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Management Practices And Effect Of Nutrient Management On Growth And Yield Parameters Of Brassica Rapa L.

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ABSTRACT
This study looks at how Brassica rapa L. growth and yield metrics are affected by nutrient management techniques. The study was carried out at Sharda University's experimental field during the month of Rabi of 2022-2023, using a split-plot approach with 11 treatments and three rounds of replication. Plant height, primary and secondary branches, dry matter accumulation, and yield components such as siliquae, seeds per siliqua, and seed weight were all analyzed. Nutrient management was shown to greatly enhance plant growth and output. The treatments that comprised 100% NPK with farmyard manure (FYM), gypsum, and Trichoderma viride demonstrated the greatest measurements of growth and yield. When compared to the control and other nutrient combinations, these treatments increased vegetative growth, the number of siliquae, seeds per siliqua, and total seed output. This study highlights the significance of effective nutrient management in optimizing the development and yield of Brassica rapa, giving useful insights for boosting rapeseed and mustard production under comparable agro-climatic settings.
Keywords: *Brassica rapa, NPK, Trichoderma viride , Agro-climate*

1. INTRODUCTION

Being among the world's significant oilseed crops at the moment, rapeseed is a member of the *Brassicaceae* family. With 12% of global production, India ranks third in the world for rapeseed mustard production, after China and Canada.[1]. The worldwide supply of vegetable oil and biodiesel is mostly dependent on rapeseed [2]. In India, 6,856.27 thousand hectares of land were used to cultivate mustard and rapeseed., where they were produced at a rate of 1,524 kilograms per hectare and a total production of 10,210 thousand tons [3]. Using 8.28 thousand hectares of agriculture, 6.76 thousand tons were produced in Uttar Pradesh at a productivity rate of 817 kg/ha. Of the nine oilseed crops that are grown extensively [4].

Many environmental parameters affect the yield and output of rapeseed [5]. Because they demand less water and have a lower chance of crop failure, rapeseed and mustard crops are ideal for rainfed agriculture[6]. Low yields are a result of sub- and marginally fertilized fields receiving inadequate nutrients. New technology together with agronomic methods is essential to fulfill the challenge of meeting global demand while minimizing losses due to biotic and abiotic stressors and considerably boosting yields [6]. Nutrient fertilization is necessary for the establishment and growth of rapeseed and mustard [7].

Applying the right volumes of nutrient fertilizers along with the right proportions of minor and micronutrients might result in a notable increase in crop yield and oil content [8]. A key component of contemporary agriculture management strategies to increase crop growth and production is the application of fertilizers [9]. Research has indicated that the utilization of fertilizers in combination with farmyard manure may considerably boost cropping systems' output .

Increased use of chemical fertilizers in intensive agricultural techniques has been proven to degrade the physical, chemical, and biological properties of soil, resulting in decreased agricultural yields [10]. Determining the appropriate nutrient dosages and their ideal combinations is so crucial. To optimize *Brassica rapa* production, the present investigation attempts In order to ascertain the optimal combinations of fertilizer applications and management techniques [11].

2. METHOD

The research was conducted during the Rabi season. of 2022–2023 at Sharda University experimental farm in Knowledge Park III, Uttar Pradesh. The farm is situated in Greater Noida, which is a part of the National Capital Region (NCR) of India, and is latitude 28.4744° N and longitude 77.5030° E. A total of 517.7 mm of rainfall was recorded throughout the growing season. Eleven treatments total, three replications of each, were used in the split-plot design experiment. Before seeding, fine seedbeds were made and the field was plowed three times with a power tiller to a depth of around thirty centimeters. Plants and rows were spaced 30 cm × 15 cm apart when the *Brassica rapa* sarson was sowed. Watering was given as needed, and necessary tasks including weeding, thinning, and inter-cultivation were completed as needed. Before seeding, the whole recommended dosage of potassium and phosphorus was added in bands based on the treatment, and two equal splits of the residual nitrogen were administered as a top dressing.

We evaluated various growth metrics across all plots, selecting and tagging five random plants per plot for recurring observations. The average number of seeds per siliqua was determined from twenty-five casually selected pods per treatment, and yield characteristics along with mustard yield were recorded. The yields of sawdust and stover for each net plot were measured in kilograms per plot and then converted to kilograms per hectare. Data analysis was performed using SPSS ANOVA procedures, and treatment means were contrasted at a 5% probability level using the least significant difference (LSD) test.

