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Effect of different nutrient doses and POLY4 on quality and physiological parameters of mustard

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Abstract

A field experiment was carried out during the *rabi* season 2021-22 to assess the effects of POLY4 on the performance of Indian mustard (*Brassica juncea* L.) variety Giriraj at Rani Lakshmi Bai Central Agricultural University research farm in Jhansi. The study utilized a randomized block design with nine distinct nutrient management treatments, each replicated three times. The findings indicated that the treatment T_7, which included 100% RDF (25% K by MOP and 75% K by POLY4), resulted in significantly higher oil content, yield, nutrient uptake, and improved physiological parameters compared to other treatments.

Keywords: *Indian mustard, oil content, physiological parameters, POLY4*

Introduction

Oilseed crops hold a significant position in Indian agriculture, ranking just behind cereals. In India, nine key oilseed crops serve as the primary sources of vegetable oil and fats. These crops are cultivated on 14.4% of the total gross cropped area, which amounts to 25.50 million hectares, and they yield 32.26 million tonnes of oilseeds with a productivity of 1265 kg per hectare (DAC & FW, 2020). The Brassicaceae family, which includes around 3500 speciesacross 350 genera, is one of the top ten most commercially important plant families (Warwick *et al*., 2009).Crops within the Brassica genus encompass a diverse array of plants utilized for various purposes, including cultivation for food, fodder, oil production, and condiments. The oleiferous species of Brassica, commonly referred to as rapeseed-mustard, is a major agricultural commodity of significant commercial value. The eight distinct varieties of rapeseed-mustard grown across 53 countries include Indian mustard, toria, yellow sarson, brown sarson, gobhisarson, karanrai, black mustard and taramira.

After Canada and China, India ranks third globally in both the acreage and production of rapeseed-mustard. The worldwide area dedicated to rapeseed-mustard is 36.81 million hectares, with a production of 72.61 million tonnes (USDA, 2020). In India, rapeseed-mustard is cultivated over 6.69 million hectares, yielding 10.1 million tonnes and achieving an average productivity of 1511 kg per hectare. This productivity is about one-third of the global average of 1960 kg per hectare (DAC & FW, 2021). India contributes 19.8% to the global acreage and 9.8% to the global production of rapeseed-mustard (USDA). Although the crop can adapt to various climatic conditions across India, fluctuations in area, output, and productivity occur annually due to biotic and abiotic stresses. Implementing a resource-efficient and sustainable conservation agriculture system can help mitigate these variations by enhancing soil health and improving crop performance. For instance, sulfur treatment has been shown to increase both the biomass and oil content of mustard crops.

POLY4 is a multi-nutrient fertilizer containing 19% sulfur, 17% calcium, 14% potassium, and 6% magnesium. Among oilseeds, mustard has the highest sulfur requirement. POLY4 is a low-chloride fertilizer suitable for organic farming, derived from the naturally occurring mineral polyhalite, which supplies a range of macro nutrients. It enhances nutrient uptake and improves fertilizer efficiency through its steady dissolution rate, providing continuous nutrition throughout the crop's growth cycle. This controlled release of nutrients aligns well with plant requirements. Additionally, POLY4 contributes to soil system stabilization, the calcium it contains increases soil tensile strength, reducing soil movement and enhancing resistance to compaction, which helps prevent water runoff.

Materials and Methods

The experiment was carried out at Rani Lakshmi Bai Central Agricultural University lies in the Bundelkhand Agro-climatic Zone (6) of Uttar Pradesh during *rabi* season of 2021-22. The soil of experimental field was clayey loam in

texture, slightly alkaline in nature with pH (7.74), low in organic matter and available nitrogen, medium in available phosphorus and potassium. The experiment included 9 treatments: T_1- Control, T_2- 100% NPS, T_3- farmers practice (60-40-0-10 kg NPKS), T_4- 100% RDF (100% K through MOP), T_5- 100% RDF (100% K through POLY4), T_6- 100% RDF (50% k by MOP and 50% K by POLY4), T_7- 100% RDF (25% K by MOP and 75% K by POLY4), T_8- 100% NPS + 75 % K (100% K by POLY4) and T_9- 100% NPS + 50% K (100% K by POLY4). All the treatments were replicated three times in completely randomized block design. All necessary agronomic practices were followed during experimentation. Observations were recorded at different growth stages. Statistical analysis of data was carried out by ANOVA in a randomized block design.

