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Shaurya Singh
Department of Agronomy, Rama University Mandhana Bithoor, Kanpur, Utter Pradesh, India

Ram Niwas
Department of Agronomy, C.S.A University, Kanpur, Utter Pradesh, India

Kripa Sankar Yadav
Department of Agronomy, C.S.A University, Kanpur, Utter Pradesh, India

Saksham Tripathi
Department of Agronomy, C.S.A University, Kanpur, Utter Pradesh, India

Corresponding Author:
Shaurya Singh
Department of Agronomy, Rama University Mandhana Bithoor, Kanpur, Utter Pradesh, India

To study the effect of integrated nutrient management on growth and yield of Indian mustard (*Brassica juncea* L.) in central zone of UP

Shaurya Singh, Ram Niwas, Kripa Sankar Yadav and Saksham Tripathi

Abstract
It was finally observed that the treatment combination (RDF 100% + FYM 5 t/ha + Vermi-compost 2.5 t/ha +Azotobacter) consisted organic and inorganic manures that increases the growth, quality production and profit of the mustard cultivation. RDF 50% is the nutrient treatment had non-significant result because the quantity of nutrients reduced by 50% according to the normal requirement of plants for proper growth and production.

Keywords: Indian mustard, nutrients, oil seed, soil properties

Introduction
Indian mustard (*Brassica juncea* L.) is an annual growing perennial herb and is one of the important oilseed crops that belongs to the family Cruciferae (Brassicaceae). Indian mustard has 36 chromosomes (2n) and is amphidiploid in nature. Other common name includes brown mustard, Indian mustard and oilseed mustard. The mustard plant is called rai or raya in India. India ranks second in the production of oilseeds followed by cereals and shares 13% of the country's gross cropped area, nearly 5% of Gross National Product and 10% of the value of all agricultural products. (Prabhu, Uma Keni, 2020) [1].
In India, rapeseed, mustard occupied 6.33-million-hectare territory with a creation 6.69 million tonnes and efficiency of kg ha-1 during 2019-20. In UP, rapeseeds, mustard is an oilseed crop, representing 19.81% region (0.95 million ha) and 20.23% absolute creation (0.79 million tonnes) of the nation during 2018-19 to 2019-20 with on a normal yield 962 kg ha-1 which is very wicked good (Annual Report, DAC & FW 2019- 20). 2 And yet we are an oil deficient economy. There is a yawning gap between demand and supply of edible oil. The genesis of this issue lies in the fact that oil consumption in India has increased in leaps and bounds—from less than 6 kg per capita in 1992-93 to 18 kg in recent year. Statistics gleaned from Directorate of Sugar & Vegetable Oil (DS&VO) corroborate this observation. According to DS&VO the total consumption of edible oils in India has shown a growth at a CAGR of 4.6% from 159.54 MMT in 2008-09 to 249.8 MMT in 2018-19. And herein lies the problem. As against the aforesaid stats, during the same period, domestic oil seed production increased only marginally at a CAGR of 1.6%-from 27 MMT to 32 MMT.

Objective
1. To study the effect of INM on growth of mustard.
2. To analyse the effect of INM on quality of mustard and soil properties.
3. To work out the economics of different nutrient combination.

Material and Methods
The details of the materials used and experimental procedures adopted during the course of investigation have been described in this chapter under appropriate headings and subheadings.

Treatment
Treatments consisted 15 with 3 replication of each treatment combinations of four levels of Bio-Organics and four levels of Mineral nutrients to mustard.

Design and layout of experiment
Field experiments having 15 treatment combinations and replicated three times were laid out in Randomized Blok Design (RBD).

Growth and yield attributes

Plant height

Five plants selected randomly from each plot were tagged. The height was measured at 30, 60, 90 DAS and at maturity in cm with the help of meter scale from the base of the plant to the top of the plant and mean values were computed.

Primary and secondary branches per plant

Primary and secondary branches of five random plants under each treatment were counted at 60 and 90 days after sowing and at maturity. Total number of branches were counted and mean values have been calculated.

No of siliquae per plant

The numbers of siliquae of the five randomly selected plants were counted and their means were computed to express as number of siliquae per plant.

Length of siliqua

Length of five randomly selected siliqua from plants taken for siliquae plant-1 were measured and average value were expressed as length of siliqua in centimeter.

Number of seeds per siliqua

Numbers of seeds per siliqua were recorded at harvest by counting the seeds of ten randomly selected siliquae from five tagged plants of each plot and average was worked out.