Table1. Management of nutrients affects Brassica rapa L. plant height and dry matter accumulation.

Treatment	**Plant height (cm)**						**Dry matter accumulation (g plant^{-1})**					
	30 days	**60 Days**	**90 days**	**120 days**	**150 days**	**Harvest**	**30 days**	**60 days**	**90 days**	**120 days**	**150 days**	**Harvest**
T1- Control	11.80	34.10	129.40	154.70	161.30	162.70	0.60	1.20	5.50	20.20	28.90	26.90
T9-100 % NP(RDF)	17.80	56.10	148.00	178.00	182.30	184.30	0.60	1.30	7.10	24.70	34.30	32.30
T10-100 % NK(RDF)	16.60	56.40	146.00	175.80	183.40	184.60	0.60	1.40	7.00	23.70	32.60	31.60
T2-100%PKRDF()	14.20	43.00	136.30	167.40	174.30	175.20	0.70	1.50	5.60	21.60	29.90	26.90
T3-100% NPK(RDF)	17.30	68.30	158.60	182.30	190.30	191.40	0.70	1.60	7.20	25.90	35.60	34.60
T4-150% RDF (NPK)	18.60	78.00	173.20	194.30	198.70	199.40	0.80	1.90	9.10	29.10	40.20	38.20
T5-100% NPK +gypsum	16.40	74.00	161.30	185.10	192.30	192.30	0.80	1.50	7.20	26.10	36.70	35.30
T6-100% NPK +*Trichorderma viride*	15.40	73.00	164.50	187.30	193.00	192.70	0.70	1.60	7.40	26.80	37.30	36.30
T7-100% NPK +RDF	17.50	69.00	160.30	183.90	192.70	191.20	0.60	1.60	7.30	25.70	35.30	34.80
T8-100% NPK + FYM +gypsum	17.20	76.10	169.40	189.70	194.60	195.10	0.50	1.70	8.80	27.80	38.60	36.60
T11-*trichorderma viride*+ gypsum	15.20	59.30	151.70	178.30	185.20	186.30	0.70	1.30	5.80	22.20	33.10	30.10
SEm ±	0.6	1.21	1.63	1.91	1.96	1.78	0.40	0.1	0.23	0.32	0.67	0.57

CD (0.05%)	NS	3.64	4.90	5.73	5.91	5.46	NS	NS	0.74	1.13	2.08	1.77

Table2. Primary and secondary branches of Brassica rapa L.are impacted by the management of nutrients

Treatment	**Primary branches plant^{-1}**					**Secondary branches plant^{-1}**			
	60 Days	**90 days**	**120 Days**	**150 days**	**Harvest**	**90 days**	**120 days**	**150 days**	**Harvest**
T1- Control	0.40	0.60	1.30	1.40	1.40	0.80	1.10	1.20	1.20
T9-100 % NP(RDF)	0.70	1.40	3.20	3.30	3.30	1.30	3.20	3.40	3.40
T10-100 % NK(RDF)	0.60	1.20	3.10	3.30	3.30	1.20	3.20	3.30	3.30
T2-100%PKRDF()	0.60	1.10	3.10	3.20	3.20	1.30	2.10	2.30	2.30
T3-100% NPK(RDF)	0.70	1.60	3.60	3.80	3.80	1.50	3.40	3.50	3.50
T4-150% RDF (NPK)	1.30	2.10	4.30	4.50	4.50	2.10	4.20	4.30	4.30
T5-100% NPK +gypsum	0.80	1.80	3.40	3.60	3.60	1.60	3.60	3.70	3.70
T6-100% NPK +*Trichorderma viride*	0.70	1.70	3.50	3.60	3.60	1.80	3.50	3.60	3.60
T7-100% NPK +RDF	0.70	1.90	3.20	3.30	3.30	1.70	3.40	3.40	3.40
T8-100% NPK + FYM +gypsum	0.90	1.90	4.10	4.30	4.30	2.00	3.90	4.10	4.10
T11-*trichorderma viride*+ gypsum	0.60	1.30	3.20	3.30	3.30	1.40	3.30	3.40	3.40
SEm ±	0.01	0.02	0.07	0.12	0.13	0.06	0.08	0.06	0.07
CD (0.05%)	NS	0.10	0.22	0.36	0.42	0.19	0.27	0.24	0.24

Table 3: Effects of management of nutrients on *Brassica rapa L.* production and yield characteristics

