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Effect of Nitrogen and Zinc levels on Yield and Economics of Mustard (*Brassica juncea L.*)

Pankaj Kumar Mishra [a*#] and Rajesh Singh [a†]

[a] *Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (Allahabad), Uttar Pradesh, India.*

Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

A field experimental trial entitled "Effect of Nitrogen and Zinc levels on Yield and Economics of Mustard (*Brassica juncea L.*)" was undertaken during *Rabi* season (2021-2022) at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (Allahabad) (U.P.). The size of experimental field is $243m^2$ and soil of experimental field was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.28 %), available Nitrogen (225 kg/ha.), available Phosphorus (19.50 kg/ha.) and available Potassium (213 kg/ha.). The treatments consisted of 3 levels of Nitrogen N_1 (60 kg/ha.), N_2(80 kg/ha.), N_3 (100 kg/ha.) and 3 levels of Zinc Zn_1 (5 kg/ha.), Zn_2 (10 kg/ha.) and Zn_3 (15 kg/ha.). The experiment was laid out in Randomized Block Design with 9 treatments and 3 replications. The results revealed that the application of Nitrogen 100 kg/ha. + Zinc 15 kg/ha. recorded maximum siliqua length (5.20 cm), number of siliquae per plant (398.90), number of seeds per siliqua (24.40), test weight (3.53 g). The economic analysis demonstrates that Nitrogen 100 kg/ha. + Zinc 15 kg/ha. treatment produced higher grain yield (1.89 t/ha.), stover yield (3.11 t/ha.), gross returns (103650.00 INR/ha.), net returns (70264.08 INR/ha.) and B:C ratio (2.10). The major challenges experienced throughout the research work were mostly related to the use of nitrogen and zinc.

Keywords: Nitrogen; growth; yield; zinc; rabi; economics.

[#] *M.Sc. Scholar;*
[†] *Assistant Professor;*
**Corresponding author: E-mail: impankaj0531@gmail.com;*

1. INTRODUCTION

Indian mustard (*Brassica juncea L.*), a member of the cruciferae family, is a valuable oilseed crop that is now rated third in terms of output and area in the world. It plays an important role in Indian agriculture since, depending on the crop and its growing stage, each portion of the plant is consumed by humans or animals. Mustard is one of the seven edible oilseeds farmed in India, accounting for 28.6% of total oilseed production and ranking second behind groundnut, which accounts for 27.8% of the Indian oilseed economy [2]. Mustard is mostly grown in Rajasthan, Uttar Pradesh, Haryana, Madhya Pradesh, and Gujarat. Rajasthan leads the world in rapeseed and mustard production, with 2.50 million hectares and 3.71 million tonnes produced. Mustard oil is used as a condiment in pickles, to flavor curries and vegetables, to make hair oils, medications, soap, and to soften leather in the tanning business. Mustard cake is mostly used as cow feed and manure. Mustard may have pharmacological effects in cancer, diabetes, and cardiovascular disease, although there are few scientific trials to back up its usage in any of these conditions. Nitrogen is essential for crops because it is a component of chlorophyll, the molecule that allows plants to utilise sunlight energy to make sugars from water and carbon dioxide in the photosynthesis process [2*].* It is a key component of amino acids, which are the building blocks of proteins. Plants wither and perish when they are deprived of proteins. Nitrogen (N), phosphorus (P), and potassium (K) are the three most important nutrients for plant growth, and nitrogen fertilizer use results in lower agricultural production costs and less pollution. Numerous plant particles containing nitrogen as a basic component, such as amino acids, chlorophyll, nucleic acids, ATP, and phytohormones, are required to complete biological processes including carbon and nitrogen metabolisms, photosynthesis, and protein biosynthesis [1]. For successful crop production, nitrogen application is now more important than the other primary fertilizers/nutrients. "Zinc is a divalent action exhibiting important role in health & disease as evidenced by the role of Zn in the functional capacity more than 200 metallic enzymes including Carbonic anhydrase, Carboxy peptidases, Alcohol dehydrogenases, Alkaline phosphatases, and RNA Polymerases etc. It is also required to maintain the structure of nucleic acid protein, cell membrane and also exerts vital role in various physiological functions viz., Cell growth, division, maturation and reproduction etc." (Alam *et al.,* 2010; Alloway, 2008)." The main functions of zinc is tendency to make up tetragonal complexes with nitrogen, oxygen and sulphur thus zinc have a catalytic, building and activating role in the enzymes" (Alloway, 2008). "Zinc is essential element for crop production and optimal size of fruit, also it required in the carbonic enzyme which present in all photosynthetic tissues and required for chlorophyll biosynthesis." (Ali *et al*., 2008).

