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Impact of integrated nutrient management on growth parameters of Indian mustard (*Brassica juncea* L.) in the Prayagraj region

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Abstract
The impact of integrated nutrient management on the growth and yield of Indian mustard (*Brassica juncea* L.) in the Prayagraj region was investigated through a field experiment, variety RH 725 at the Agriculture College Research Farm, Prof. Rajendra Singh (Rajju Bhaiya) University, Prayagraj (U.P.), during *rabi* season, 2024-25. The experimental field's soil had a sandy loam texture, an alkaline pH of 8.25, a low organic carbon content of 0.42%, and abundant amounts of nitrogen (181.60 kg/ha), phosphorus (16.50 kg/ha), potassium (230.47 kg/ha), and sulphur (7.38 kg/ha). Ten treatments using various nutrition management techniques include (T_1) Control, (T_2) 100% RDF, (T_3) 75% RDF + FYM @ 5.0 t ha^{-1}, (T_4) 75% RDF+ vermicompost @ 1.5t ha^{-1}, (T_5) 75%RDF+ humic acid @ 5.0 kg ha^{-1}, (T_6) 75% RDF+ poultry manure @ 1.5t ha^{-1}, (T_7) 50% RDF + FYM @ 10.0 t ha^{-1}, (T_8) 50% RDF+ vermicompost @ 3.0 t ha^{-1}, (T_9) 50% RDF + humic acid @ 10. kg ha^{-1}, (T_{10}) 50% RDF + Poultry manure 3 t ha^{-1}. were examined using three replications and a randomised block design. According to the experimental findings, the maximal growth parameters (plant height, dry matter accumulation and branches plant^{-1}), yield attributes (siliqua length and siliqua plant^{-1}), were recorded with application of 75%RDF+ humic acid @ 5.0 kg ha^{-1} higher than the rest of the treatments. Integrated nutrient management improves the soil health and sustains the productivity of Indian mustard.

Keywords: Indian mustard, integrated nutrient management, humic acid, vermicompost, poultry manure

1. Introduction
Common names for Indian mustard (*Brassica juncea* L.) include raya and laha. It is one among the world's major oilseed crops. It is crucial to supplying the nation's demand for edible oil. Gujarat, Madhya Pradesh, Haryana, Rajasthan, and Uttar Pradesh are the main growing regions for Indian mustard. In southern states like Karnataka, Tamil Nadu, and Andhra Pradesh, its cultivation is also being expanded to non-traditional locations. Fats and oils have a significant role in human existence. In addition to providing the fundamental raw ingredients for making a variety of consumer goods, they are an important and fundamental component of our everyday diet. These are used as laxatives and have therapeutic and medical benefits (Gurpreet K. and Karan V. 2024) [4]. With 6.5% of the world's oilseed production, 3.7% of its vegetable oil production, 5.4% of its oil meal production, 2.5% of its oil meal export, 18.8% of its oil imports, and 11.3% of its edible oil consumption, India is the fourth-largest vegetable oil economy in the world, behind the United States, China, and Brazil (Chauhan *et al.,* 2021) [1]. Our country also fourth largest producer of oilseeds even though it is also the second largest importer of edible oil owing to its large population and ranking third in consumption. India's varied agroecological conditions have led to a rich diversity of annual oilseed crops. Of these, seven edible annual oilseed crops-groundnut, rapeseed and mustard, soybean, sunflower, niger, sesamum, and safflower-as well as two non-edible oilseeds-linseed and castor-provide more than 80% of the country's vegetable oil and fat needs. These oilseed crop occupy 26.63-million-hectare (Mha) area, which accounts for 13% of the total cultivated area in the country during 2016-17 (Singh *et al.,* 2017) [10].

Whereas, 20% contribution of vegetable oil crops from secondary sources like rice bran, cottonseed, palm oil, coconut and other tree borne oilseeds (Chauhan *et al.,* 2021) [1].

Oilseeds are the second most important agricultural economy and India's second-largest crop after cereals has continued to increase at a rate of 4.1% annually over the past three decades (Jat *et al.,* 2021) [6], accounting for nearly 0.74% of the Gross National Product (GNP) and 4.49% of the value of all agricultural products (Chauhan *et al.,* 2021) [1]. Since the inception of Technological Mission on Oilseeds (TMO) in May, 1986 leading to the evolution of Yellow Revolution and later broadening its scope by including pulses in1990's and rechristen it as Technology Mission on Oilseeds and Pulses (TMOP), the country has made a good stride in the production of oilseeds.