Table 1: Physicochemical properties of experimental soil

Properties	Value
Sand (%)	52.1
Silt (%)	15.6
Clay (%)	32.3
Textural class	Clay loam
Soil pH	7.74
Electrical conductivity (dS/m)	0.24
Organic C (%)	0.21
Available N (kg ha^{-1})	122
Available P (kg ha^{-1})	10.8
Available K (kg ha^{-1})	265.44

Results and Discussion

Effect on quality parameters

The perusal of data presented in Table 2 concluded that the different doses of nutrient and POLY4 influenced the quality parameters. The treatment T_7 recorded highest oil content (36.6%) as well as oil yield (654 kg ha^{-1}) while the lowest was recorded in treatment T_1 (32.2% and 208 kg ha^{-1}), respectively. Treatment T_7 significantly influenced nutrient content of mustard seed and stover as compared with treatment T_1. Significantly higher N, P and K content in mustard seed was recorded in T_7 (2.84, 0.98 and 0.49%, respectively) similarly NPK content in stover of mustard was recorded highest in treatment T_7 (0.79, 0.25 and 0.88%, respectively), although lowest values of NPK content in seed and stover were obtained from control treatment. It might be due to availability of 4 macro nutrients out of 6 and micro nutrients at all growth stages of crop. Satisha *et al.* (2012) found that potassium enhanced S uptake, while in turn, S appeared to promote phosphorus (P) and Ca uptake. The highest yields of cabbage and cauliflower, 32.8 and 39.5% more than the control, respectively, were obtained with 100% and 75% of the recommended N-P-K and S doses, respectively,

Table 2: Effect of different nutrient doses and POLY4 on oil yield and nutrient content of mustard

Treatment	Treatment details	Oil content (%)	Oil yield (kg ha^{-1})	N content (%) in grain	P content (%) in grain	K Content (%) in grain	N content (%) in stover	P content (%) in stover	K Content (%) in stover
T1	Control	32.2	208	2.44	0.55	0.327	0.60	0.10	0.760
T2	100% NPS	32.5	355	2.60	0.73	0.390	0.65	0.15	0.803
T3	Farmers practice (60-40-0-10 Kg ha^{-1} NPKS)	32.3	277	2.47	0.61	0.353	0.61	0.12	0.773
T4	100% RDF (120-60-60-40Kg ha^{-1} NPKS) and 100% K through MOP	36.1	468	2.70	0.89	0.447	0.69	0.20	0.833
T5	100% RDF (120-60-60-40Kg ha^{-1} NPKS) and 100% K through POLY4	36.6	511	2.79	0.96	0.477	0.78	0.24	0.870
T6	100% RDF (50%K by MOP and 50% K by POLY4)	32.5	335	2.52	0.67	0.370	0.62	0.14	0.787
T7	100% RDF (25% K by MOP and 75% K by POLY4)	36.6	654	2.84	0.98	0.493	0.79	0.25	0.887
T8	100% NPS + 75%K (100% K by POLY4)	36.1	491	2.73	0.94	0.460	0.71	0.22	0.853
T9	100% NPS+50%K (100%K by POLY4)	33.7	436	2.66	0.78	0.417	0.68	0.17	0.820
	S E m ±	1.17	35.0	0.04	0.05	0.03	0.05	0.01	0.03
	LSD (p=0.05)	3.52	103	0.13	0.15	0.08	NS	0.04	0.08

Table 3: Effect of different nutrient doses and POLY4 on physiological parameters of mustard