2. MATERIALS AND METHODS

The experiment entitled "Effect of Nitrogen and Zinc levels on Yield and Economics of Mustard (*Brassica juncea L.*)" was conducted during *Rabi* season of 2021-2022. The experiment was conducted in Randomized Block Design consisting of nine treatment combinations with three replications. The size of experimental field is 243m^2 and the soil of the experimental field was sandy loam in texture, slightly alkaline reaction (pH 7.1) with low level of organic carbon (0.28%), available N (225 kg/ha.), P (19.50 kg/ha.) and higher level of K (213 kg/ha.). The treatment combinations are T_1 Nitrogen 60 kg/ha. + Zinc 5 kg/ha., T_2 Nitrogen 60 kg/ha. + Zinc 10 kg/ha., T_3 Nitrogen 60 kg/ha. + Zinc 15 kg/ha., T_4 Nitrogen 80 kg/ha. + Zinc 5 kg/ha., T_5 Nitrogen 80 kg/ha. + Zinc 10 kg/ha., T_6 Nitrogen 80 kg/ha. + Zinc 15 kg/ha., T_7 Nitrogen 100 kg/ha. + Zinc 5 kg/ha., T_8 Nitrogen 100 kg/ha. + Zinc 10 kg/ha., T_9 Nitrogen 100 kg/ha. + Zinc 15 kg/ha. The observations were recorded on different yield parameters at harvest viz. After harvest, the cost of cultivation (INR/ha.), gross return (INR/ha.), net return (INR/ha.), and B:C ratio are computed, as well as the number of siliquae per plant, number of seeds per siliqua, length of siliqua, test weight, seed yield, and stover yield.

3. ANOVA for RBD

Sources of variance	Df	SS	MS	F
Replication	r-1	RSS	RMS	RMS/EMS
Treatment	t-1	TSS	TMS	TMS/EMS
Error	(r-1) (t-1)	ESS	EMS	
Total	rt-1	Total SS		

3.1 Computation of ANOVA

C.F. = Correction factor = G^2/N
G = Grand total
N = Number of observations

Total sum of squares (T.S.S.) = $\Sigma i \Sigma j X^2 ij$- C.F.

$$\text{Replication Sum of Square (R.S.S.)} = \frac{\Sigma_j R^2 j}{T} - \text{C.F.}$$

$$\text{Treatment Sum of Square (Tr.S.S.)} = \frac{\Sigma_j T^2 i}{T} - \text{C.F.}$$

Error Sum of Square (E.S.S.) = T.S.S. – R.S.S. – Tr.S.S

4. RESULTS AND DISCUSSION

4.1 Yield Attributes

The data pertaining to yield parameters have been presented in Table 1. The important yield parameters are number of siliquae per plant, number of seeds per siliqua, length of siliqua (cm), test weight (g), seed yield (t/ha.), stover yield (t/ha.) and harvest index (%) which were influenced by significantly by various treatments.

4.2 No. of Siliquae per plant

Treatment with application of Nitrogen 100 kg/ha. + Zinc 15 kg/ha. was recorded maximum number of siliquae per plant (398.90) which was significantly superior over all other and treatment with application of Nitrogen 100 kg/ha. + Zinc 10 kg/ha. (375.40) which was statistically at par with the treatment with application of Nitrogen 100 kg/ha. + Zinc 15kg/ha. (Hussain *et al.* 2006).

4.3 No. of Seeds per Siliqua

Treatment with application of Nitrogen 100 kg/ha. + Zinc 15 kg/ha. was recorded maximum number of seeds per siliqua (24.40) which was significantly superior over all other treatment and treatment with application of Nitrogen 100 kg/ha. + Zinc 10 kg/ha. (22.30) which was statistically at par with the treatment with application of Nitrogen 100 kg/ha. + Zinc 15 kg/ha [3].

4.4 Length of Siliqua (cm)

Treatment with application of Nitrogen 100 kg/ha. + Zinc 15 kg/ha. was recorded maximum length of siliqua (5.20) which was significantly superior over all other treatment and treatment with application of Nitrogen 100 kg/ha. + Zinc 10 kg/ha. (5.10) which was statistically at par with the treatment with application of Nitrogen 100 kg/ha. + Zinc 15 kg/ha [4].