However, after achieving this milestone in edible oil production, the momentum was lost in few years owing to multiple reasons. Therefore, despite having the largest area under oilseeds in the world (26.63 m ha), the current estimates of demand and supply of edible oils are 25.4 million tonnes (M tonnes) and 10.1 Mtonnes (2016-17), created very large gap of 15.3 M tonnes which is just met out through import of edible oil (Jat *et al.,* 2021) [6]. India imported about 50% of itstotal oil requirement at very high cost of Rs.95,750 crores in the year 2016-17 (Singh *et al.,* 2017b) [10]. The annual oilseed production could be increased through vertical growth of oilseed crops as horizontal expansion of these crops would not be possible due to shrinkage of land holdings because of increasing urbanization due to the ever-growing human population and competition with cereals (Chauhan *et al.,* 2021) [1].

All of the essential nutrients-nitrogen, phosphorus, sulphur, and boron-are crucial for raising mustard production and quality. The majority of metabolic processes and energy transformation are known to be activated by nitrogen. Cell division and tissue meristematic development depend on phosphorus. Increasing oil output and oil content (%) requires sulphur. Application of sulphur has a significant impact on the production of amino acids, proteins, carbohydrates, and chlorophyll. A variety of minerals and micronutrients are essential for oilseed production, with sulphur being vital for the nutrition of oilseed crops, particularly those in the Cruciferae family (Sharma *et al.,* 2020) [9]. Integrated nutrient management involving the use of chemical fertilizer and organic manure has been reported to improve the soil health and sustain the productivity of crops (Kumawat *et al.,* 2024) [7]. In view of the declining soil health and escalating fertilizer price, this practice seems ideal for the exhaustive crops like mustard.

2. Materials and Methods

The proposed research study entitled "Effect of Integrated Nutrient Management on Growth and Yield of Indian Mustard (*Brassica juncea* L.) in Prayagraj Region" the field experiment is to be conducted out at the Agriculture College Research Farm, Prof. Rajendra Singh (Rajju Bhaiya) University, Prayagraj (U.P.) during winter (*Rabi*) season of 2024-25.

The trial was structured using a Randomised Block Design, consisting of 10 treatment combinations and 3 replications.

Treatment	Detail
T_1	Control
T_2	100% RDF
T_3	75% RDF + FYM @ 5.0 t ha^{-1}
T_4	75% RDF+ vermicompost @ 1.5t ha^{-1}
T_5	75%RDF+ humic acid @ 5.0 kg ha^{-1}
T_6	75% RDF+ poultry manure @ 1.5t ha^{-1}
T_7	50% RDF + FYM @ 10.0 t ha-1
T_8	50% RDF+ vermicompost @ 3.0 t ha^{-1}
T_9	50% RDF + humic acid @ 10. kg ha^{-1}
T_{10}	50% RDF + Poultry manure 3 t ha^{-1}

The Indian mustard variety used in experiment was RH 725. The advised amount of N, P, K, S for each plot was utilized according to the treatment, employing urea (46% N), diammonium phosphate (46% P2O5), muriate of potash (60% K2O), and bentonite sulfur (90% S). A half dose of nitrogen and full doses of phosphorus, potassium, and sulfur were applied as a basal treatment, while the remaining half of nitrogen was applied as top dressing at 35 DAS. Sowing was done in the second week of November at 30x10 cm row spacing.

The various plant growth studies *viz*. Plant height, Dry matter accumulation and Number of branch reported at 30, 60, 90 DAS and at harvest, Number of siliquae $plants^{-1}$, reported on per plant basis and Length of siliqua reported average length of siliqua in cm.