Treatment	**No of plants**	**No of pods plant**	**No of seeds pods**	**1000 seed weight (g)**	**Seed yield (kg ha^{-1})**	**Stover yield (kg ha^{-1})**	**Biological yield (kg ha^{-1})**
T1- Control	20.20	80.20	20.20	3.07	476.70	1061.10	1537.80
T9-100 % NP(RDF)	23.00	185.60	23.10	3.37	1189.30	2381.40	3570.70
T10-100 % NK(RDF)	22.80	169.80	23.30	3.36	1129.70	2291.70	3421.40
T2-100%PKRDF()	22.70	126.00	22.40	3.13	794.40	1584.10	2378.40
T3-100% NPK(RDF)	22.30	222.20	24.30	3.41	1259.30	2519.80	3779.20
T4-150% RDF (NPK)	24.70	269.00	25.70	3.61	1451.20	2815.70	4266.90
T5-100% NPK +gypsum	22.40	229.80	24.30	3.49	1348.30	2700.20	4048.50
T6-100% NPK +*Trichorderma viride*	23.40	223.30	24.00	3.46	1408.60	2816.90	4225.60
T7-100% NPK +RDF	23.60	229.1	24.30	3.42	1358.30	2717.20	4075.50

		0					
T8-100% NPK + FYM +gypsum	24.40	247.00	24.80	3.55	1421.00	2801.80	4222.80
T11-*trichorderma viride*+ gypsum	22.80	129.70	22.30	3.37	791.2	2113.0	2904.2
SEm ±	0.82	3.81	0.12	0.05	26.2	26.2	74.3
CD (0.05%)	NS	11.32	0.37	0.17	78.6	78.6	223.6

3.0 RESULTS

3.1 Growth parameters

Plant height: is a necessary material trait that represents growth in vegetation (Table 1).Frequently used to evaluate exactly how different treatments affect the growth of crops. When compared to without applying fertilizer, the use of fertilizer greatly increased vegetative growth. Plant height rose gradually up to 60 days after sowing (DAS), then sharply and linearly up to 150 DAS, at which point growth slowed. As plants reached 30 DAS, the effects of different treatments were not statistically significant. On the other hand, applications of farmyard manure (FYM) and different amounts of inorganic fertilizers had a noticeable impact on plant height starting at 60 Das. In particular, during the course of the crop, spraying 150% NPK produced noticeably taller plants than 100% NPK. Results were similar to those of 100% NPK mixed with sulfur at 35 kg/ha, NPK, and RDF, and only 100% NPK at all stages when zinc sulphate was added by the prescribed fertilizer dosage. Plants treated with 100% NP and 100% NK skip fertilizer appeared noticeably taller than those treated with 100% PK skip fertilizer did. Except for DAS 30 and 60, the plants in SPNF-treated plots were likewise much taller than those in the control. Because NPK plays a part in cell division and growth, the administration of fertilizer is likely responsible for the increased height of plants. The results presented by Indira et al., 2021 are in line with our findings.

The number of primary branches: Various treatments required no discernible influence at 30 and 60 days after sowing (DAS) on the number of primary branches. Nevertheless, between 60 and 150 days after sowing, branches became noticeably visible (Table 2). Except for the 30 and 60 DAS stages, every stage when 150% NPK was applied produced the greatest number of branches, well exceeding the suggested fertilizer dosage. As with the 150% NPK treatment at 120, 150 DAS, and harvest, the 22.5 t/ha 100% NPK plus FYM treatment was similar. Results were comparable to 100% NPK, except 60 and 90 DAS, and numerically greater than 100% NPK coupled with NPK and RDF when 100% NPK was used in conjunction with zinc sulfate at 25 kg/ha and sulfur at 35 kg/ha [12]. Furthermore, in comparison to the control, the NPK treatment produced the greatest number of main branches in canola.

Number of secondary branches: At every development stage, *Brassica rapa* sarson branching was considerably higher when the appropriate fertilizer dose was applied as opposed to the control (Table 2). At all phases, the application of 150% NPK resulted in the highest branching, which was noticeably higher than that of 100% NPK. 150% NPK also showed much stronger branching than the recommended dose alone, and at 2.5 t/ha, it was similar to 100% NPK + FYM. Comparable to 100% NPK were treatments with 100% NPK + S at 35 kg/ha, 100% NPK + *Trichoderma viride* at 25 kg/ha, and 100% NPK + B at 1 kg/ha. Though somewhat below the suggested fertilizer dose, applications of 100% NP, 100% NK, and 100% PK produced much increased branching than the absolute control. These results are consistent with those published by [13].