4.5 Test Weight (g)

Treatment with application of Nitrogen 100 kg/ha. + Zinc 15 kg/ha. was recorded maximum test weight (3.53 g) which was significantly superior over all other and treatment with application of Nitrogen 100 kg/ha. + Zinc 10 kg/ha. (3.29 g) which was statistically at par with the treatment with application of Nitrogen 100 kg/ha. + Zinc 15 kg/ha [3].

4.6 Seed Yield (t/ha.)

Treatment with application of Nitrogen 100 kg/ha. + Zinc 15 kg/ha. was recorded maximum seed yield (1.89 t/ha.) which was significantly superior over all other treatments with application of Nitrogen 100 kg/ha. + Zinc 10 kg/ha. (1.79 t/ha.) and Nitrogen 80 kg/ha. + Zinc 15 kg/ha. (1.75 t/ha.) which was statistically at par with the treatment with application of Nitrogen 100 kg/ha. + Zinc 15 kg/ha.

4.7 Stover Yield (t/ha.)

Treatment with application of Nitrogen 100 kg/ha. + Zinc 15 kg/ha. was recorded maximum stover yield (3.11 t/ha.) which was significantly superior over all other treatment with application of Nitrogen 100 kg/ha. + Zinc 10 kg/ha. (3.06 t/ha.) which was statistically at par with the treatment with application of Nitrogen 100 kg/ha. + Zinc 15 kg/ha.

4.8 Harvest Index (%)

Treatment with application of Nitrogen 80 kg/ha. + Zinc 10 kg/ha. was recorded maximum harvest index (38.63%) and minimum with application of Nitrogen 100 kg/ha. + Zinc 15 kg/ha. (36.83%). There was no significance difference between different treatment combinations.

4.9 Economics

Table 2 shows the gross returns, net returns, and benefit cost ratio for various therapies.

4.10 Cost of Cultivation (INR/ha.)

Cost of cultivation (33385.92 INR/ha.) was found to be highest in Nitrogen 100 kg/ha. + Zinc 15 kg/ha. And the minimum cost of cultivation (31171.52 INR/ha.) was found to be in Nitrogen 60 kg/ha. + Zinc 5 kg/ha. as compared to other treatments.

Table 1. Effect of Nitrogen and Zinc levels on Yield Attributes and Yield of Mustard

Treatments	**No. of Siliquae per plant**	**No. of Seeds per Siliqua**	**Length of Siliqua**	**Test Weight (g)**	**Seed Yield (t/ha.)**	**Stover Yield (t/ha.)**	**Harvest Index (%)**
Nitrogen 60 kg/ha. + Zinc 5 kg/ha.	289.80	17.90	4.40	2.52	1.41	2.39	36.98
Nitrogen 60 kg/ha. + Zinc 10 kg/ha.	312.70	18.70	4.70	2.69	1.51	2.43	38.25
Nitrogen 60 kg/ha. + Zinc 15 kg/ha.	330.20	19.40	4.80	2.74	1.59	2.64	37.62
Nitrogen 80 kg/ha. + Zinc 5 kg/ha.	320.20	18.90	4.70	2.68	1.54	2.57	37.49
Nitrogen 80 kg/ha. + Zinc 10 kg/ha.	348.50	20.20	4.80	2.91	1.71	2.75	38.63
Nitrogen 80 kg/ha. + Zinc 15 kg/ha.	365.00	21.70	4.90	3.04	1.75	2.87	37.93
Nitrogen 100 kg/ha. + Zinc 5 kg/ha.	341.00	19.70	4.80	2.88	1.66	2.70	38.16
Nitrogen 100 kg/ha + Zinc 10 kg/ha.	375.40	22.30	5.10	3.29	1.79	3.06	37.06
Nitrogen 100 kg/ha. + Zinc 15 kg/ha.	398.90	24.40	5.20	3.53	1.89	3.11	36.83
SEm (±)	7.85	0.71	0.08	0.12	0.05	0.05	1.08
CD (5%)	23.54	2.13	0.25	0.35	0.15	0.17	-----

Source – Experimental Field, Crop Research Farm, SHUATS, Prayagraj (U.P.)