Treatment	Treatment details	CGR ($g/m^2/day$) 0-45 DAS	45-90 DAS	90 DAS harvest	RGR (mg/g/day) 45-90 DAS	90 DAS harvest	AGR ($mg\ day^{-1}$) 0-45 DAS	46-90 DAS	91 DAS harvest	Chlorophyll content At 45 DAS	At 90 DAS
T1	Control	0.53	5.12	1.90	52.5	6.44	16.12	155.06	57.58	35.3	14.4
T2	100% NPS	0.67	6.34	3.01	52.2	7.77	20.26	192.07	91.36	37.8	17.7
T3	Farmers practice (60-40-0-10 Kg ha^{-1} NPKS)	0.53	5.63	2.58	54.4	7.79	16.15	170.64	78.22	36.5	16.7
T4	100% RDF (120-60-60-40Kg ha^{-1} NPKS) and 100% K through MOP	0.76	7.85	2.50	55.1	5.64	23.00	237.89	75.70	39.1	19.5
T5	100% RDF (120-60-60-40Kg ha^{-1} NPKS) and 100% K through POLY4	0.98	8.58	3.01	50.8	6.05	29.65	260.02	91.36	40.8	23.0
T6	100% RDF (50%K by MOP and 50% K by POLY4)	0.66	6.05	2.47	51.4	7.36	20.00	183.26	74.89	37.5	17.5
T7	100% RDF (25% K by MOP and 75% K by POLY4)	1.00	8.94	3.07	51.2	5.97	30.21	271.00	92.99	45.0	25.6
T8	100% NPS + 75%K (100% K by POLY4)	0.84	8.31	3.26	54.0	6.80	25.50	251.86	98.74	40.1	20.7
T9	100% NPS+50%K (100%K by POLY4)	0.68	7.36	2.58	55.1	6.34	20.64	222.94	78.22	38.4	18.8
	SEm±	0.09	0.40	0.67	2.71	1.52	3.02	12.4	20.4	1.51	1.32
	LSD (p=0.05)	0.29	1.22	NS	NS	NS	9.06	37.2	NS	4.54	3.96

delivered through polyhalite.The increased nitrogen fixation may be the cause of the improvement in leghaemoglobin content and nitrogenase activity of nodules caused by an increase in P levels, these similar findings were reported by results Singh *et al*. (2016) and Wang *et al*. (2021).

Effect on physiological parameters

The effect of different treatments was seen on physiological parameters like CGR, RGR and AGR (Table 3). The significantly highest CGR at 0 to 45 DAS and at 45 to 90 DAS recorded in T_7 (1.00 and 8.94 g/m^2day, respectively), while at 90 DAS to harvest were recorded non-significant, whereas, lowest were recorded in control (0.53 and 5.12 g/m^2day, respectively). Similarly, AGR (at 0-45 DAS and at 45-90 DAS) was recorded significantly highest in T_7 treatment (30.21 and 271.00 mg/day, respectively) while T_1 recorded lowest value (16.12 and 155.06 mg/day, respectively), where as, AGR at 91 DAS to harvest were found non-significant. There was no significant effect found on RGR at different crop growth stages. High plant height and a greater number of primary and secondary branches all contribute to greater dry matter accumulation, which may be a genotypic capacity. Shiv kumar *et al.* (2004) reported similar findings and stated that the growth characteristics of chickpea, including plant height, branches per plant and dry matter accumulation, increased with increasing levels of P_2O_5 up to 80 kg ha^{-1} over control.

The significant effect was seen in treatment T_7 and maximum chlorophyll content was observed (45.0 and 25.65) in T_7, Whereas T_1 recorded lowest value 35.3 and 14.4, respectively. It might be due to the availability of Mg through POLY4. Magnesium is crucial for photosynthesis because it is a crucial component of the chlorophyll molecule. Magnesium is crucial for the creation and transportation of metabolites to fruits.This finding is confirmed with the research of Wang *et al.* (2021) reported that the no fertilizer (CK), traditional fertilization (TF), slow-release fertilizers (SRF), and decreased fertilization with slow-release fertilizers (DSRF) which resulted that in SRF and DSRF increased leaf length (13% and 8.3%) and chlorophyll content (7.1% and 8.2%) were observed of Chinese chives compared to TF.

Conclusion

On the basis of experimental finding, it can be concluded that, the quality parameters in mustard were found highest in the treatment T_7 consisted of 100% RDF and K-75% through POLY4 and 25% through MOP in clay loam soils of Bundelkhand region.

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