Dry matter accumulation: revealed that There was no observable difference in the days after sowing (DAS) at 30 and 60 due to fertilizer treatment (Table 1). However, when 100% NPK was applied dry matter accumulation was much higher than with the control at 90, 120, and 150 DAS, and it was even higher at harvest when 150% NPK was applied. In terms of outperforming the recommended fertilizer dose, the use of 150% fertilizers was similar to applying 100% NPK together with 2.5 t/ha of farmyard manure (FYM), applied at 25 kg/ha together with 100% NPK was comparable to 100% NPK applied at all stages, 100% NPK applied in conjunction with sulfur at 35 kg/ha, and RDF at 1 kg/ha. Except at 30 and 90 DAS, adding FYM together with the prescribed amount of fertilizer produced outcomes that were comparable to the *Trichoderma viride* therapy. *Brassica rapa* sarson's branching was decreased by removing any main nutrients. Plots treated with dry matter accumulated at a much greater rate than the control. The administration of fertilizer promoted the growth, elongation, and multiplication of cells, resulting in increased chlorophyll production and a rich green coloration of the leaves. An increase in dry matter buildup was the outcome of this increase in the effective photosynthetic area.

3.2 Yield parameters

Plant yield: There was no discernible impact of nutrient management treatments on the *Brassica rapa* plant population. The 100% NPK + FYM at 2.5 t/ha treatment (24.4 plants per square meter) and the 150% NPK treatment (24.7 plants per square meter) had the largest plant populations, nevertheless. Table 3 shows that the plant population was lowest in the control treatment.

Number of siliquae/pods per plant: Compared to 100% NPK, the application of 150% NPK produced noticeably more siliquae. Table 3 indicates that a higher number of siliquae were seen when 100% NPK and FYM were used at 2.5 t/ha, in comparison to the recommended dose. However, this was still less than when 150% NPK was used. About siliquae count, the utilization of 100% NPK + S at 35 kg/ha was equivalent to that of 100% NPK + *Trichoderma viride* at 25 kg/ha, 100% NPK + RDF at 1 kg/ha, and plain 100% NPK. In contrast to balanced fertilizer treatment, a significant decline in siliquae was seen when any one key nutrient was left out of the appropriate dosage. Interestingly, compared to 100% NP and 100% NK, the application of 100% PK produced noticeably less siliquae. Its significant effect on improving branching, which in turn promotes enhanced flower development, may account for the noticeable rise in siliquae per plant with 150% NPK administration. These results coincide with those that have been published [14].

Number of seeds per siliqua/pods: Comparing 25.7 seeds per siliqua with 150% NPK treatment vs 24.3 with 100% NPK, there was a substantial increase (Table 3). In comparison to 100% fertilizer+ S at 35 kg/ha (24.3), 100% fertilizer + *Trichoderma viride* at 25 kg/ha (24.0), and 100% NPK + RDF at 1 kg/ha (24.3), the combination of 100% NPK with farmyard manure likewise produced much higher values (24.3). In comparison, skip-fertilizer treatments produced significantly more seeds per siliqua. Furthermore, compared to the control, *Brassica rapa's* adoption of gypsum + *Trichoderma viride* greatly increased the number of seeds. Increased photosynthate accumulation that is transferred to pods and seeds is often associated with greater photosynthesizing regions in well-fertilized plants [15].

1000 seed weight: Comparing the 1000 seed weight of *Brassica rapa* with and without the use of suggested chemical fertilizers, the results showed an improvement. More specifically, 3.41g was the seed weight at 100% fertilizer application, while 3.61g was the seed weight with 150% NPK application. 150 percent fertilizer for seed weight was similar to 25 kg/ha (3.46 grams) of 100% NPK *Trichoderma viride*, 2.5 t/ha (3.55 grams), and 35 kg/ha (3.49 grams) of 100% NPK + S. Additionally, compared to 100% PK (3.13g), the treatments had much larger seed weights. Compared to the control, plots using *Trichoderma viride* +Gypssum had significantly greater seed weights.