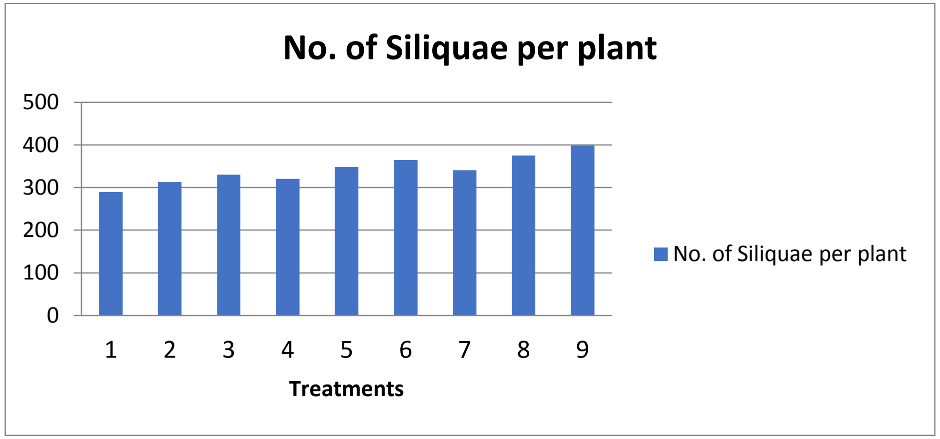

Fig. 1. of Siliquae per plant

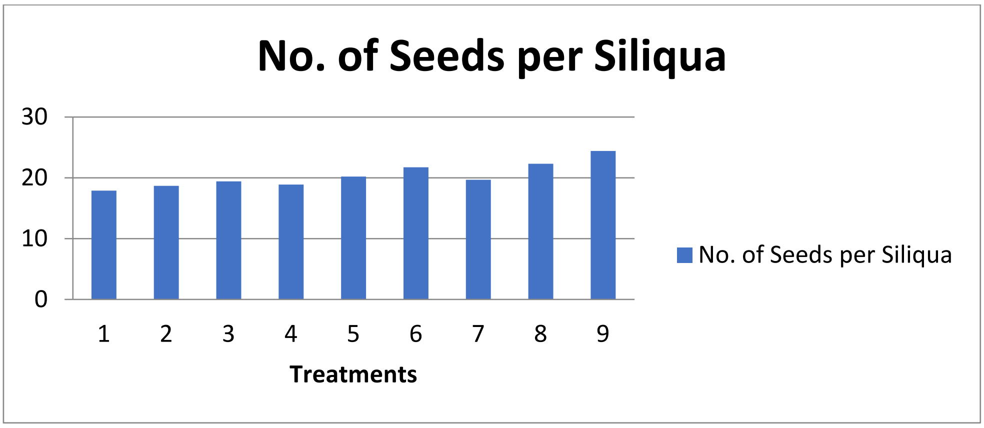

Fig. 2. of Seeds per Siliqua

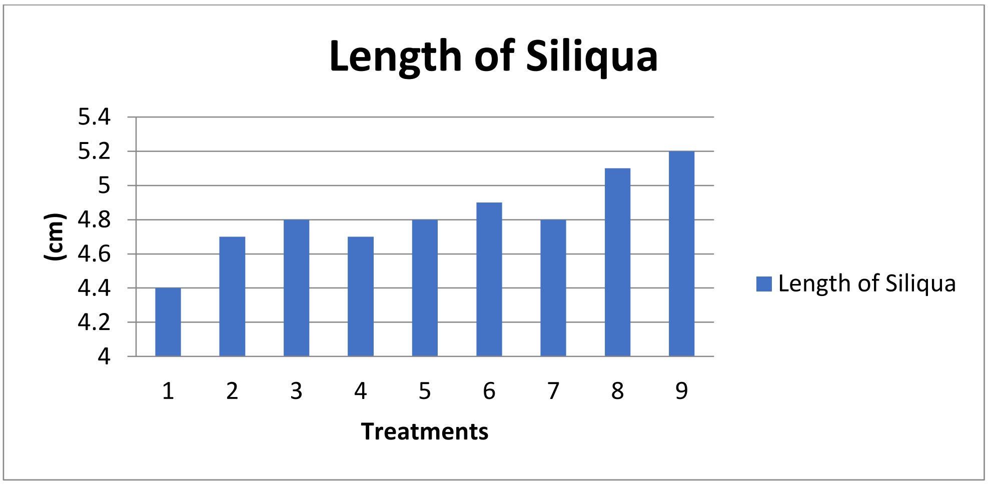