3. Results and Discussion

3.1 Plant height (cm)

The results presented in Table 3.1, depicted in fig 3.1 plant height of Indian mustard varied from 32.7 to 41.3, 98.7 to 119.9, 116.8 to 157.6 and 121.5 to 198.6 at 30, 60, 90 DAS and at harvest respectively. The lowest plant height was recorded under T_1 (Control) which was significantly lower than rest of the other treatments. Among the different nutrient levels, the application of T_5 (75% RDF+ humic acid @ 5.0 kg ha^{-1}) exhibited significantly taller plant at 30 DAS. Tallest plant of 119.9 cm was obtained in treatment T_5 (75% RDF+ humic acid @ 5.0 kg ha^{-1}) at 60 DAS which was on par with T_7, T_6 and T_4. At 90 DAS tallest plant with height 157.6 cm was recorded in T_5 (75%RDF+ humic acid @ 5.0 kg ha^{-1}) which was statistically at par to T_6, T_9 and T_7. Lowest plant height was recorded under T_1 (Control). At harvest tallest plant with height 198.6 cm was recorded in T_5 (75%RDF+ humic acid @ 5.0 kg ha^{-1}) which was statistically at par to T_6 (75% RDF+ poultry manure @ 1.5t ha^{-1}), T_{10} (50% RDF + Poultry manure 3 t ha^{-1}), T_4 (75% RDF + vermicompost @ 1.5t ha^{-1}), T_7 (50% RDF + FYM @ 10.0 t ha^{-1}), T_8 (50% RDF + vermicompost @ 3.0 t ha^{-1}), T_9 (50% RDF + humic acid @ 10. kg ha^{-1}) and T_3 (75% RDF + FYM @ 5.0 t ha^{-1}). Lowest plant height was recorded under T_1 (Control). Similar results were noted by Tripathi *et al.* (2011) [13] and Patel *et al.* (2012) [8].

Table 1: Plant height (cm) at successive growth stages of Indian mustard crop as influenced by various Treatments

Treatments		Plant height (cm)			
		30 DAS	60 DAS	90 DAS	At harvest
T_1	Control	32.7	98.7	116.8	121.5
T_2	100% RDF	34.1	106.4	118.3	124.3
T_3	75% RDF + FYM @ 5.0 t ha^{-1}	37.2	109.3	118.5	129.2
T_4	75% RDF+ vermicompost @ 1.5t ha^{-1}	36.7	116.8	135.4	169.9
T_5	75%RDF+ humic acid @ 5.0 kg ha^{-1}	41.3	119.9	157.6	198.6
T_6	75% RDF+ poultry manure @ 1.5t ha^{-1}	37.6	117.1	148.3	186.3
T_7	50% RDF + FYM @ 10.0 t ha^{-1}	40.1	118.3	129.4	162.2
T_8	50% RDF+ vermicompost @ 3.0 t ha^{-1}	37.3	113.6	121.9	152.5
T_9	50% RDF + humic acid @ 10. kg ha^{-1}	38.7	114.7	121.2	149.3
T_{10}	50% RDF + Poultry manure 3 t ha^{-1}	36.9	111.4	144.1	181.2
SEm (±)		1.69	3.72	5.24	6.96
F-Test		NS	S	S	S
CD at 5%		5.02	11.06	15.56	20.68

