sulphur application. The plants supplemented with adequate sulphur, according to the requirement, might have synthesized greater photosynthesis and Tran located towards the reproductive organs (sink) resulting in higher seed yield. The increase in straw yields may be attributed to the increased growth characters viz. Plant height and trifoliate leaf plant due to application of sulphur up to 20kg/ha The beneficial influence of sulphur application on mustard seed yield supported by **Gangwal (2011).**

The physiological basis of variations in grain yield was mainly due to the increase in trifoliate leaf per plant, number of Siliqua per plant and 1000 seed weight. In the present study of grain and straw yields were significantly increased due to increase in phosphorus level only up to the maximum yields were 14.01q/ha respectively 30kg/ha. The increased grain yield may be attributed to the accumulative due to phosphorus application. The nutritional environment for plant growth and development might have improved which favorably influenced the energy transformation activities of enzymes and chlorophyll synthesis as well as carbohydrate metabolism. Moreover, phosphorus is a component of many bio-molecules involved in photosynthesis, respiration and branches growth. The beneficial effect of phosphorus on the productivity of mustard supported by Gangwal(2011).

Table 3. Efeect of different levels on growth attributing characters

Levels	Plant height	Leves	Branches

(kg/ha)							Primery Branches		Secondary Branches	
P-level	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90DAS	60 DAS	90 DAS	60 DAS	90 DAS
0	17.11	148.87	178.03	5.24	52.11	142.93	3.23	5.44	9.31	17.02
20	18.77	151.15	180.52	6.04	53.75	147.4	3.74	6.44	11.2	17.72
30	21.22	151.74	183.46	6.37	57.22	153.84	4.6	7.31	13.36	19.83
CD(P=0.05)	0.68	0.25	0.78	0.1	0.84	1.02	0.17	0.35	0.41	0.48
S- Levels										
0	17.33	149.93	178.34	5.55	52.13	144.46	3.18	5.44	9.44	16.67
10	18.66	150.66	180.7	6	54.51	148.04	3.94	6.42	11.43	18.25
20	21.11	151.17	182.97	6.11	56.44	151.66	4.44	7.33	13	19.64
CD (P=0.05)	0.68	0.25	0.78	0.1	0.84	1.02	0.17	0.35	0.41	0.48

Table 4. Efeect of different levels on yield attributing characters

Levels (kg/ha)	Siliqua/plant	Seeds/Siliqua	1000seed weight (g)	Seed yield(q/ha)
P-level				
0	466.93	13.84	9.84	8.8
20	471.71	15.22	11.28	11.51
30	473.8	15.68	14.05	14.01
CD(P=0.05)	0.48	0.1	0.3	0.26
S- level				
0	468.66	14.42	10.21	9.84
10	471.28	14.97	11.57	11.07
20	472.48	15.35	13.4	13.41
CD(P=0.05)	0.48	0.1	0.3	0.26

CONCLUSION

The growth and yield of mustard responded significantly upto 30 kg P_2O_5 and 20 kg S/ha. However the combination of 30 kg P_2O_5 + 20 kg S/ha gave highest value of crop growth and yield. The findings elude that application of 30kg P with 20kg S/ha proved the most optimum

and the beneficial fertility management for the “PUSA MAHAK” Variety Mustard for the Bundelkhand /Chitrakoot region of Madhya Pradesh.

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