Fig. 3. Length of Siliqua

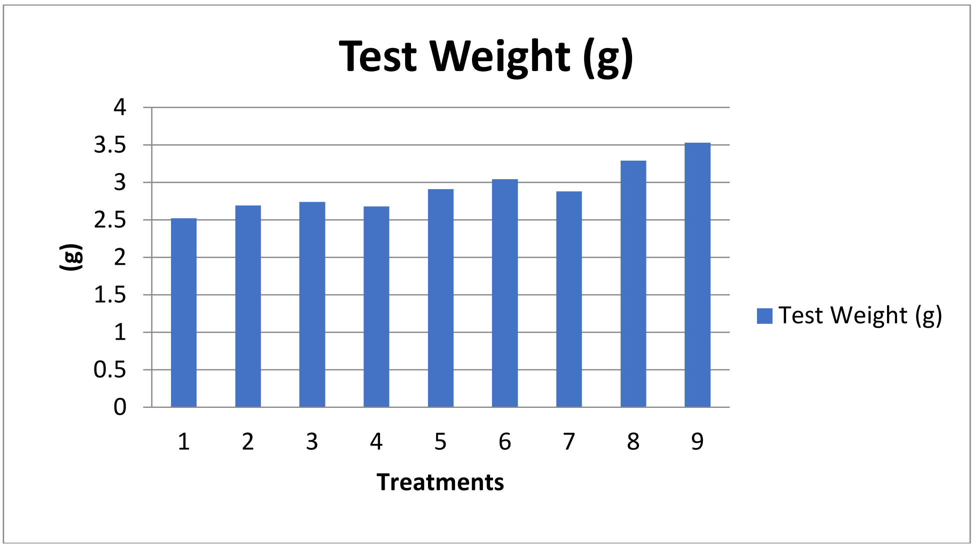

Fig. 4. Test Weight (g)

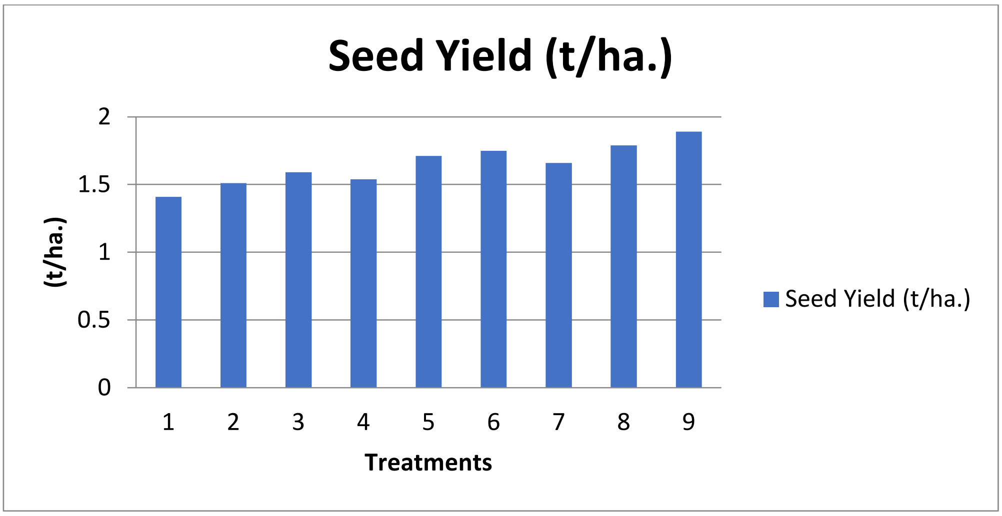

Fig. 5. Seed Yield (t/ha.)