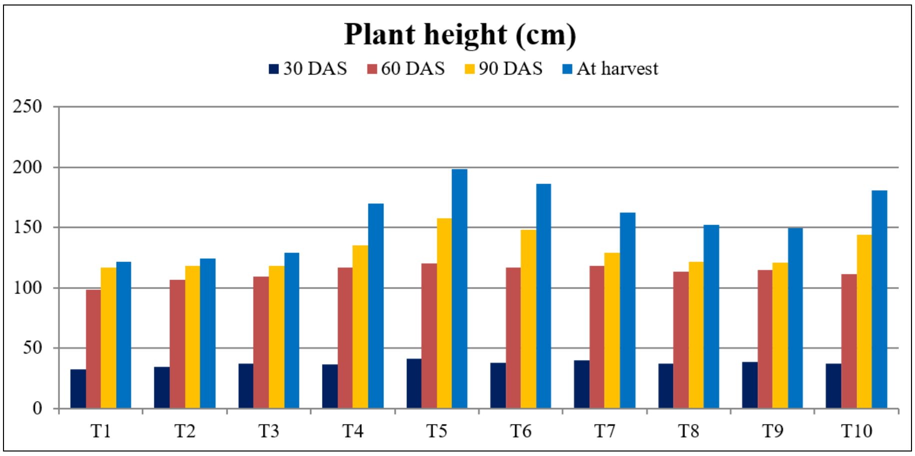

Fig 1: Plant height (cm) of Indian mustard as influenced by various Treatments

3.2 Dry matter accumulation

Data pertaining to plant dry weight (g m^{-2}) as influenced by different treatments of nutrient management at 30 DAS, 60 DAS, 90 DAS and at harvest are presented in Table 3.2, depicted in fig 3.2. It is evident that plant dry weight g m^{-2} increased with the advancement of crop age, irrespective of the treatments and reached to maximum at harvest. The data revealed the significant influence of various treatments at all stages of crop growth. Treatment T_5 recorded significantly higher plant dry weight (14.3 g m^{-2}) it remained at par with T_4, T_3 and T_6 at 30 DAS. Similarly T_5 recorded significantly higher plant dry weight (35.98 g m^{-2}) which remained at par with T_4, T_9 and T_6 at 60 DAS. Similarly T_5 recorded significantly higher plant dry weight (51.2 g m^{-2}) which remained at par with T_6, T_{10} and T_4 at 90 DAS. Similarly T_5 recorded significantly higher plant dry weight (62.5 g m^{-2}) which remained at par with T_7, T_6 and T_8 at harvest. The similar results were reported by Gudadhe *et al.* (2005) [3], Tripathi *et al.* (2011) [13], Dabi *et al.* (2015) [2] and Singh *et al.* (2015) [2]. Singh *et al.* (2015) [11] observed that application of 75% or 100% RDF along with seed treatment recorded significant increase in dry matter accumulation per m^{-2} in mustard.

Table 2: Plant dry weight (g plant^{-1}) at successive growth stages of Indian mustard crop as influenced by various Treatments

Treatments		Plant dry weight (g plant^{-1})			
		30 DAS	60 DAS	90 DAS	At harvest
T_1	Control	12.1	26.7	29.7	37.3
T_2	100% RDF	12.8	28.4	31.5	41.1
T_3	75% RDF + FYM @ 5.0 t ha^{-1}	13.9	28.9	33.3	45.2
T_4	75% RDF+ vermicompost @ 1.5t ha^{-1}	14	34.3	43.8	47.3
T_5	75%RDF+ humic acid @ 5.0 kg ha^{-1}	14.3	35.9	51.2	62.5
T_6	75% RDF+ poultry manure @ 1.5t ha^{-1}	13.8	33.9	48.1	57.9
T_7	50% RDF + FYM @ 10.0 t ha^{-1}	13.7	30.2	41.8	59.1
T_8	50% RDF+ vermicompost @ 3.0 t ha^{-1}	13.4	32.1	39.3	54.7
T_9	50% RDF + humic acid @ 10. kg ha^{-1}	13.1	34.2	37.9	55.7
T_{10}	50% RDF + Poultry manure 3 t ha^{-1}	12.9	33.1	46.7	53.4
SEm (±)		0.64	1.05	1.81	1.59
F-Test		NS	S	S	S
CD at 5%		1.91	3.12	5.39	4.74

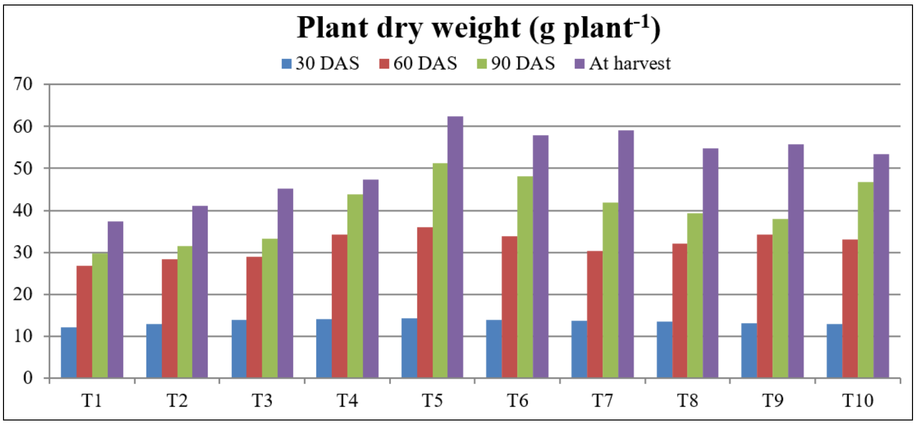

Fig 2: Plant dry weight (g plant^{-1}) at successive growth stages of Indian mustard crop as influenced by various Treatments