Test weight

One thousand seeds were counted from samples of each plot and their weight was recorded as test weight (g).

Seed yield

After threshing and winnowing, the clean seeds obtained from the produce of individual plot, were weighed and weight was recorded as seed yield kg plot-1.

Stover yield

Stover yield was obtained by subtracting the seed yield (kg ha-1) from the biological yield (kg ha-1).

Harvest index

The harvest index was computed on the basis of seed yield and total biomass production and presented in term of per cent. The harvest index was calculated by following formula:

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}}$$

Chemical analysis

Nutrient content

For estimation of nutrient content from representative samples of seed and stover were taken at the time of threshing. Each dried seed and stover samples were ground to fine powder in an electric grinder. Nitrogen, phosphorus, potassium and sulphur in seed and stover were estimated by using standard methods.

Nutrient uptake

The uptake of nitrogen, phosphorus, potassium, sulphur and zinc at harvest in seed and stover were estimated by using the following formula:

$$\frac{\text{Nutrient content in seed(\%)x } \textit{Seed yield} \left(\frac{kg}{h}\right) \text{ x Nutrient in strover(\%)x} \textit{Strover yield} \left(\frac{kg}{h}\right)}{100}$$

Protein content

Protein content in seed was determined by multiplying per cent nitrogen in seed with a constant factor 6.25 (A.O.A.C., 1960).

Oil content and oil yield

Oil content in mustard seed was determined by using Soxhlet's Ether extraction method (A.O.A.C., 1955). The oil yield was calculated by using following expression:

$$\text{Oil yield } \left(\frac{\text{kg}}{\text{h}}\right) = \frac{\text{Seed yield } \left(\frac{\text{kg}}{\text{h}}\right) \text{ x Oil content (\%)}}{100}$$

Results

The experimental findings described in the preceding chapter are discussed herein with the supporting evidences on the subject which are available to the author.

Growth parameters

Plant height

Integrated nutrient management system significantly effects on plant height of mustard over control at all the growth intervals of 30, 60, 90 DAS and maturity stages.

At 30 days stage, the plant height of mustard ranges from 16.033 cm (T3) to 27.300 cm (T15). The significant plant height was recorded in the treatment T15 (RDF 100% + FYM 5 t/ha + Vermi-compost 2.5 t/ha + Azotobacter) followed by treatment T14 (RDF 100% + FYM 5 t/ha + Vermi-compost 2.5 t/ha) and lowest height was in treatment T3 (RDF 50%).

At 60 days stage, the higher height of plant was recorded in the T15 (RDF 100% + FYM 5 t/ha + Vermi-compost 2.5 t/ha +Azotobacter) which is significant over all treatments and lowest height of plant was recorded in T1 (RDF 100%).

At 90 days stage, most of plants attain their full growth. The highest height was 146.50 cm which is recoded in the treatment T15 (RDF 100% + FYM 5 t/ha + Vermi-compost 2.5 t/ha +Azotobacter) and lowest height 125.933 cm in the treatment T3 (RDF 50%) followed by T4 (RDF 50% + FYM 10 t/ha).

At maturity, the significant height was recorded in the treatment T15 (RDF 100% + FYM 5 t/ha + Vermi-compost 2.5 t/ha +Azotobacter) followed by Treatment T14 (RDF 75% + FYM 5 t/ha + Vermi-compost 2.5 t/ha) These results are in agreement with the findings of Kumar *et al*. (2001) and Mandal and Sinha (2002)

No. of primary branches per plant

At 60 DAS, the maximum number of primary branches per plant1 i.e., 8.00 recorded in T15 RDF 100% + FYM 5 t/ha + Vermi-compost 2.5 t/ha +Azotobacter were significantly higher over T3 (RDF 50%), T1 (RDF 100%), T2 (RDF 75%).

At 90 DAS plant attain their maximum number of primary branches. The minimum number of branches was obtained in

the treatment T3 (3.33). The least no. of primary branches was in treatment T15 (10.333).
Maturity stage and 90 DAS stage both have approx. same number of branches. There may be little difference. The maximum 12.00 branches were recorded in T15 (RDF 100% + FYM 5 t/ha + Vermi-compost 2.5 t/ha +Azotobacter) and lowest branches 4.33 branches was observed in T3 (RDF 50%) followed by T4 (RDF 50% + FYM 10 t/ha).