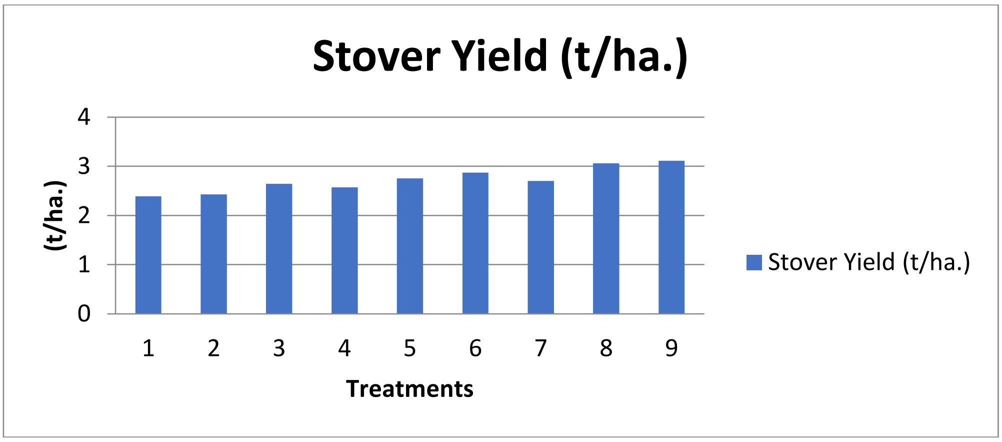

Fig. 6. Stover Yield (t/ha.)

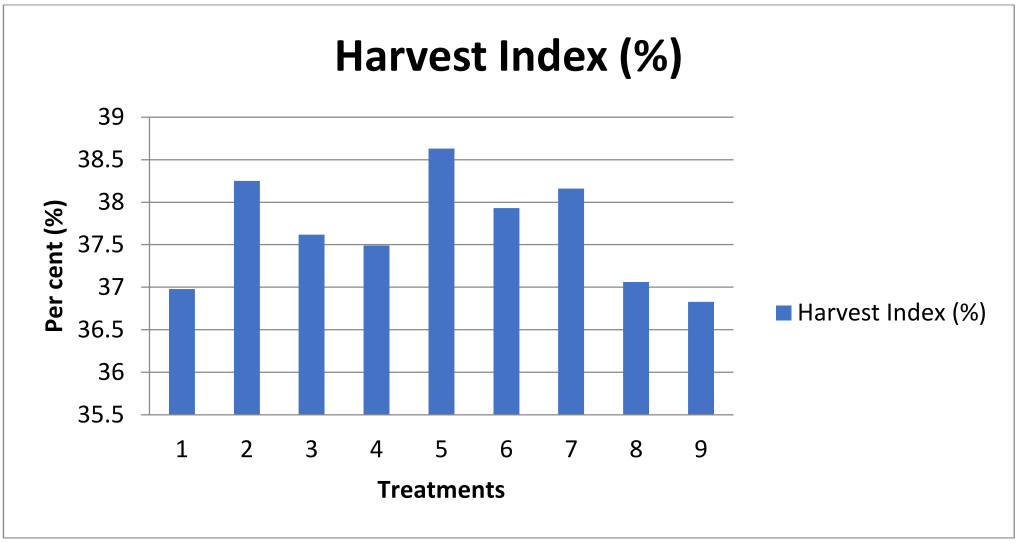

Fig. 7. Harvest Index (%)

4.11 Gross Returns (INR/ha.)

Gross returns (103650.00 INR/ha.) were found to be highest in Nitrogen 100 kg/ha. + Zinc 15 kg/ha. and the minimum gross returns (78450.00 INR/ha.) was found to be Nitrogen 60 kg/ha. +Zinc 5 kg/ha. as compared to other treatments [5-8].

4.12 Net Returns (INR/ha.)

Net returns (70264.08 INR/ha.) were found to be highest in Nitrogen 100 kg/ha. + Zinc 15 kg/ha. and the minimum net returns (47278.48 INR/ha.) was found to be Nitrogen 60 kg/ha. + Zinc 5 kg/ha. as compared to other treatments [6].

4.12 Benefit Cost Ratio (B:C)

Benefit Cost ratio (2.10) was found to be highest in Nitrogen 100 kg/ha. + Zinc 15 kg/ha. and the minimum benefit cost ratio (1.51) was found to be in Nitrogen 60 kg/ha. + Zinc 5 kg/ha. as compared to other treatments [9,10].