3.3 Number of branches plant^{-1}

It is clearly evident from the table 3.3 depicted in fig 3.3, that number of branches plant^{-1} increased with the advancement of crop age up to harvest. The different nutrient management practices brought significant variation in number of branch plant^{-1} at all stages of crop growth. Among all the treatments, the maximum number of branches plant^{-1} were recorded by the application of T_5 (75%RDF+ humic acid @ 5.0 kg ha^{-1}) at 60 DAS which was found to be par with T_9 (50% RDF + humic acid @ 10. kg ha^{-1}), T_7 (50% RDF + FYM @ 10.0 t ha^{-1}) and T_{10} (50% RDF + Poultry manure 3 t ha^{-1}). Lowest number of primary branches was recorded in control. At 90 DAS maximum number of branches plant^{-1} were recorded in T_5 (75%RDF+ humic acid @ 5.0 kg ha^{-1}) which was at par with T_9 (50% RDF + humic acid @ 10. kg ha^{-1}). T_5 recorded maximum number of branches plant^{-1} at harvest and this was on par with T_9 (50% RDF + humic acid @ 10. kg ha^{-1}), T_8 (50% RDF+ vermicompost @ 3.0 t ha^{-1}), T_6 (75% RDF+ poultry manure @ 1.5t ha^{-1}) and T_7 (50% RDF + FYM @ 10.0 t ha^{-1}). These findings are in agreement with those of Gudadhe *et al.* (2005) [3], Tripathi *et al.* (2011) [13], Patel *et al.,* (2012) [8], Dabi *et al.* (2015) [2], Singh *et al.* (2015) [11] and Indira *et al.* (2021) [5].

Table 3: Number of branches plant^{-1} at successive growth stages of Indian mustard crop as influenced by various Treatments

Treatments		Number of branches plant^{-1}		
		60 DAS	90 DAS	At harvest
T_1	Control	3.0	10.0	10.0
T_2	100% RDF	3.2	11.2	10.7
T_3	75% RDF + FYM @ 5.0 t ha^{-1}	3.7	11.7	11.1
T_4	75% RDF+ vermicompost @ 1.5t ha^{-1}	3.9	12.6	12.3
T_5	75%RDF+ humic acid @ 5.0 kg ha^{-1}	5.0	15.0	14.0
T_6	75% RDF+ poultry manure @ 1.5t ha^{-1}	4.3	13.4	12.7
T_7	50% RDF + FYM @ 10.0 t ha^{-1}	4.6	13.9	12.5
T_8	50% RDF+ vermicompost @ 3.0 t ha^{-1}	4.4	14.5	12.9
T_9	50% RDF + humic acid @ 10. kg ha^{-1}	4.7	14.7	13.7
T_{10}	50% RDF + Poultry manure 3 t ha^{-1}	4.5	13.7	11.9
SEm (±)		0.13	0.42	0.63
F-Test		S	S	S
CD at 5%		0.39	1.25	1.87

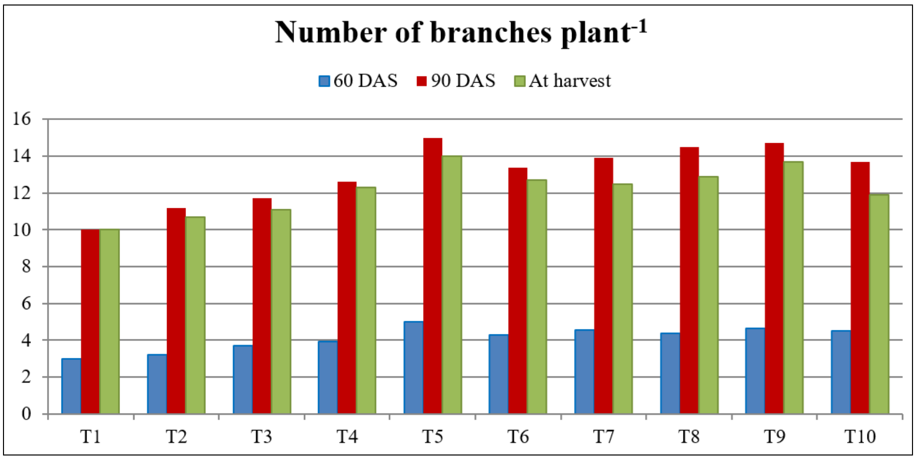

Fig 3: Number of branches plant^{-1} of Indian mustard as influenced by various Treatments

3.4 Number of siliquae plant^{-1}

It may be deduced from the provided data (Table 3.4) that the maximum number of siliqua plant^{-1} (233) were produced in the treatment T_5 (75%RDF+ humic acid @ 5.0 kg ha^{-1}) which was found to be on par with T_6 (75% RDF+ poultry manure @ 1.5t ha^{-1}), T_{10} (50% RDF + Poultry manure 3 t ha^{-1}), T_7 (50% RDF + FYM @ 10.0 t ha^{-1}), T_9 (50% RDF + humic acid @ 10. kg ha^{-1}), T_8 (50% RDF+ vermicompost @ 3.0 t ha^{-1}) and T_4 (75% RDF+ vermicompost @ 1.5t ha^{-1}). The treatment T_1 (Control) had the lowest number of siliqua $plants^{-1}$ (148), nevertheless, and this was far lower than the other treatments.