Yield

Seed yield: A seed yield of 1259.3 kg/ha was obtained with 100% NPK application; however, with 150% NPK, this yield considerably improved to 1451.2 kg/ha. Similarly, 1421.0 kg/ha were produced by applying 100% NPK mixed with FYM at 2.5 t/ha, 1408.6 kg/ha by applying 100% NPK with *Trichoderma viride*, and 1358.3 kg/ha by applying 100% NPK combined with RDF at 1 kg/ha. *Trichoderma viride* at 25 kg/ha (1408.6 kg/ha) and 100% NPK with S at 35 kg/ha were applied similarly. This increase can probably be attributed to the latter phases of seed development providing macro and micronutrients, which improve assimilate accumulation and produce heavier seeds. These outcomes agree with what Ramya et al. reported [16]. When compared to balanced fertilizer treatment, the yield of *Brassica rapa* seeds was considerably reduced when any major nutrient from the prescribed amount was skipped. Moreover, 100% NP (1189.3 kg/ha) and 100% NK (1129.7 kg/ha) applications produced yields that were comparable and much greater than 100% PK (794.4 kg/ha). Brassica rapa production was 39.82% greater than the control and 37.20% lower than 100% NPK in *Trichoderma viride* + Gypsum plots. Thus, *Brassica rapa* with *Trichoderma viride* + Gypsum produced an equal yield that was statistically equivalent to 100% NPK. Increased accumulation of photosynthates that are translocated to pods and seeds is a characteristic of well-fertilized plants, which often have bigger photosynthetic areas [17].

Stover yield: A stover yield of 2519 kg/ha was obtained by applying 100% NPK; however, when fertility levels were boosted to 150% NPK, the stover yield dramatically increased to 2815.7 kg/ha. Table 2 indicates that there were noteworthy increases seen when 100% NPK was combined with FYM at 2.5 t/ha (2801.8 kg/ha), 100% NPK with *Trichoderma viride* (2816.9 kg/ha), and 100% NPK with B at 1 kg/ha (2717.2 kg/ha). The yield of applying 100% NPK with *Trichoderma viride* at 25 kg/ha (2816.9 kg/ha) was equaled by applying 100% NPK with S at 35 kg/ha. A substantial reduction in *Brassica rapa* stover production was observed when any primary nutrient was excluded from the suggested NPK treatment [18]. Also, yields from the 100% NP application (2381.4 kg/ha) were similar to those from the 100% NK application (2291.7 kg/ha), and both were far greater than yields from the 100% PK application (1584.1 kg/ha). *Brassica rapa* stover yield (2113.0 kg/ha) in the Gypsum + *Trichoderma viride* treatment was 16.1% lower than in the 100% NPK treatment and 49.7% greater than in the control, respectively. As a result, *Brassica rapa's* equivalent yield in Gypsum + *Trichoderma viride* equaled 100% NPK statistically.

Biological Yield: Comparing *Brassica rapa's* biomass to the control, fertilizer treatment greatly boosted it. The largest seed and stover yields were obtained by the treatment with the best yield features (table 2). Application of 150% NPK (4266.9 kg/ha) was equivalent to 100% NPK + *Trichoderma viride* at 25 kg/ha (4225.6 kg/ha) and produced a much greater biological yield than 100% NPK (3779.2 kg/ha). One kilogram of NPK + RDF at one kilogram per hectare (4075.5 kg/ha). 2.5 t/ha (4222.8 kg/ha) of 100% NPK + FYM, and 35 kg/ha (4048.5 kg/ha) of 100% NPK + S. The biomass of *Brassica rapa* was reduced by 5.83%, 10.45%, and 58.9% when any one primary nutrient was omitted [19]. 2904.2 kg/ha of biomass were produced by the Gypsum + *Trichoderma viride* treatment, which was much greater than the control (1537.8 kg/ha) but less than the 3779.2 kg/ha from the 100% NPK application. Additional factors contributing to improved biological output were higher rates of fertilizer application and enhanced rates of photosynthesis and carbohydrate metabolism. According to [20], these results are in line with their findings.

3. CONCLUSION

Rapeseed crop production and profitability are negatively impacted by the overuse and imbalance of chemical fertilizers, which also creates ecological problems. A more balanced approach to feeding rapeseed crops may be achieved by implementing environmentally and financially sustainable practices, such as combining inorganic fertilizers with farmyard manure and vital macro- and micronutrients. It has been demonstrated that Brassica rapa yields may be increased by applying fertilizer in amounts higher than those advised. Rapeseed yield and yield components may be successfully increased by combining NPK with *Trichoderma viride*, RDF, and S fertilizers.

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