Table 2. Effect of Nitrogen and Zinc levels on Yield and Economics of Mustard

Treatments	Total Cost of Cultivation (INR/ha.)	Gross Returns (INR/ha.)	Net Returns (INR/ha.)	B:C ratio
Nitrogen 60 kg/ha. + Zinc 5 kg/ha.	31171.52	78450.00	47278.48	1.51
Nitrogen 60 kg/ha. + Zinc 10 kg/ha.	32171.52	81800.00	49628.48	1.54
Nitrogen 60 kg/ha. + Zinc 15 kg/ha.	33171.52	87400.00	54228.48	1.63
Nitrogen 80 kg/ha. + Zinc 5 kg/ha.	31278.72	84750.00	53471.28	1.70
Nitrogen 80 kg/ha. + Zinc 10 kg/ha.	32278.72	92850.00	60571.28	1.82
Nitrogen 80 kg/ha. + Zinc 15 kg/ha.	33278.72	95750.00	62471.28	1.87
Nitrogen 100 kg/ha. + Zinc 5 kg/ha.	31385.92	90400.00	59014.08	1.88
Nitrogen 100 kg/ha + Zinc 10 kg/ha.	32385.92	99700.00	67314.08	2.07
Nitrogen 100 kg/ha. + Zinc 15 kg/ha.	33385.92	103650.00	70264.08	2.10

Source – Experimental Field, Crop Research Farm, SHUATS, Prayagraj (U.P.)

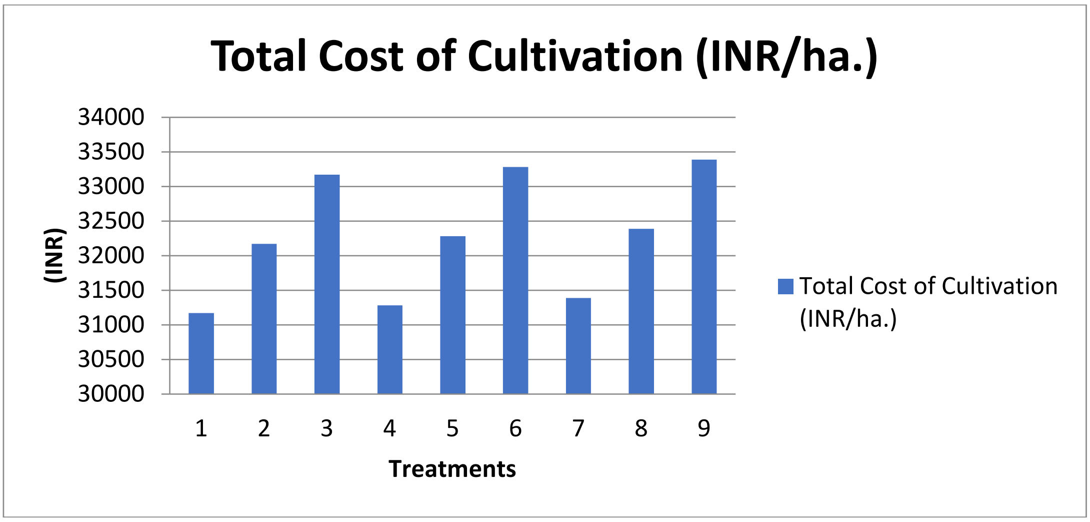

Fig. 8. Total Cost of Cultivation (INR/ha.)