3.5 length of Siliqua (cm): Among the different nutrients, significantly higher siliqua length (4.54 cm) was recorded in treatment T_5 (75% RDF+ humic acid @ 5.0 kg ha^{-1}) which was statistically found to be on par with, T_4 (75% RDF+ vermicompost @ 1.5t ha^{-1}), T_6 (75% RDF+ poultry manure @ 1.5t ha^{-1}) and T_7 (50% RDF + FYM @ 10.0 t ha^{-1}). Treatment T_1 (Control) recorded the lowest siliqua length (4.17 cm).

Table 4: Yield attributes at successive growth stages of Indian mustard crop as influenced by various Treatments

Treatments		No. of siliqua $plant^{-1}$	Length of Siliqua (cm)
T_1	Control	148	4.17
T_2	100% RDF	157	4.34
T_3	75% RDF + FYM @ 5.0 t ha^{-1}	169	4.29
T_4	75% RDF+ vermicompost @ 1.5t ha^{-1}	197	4.49
T_5	75%RDF+ humic acid @ 5.0 kg ha^{-1}	233	4.54
T_6	75% RDF+ poultry manure @ 1.5t ha^{-1}	221	4.46
T_7	50% RDF + FYM @ 10.0 t ha^{-1}	213	4.37
T_8	50% RDF+ vermicompost @ 3.0 t ha^{-1}	203	4.27
T_9	50% RDF + humic acid @ 10. kg ha^{-1}	209	4.33
T_{10}	50% RDF + Poultry manure 3 t ha^{-1}	214	4.32
SEm (±)		8.18	0.21
F-Test		S	NS
CD at 5%		24.32	0.61

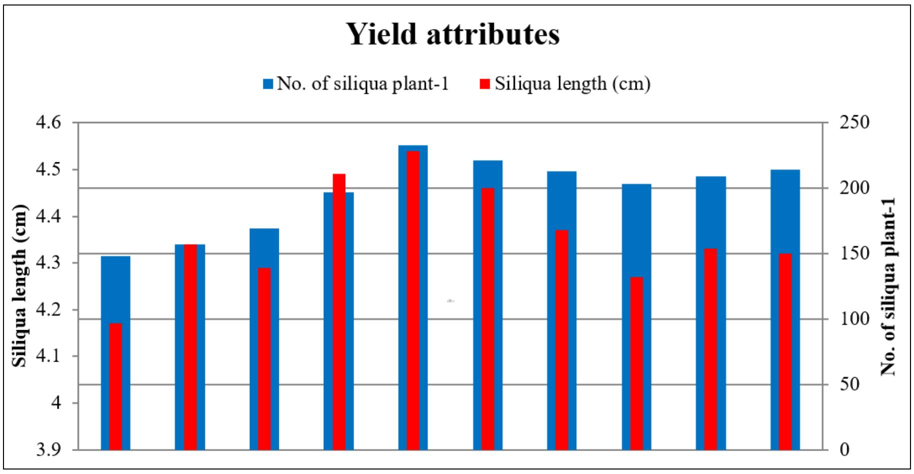

Fig 4: Yield attributes of Indian mustard as influenced by various Treatments

4. Conclusion

A field study carried out in the season of *Rabi* 2024-2025 at the Agriculture College Research Farm, demonstrated that various nutrient management practices, treatment T_5 (75% RDF+ humic acid @ 5.0 kg ha^{-1}) and T_9 (50% RDF+ humic acid @ 10.0 kg ha^{-1}) exhibited significant influence on the growth and yield attributes of Indian mustard as compared to the application of 100% NPK alone. In the light of results obtained from this investigation, In order to maintain soil health and increase the seed production of Indian mustard cv. RH 725, the application of 75% RDF+ humic acid @ 5.0 kg ha^{-1} will be most beneficial followed by 50% RDF+ humic acid @ 10.0 kg ha^{-1} and 75% RDF+ poultry manure @ 1.5 t ha^{-1}.

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6. Conflict of interest statement

There are no conflicts of interest to report, according to the authors. This study was carried out on its own without outside funding or assistance.

The authors prepared the document, gathered and analysed the data, and helped with the idea and design of this analytical report. Additionally, they suggested that the paper be published in this journal after reviewing and assessing its final draft.

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