No. of primary branches per plant
At 60 DAS, the maximum number of secondary branches per plant (12.667) recorded in T15 (RDF 100% + FYM 5 t/ha + Vermi-compost 2.5 t/ha +Azotobacter) superior over control.
At 90 DAS and maturity plant attain their maximum number of secondary branches. The minimum number of branches was obtained in the treatment T3 (RDF 50%) followed by T4, and T5. The maximum branches were in treatment T15 (RDF 100% + FYM 5 t/ha + Vermicompost 2.5 t/ha +Azotobacter).

Yield attributes
No. of siliquae per plant
The yield is directly proportional to availability of nutrients in soil. Maximum number of siliquae per plant (239.0) was recorded in the nutrient combination of RDF 100% + FYM 5 t/ha + Vermi-compost 2.5 t/ha +Azotobacter followed by RDF 100% + FYM 5 t/ha + Vermicompost 2.5 t/ha and RDF 100% + Vermi-compost 5 t/ha. The lowest number of siliquae per plant was recorded in treatment T3 RDF 50%.

Length of siliqua, No. of seeds per siliqua and test weight
Length of a siliqua, seeds per siliqua and test weight are influenced by various INM combinations the bigger length of siliqua obviously contain a greater number of seed. The lower length of siliqua was observed in treatment RDF 50%. The significant length of siliqua, no. of seed per siliqua and test weight were observed in the treatment combination of RDF 100% + FYM 5 t/ha + Vermi-compost 2.5 t/ha +Azotobacter followed by RDF 100% + FYM 5 t/ha + Vermi-compost 2.5 t/ha and RDF 75% + FYM 5 t/ha + Vermi-compost 2.5 t/ha +Azotobacter. Similar findings were also reported by Kumar *et al*. (2001) and Mandal and Sinha (2002).

Seed yield and stover yield
Seed and stover yield of mustard were significantly influenced by integrated nutrient management system. Maximum increment in seed and stover yield was observed in treatment of RDF 100% + FYM 5 t/ha + Vermi-compost 2.5 t/ha +Azotobacter nearly followed by RDF 100% + FYM 5 t/ha + Vermi-compost 2.5 t/ha. The lower yield of seed and stover both recorded in the treatment RDF 50%. RDF 50% could not complete the nutrient requirement of plant for their growth and production. The similar data was also reported by Shankar *et al*. (2002) [5].

Quality parameters
Oil and protein content in seeds
Oil and protein content both were affected by nutrient management. The recorded data revealed that the oil content in mustard seed ranged between 34.36 to 43.33%. Oil content in mustard seed have been increased by integrated use of sulphur bio-organics. The significant oil content (43.33%) was recorded in the treatment T15 (RDF 100% + FYM 5 t/ha + Vermicompost 2.5 t/ha +Azotobacter) followed by T14 (RDF 100% + FYM 5 t/ha + Vermi-compost 2.5 t/ha) and least oil content (34.36%) was receded in treatment T3 (RDF 50%). The organic manure in soil helps in maintaining the moisture in soil that facilitate the better flower retention and pod filling.
The maximum protein content (352.80 kg) recorded in treatment T15 RDF 100% + FYM 5 t/ha + Vermi-compost 2.5 t/ha +Azotobacter was statistically at par with rest of the treatments. The minimum protein content (97.3 kg/ha) was recorded in T3 (RDF 50%) treatment. The data revealed that all the treatments were found superior over control. Individually Azotobacter did not increase the oil content of seeds significantly over 100% NPK at both fertility levels. Higher N utilization by the crop, which enhances the protein synthesis in plants and ultimately increased the protein content in mustard seeds. Similar findings were also reported by Abraham (2000) and Narwal *et al*. (2000).

Oil yield
The effect of integrated nutrient management on oil yield (kg/ha). The significant yield of oil (539.23 kg/ha) was recorded in treatment T15 (RDF 100% + FYM 5 t/ha + Vermi-compost 2.5 t/ha +Azotobacter) followed by the T11 (RDF 75% + FYM 5 t/ha + Vermi-compost 2.5 t/ha +Azotobacter). The least oil yield (171.73 kg/ha) was obtained in treatment T3 (RDF 50%). The oil content increased by the sulphur content present in soil or supplemented by nutrients but bio organic significantly increase the oil yield. Similar findings were also reported by Abraham (2000) and Narwal *et al*. (2000).

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