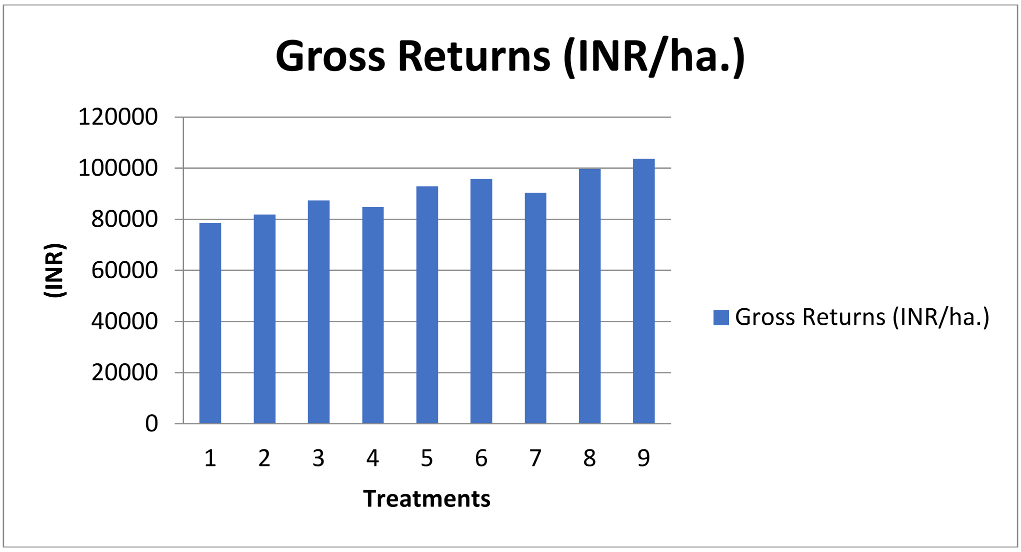

Fig. 9. Gross Returns

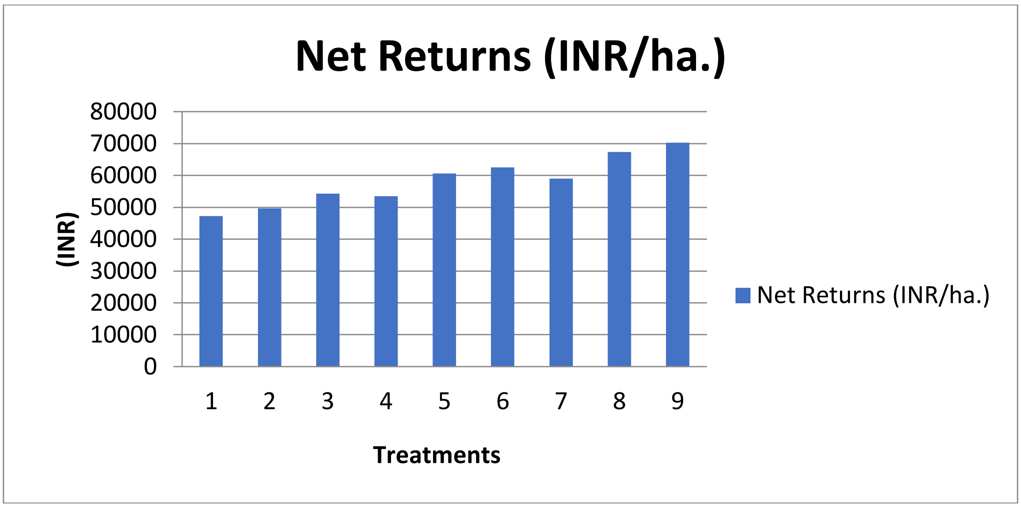

Fig. 10. Net Returns

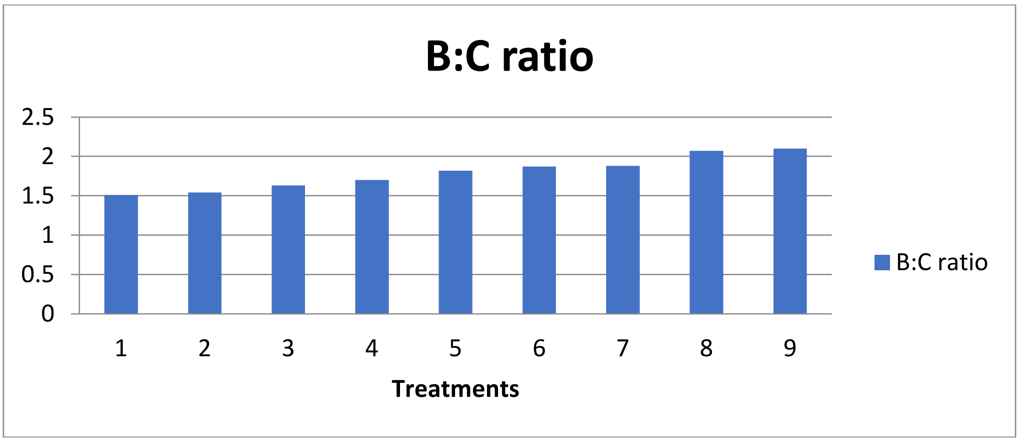

Fig. 11. B C ratio

Fig. 12. Fertilizer application before sowing

Fig. 13. Weeding at 20 DAS

Fig. 14. Observation recorded at 60 DAS

Fig. 15. Mustard seed at 120 DAS

5. CONCLUSION

Based on the one season experimentation it is concluded that combined application of Nitrogen 100 kg/ha. + Zinc 15 kg/ha. gave significant effect on yield and economics parameters in mustard. The combined application of Nitrogen 100 kg/ha. + Zinc 15 kg/ha. was found more productive (1.89 t/ha.) as well as economically viable (INR 70264.08/ha.) also. The conclusions reached are based on a single season of research, and they need to be confirmed and recommended further [11].

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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