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Effect of zinc and boron on growth and yield of greengram (*Vigna radiata* L.)

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Abstract
A field experiment was conducted during *Zaid* season of 2023 at Crop Research Farm Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture Sciences and Technology. To determine "Effect of zinc and boron on Growth and Yield of greengram" The result revealed that treatment 9 [15 kg/ha zinc + 1.5 kg/ha boron] recorded significantly higher plant height (42.57 cm), higher nodules/plant (17.27), higher branches/plant (6.70), higher plant dry weight (16.88 g), higher crop growth rate (23.18 g/m²/day), higher relative crop growth rate (0.1358), higher pods/plant (14.2), higher seeds/pod (12.51), higher test weight (39.05), higher seed yield (1.37 t/ha) and higher stover yield (3.20t/ha), higher harvest index (30.41%). the aforesaid treatment also recorded maximum gross return (INR105746.96/ha), net return (INR74906.96/ha) and B:C ratio (2.43).

Keywords: Greengram, zinc, boron, growth, yield and economic

Introduction

Pulses are the important group of crops belonging to the family Fabaceae. For both large and small farmers, which represent economic opportunities to increase income and reduce risk by diversifying their crop and income stream portfolio. Pulses could help at future needs for protien, help minimize soil degradation, and support diversification in food production and consumption. Pulses are an important component in diversifying diets and in replenishing soil nutrients. It is an important source of protein and several essential micronutrients. It is synthesizes nitrogen (N) symbiosis with rhizobia and enriches the soil. It ameliorates the fertility status through atmospheric nitrogen fixation. Mungbean [*Vigna radiata* (L.)] is one of the excellent sources of high quality protein. It contains about 25% of protein. It ranks third among important pulse crops, coming after chickpea and pigeon pea.

Mungbean is more nutritive, palatable, digestible and non-flatulent than other pulses grown in different parts of the world. Although it is a rainy season crop and it has also proved to be an ideal crop for spring and summer season. This has become possible only due to the development of early maturing varieties. It can also be used as a green manure crop. The green plants of mungbean crop are used as fodder after picking the mature pods. In addition to an excellent amount of protein, it also contains high quality of lysine (4600 mg/g N) and tryptophan (60 mg/g N). It is consumed in the form of dal as well as whole grain in a variety of ways. It is preferred by patients because of its easily digestible character. Sprouted seeds of munbean are also consumed as they are rich source of ascorbic acid (vitamin C), riboflavin and thiamine.

India is the major producer of green gram in the world and grown in almost all the States. It is grown in about 4.5 million hectares with the total production of 2.5 million tonnes with a productivity of 548 kg/ha and contributing 10% to the total pulse production. According to Government of India 3rd advance estimates, green gram production in 2020- 21 is at 2.64 million tonnes. In the marketing year 2020-21, the consumption of green gram was 22.5 lakh tonnes against the production of 21.42 lakh tonnes with the rest of the demand-supply gap was covered by importing around 1.08 lakh tones along with the opening stocks 2.10 lakh tonnes. (Ahmad F *et al*., 2018) [1].

The important green gram producing states in the country are Rajasthan, Maharashtra, Andhra Pradesh, Madhya Pradesh and Bihar. Andhra Pradesh ranks 6th in greengram production with 0.83 lakh tonnes under an area of 1.13 lakh ha with productivity of 735 kg/ha according to third advance estimates of 2020-21 (DES, AP). Rajasthan and Madhya Pradesh States showed an increased in the area grown over the two decades while the states Andhra Pradesh, Bihar, Karnataka and Maharashtra showed a decreased area grown over two decades. The reason behind the decline in green gram production is that the improved irrigation facilities, which allows to grow-intensive crops such as rice and wheat.

Non-availability of quality seeds of improved and short duration varieties, growing under marginal and less fertile soil with low input supply and without management of pest and diseases properly, growing of mungbean under moisture stress conditions, unscientific post-harvest practices and storage under unfavorable conditions etc. are the major factors contributing to low yields of mungbean in India. The productivity of this crop is very low because of its cultivation on marginal and sub marginal lands having lesser soil fertility and also little attention is paid to proper fertilization (Hiren & Devi *et al.*, 2020) [3]. The scope for improving the production potential of this crop can be increased with the use of inorganic manures, organic manures and biofertilizers in conjugation or in different combinations (Farhan A *et al*., 2019) [7].

Being a legume crop, mungbean does not require much nitrogen except at the beginning of its life cycle in small quantities. The studies of different scientists has shown that the effect of the studies of different scientists has shown that the effect of phosphorus fertilizer to mungbean crop has more importance than the nitrogen because later is fixed by symbiosis with Rhizobium bacteria. Phosphorus plays an important role in the formation of energy rich phosphate bond like ADP and ATP, nuclear proteins, phospholipids. It is crucial for growth of root system and also improves the quality of grains. It not only increases the yield of main crop but also the succeeding crop (Goud *et al*., 2021) [13]. Yield potential of summer green gram is high, even after that low yield has been reported due to non-use of fertilizers.

Micronutrients constitute an important role in increasing yield of pulses and oilseed legumes through their effects on the plant itself and on nitrogen fixing symbiotic process. Their deficiencies have been occurred due to multiple cropping systems with high yield variety (HYV) crops and hence their exogenous supplies are urgently require (Amarghade and singh, 2021) [5]. Mineral nutrient deficiencies limit nitrogen fixation by the legume rhizobium symbiosis, resulting in low yield.

Since Zinc (Zn) is not mobile in the plants, thus zinc-deficiency symptoms occur mainly in terminal growth. Due to poor mobility in plants, constant supply of zinc is essential for optimum growth. Besides its major role in formation of chlorophyll, it is involved in several enzyme systems, growth hormone (Auxins) and the synthesis of nucleic acids and plays an important role in the intake and use of water by plants. Plants emerged from seeds with low concentrations of zinc could be highly sensitive to biotic and abiotic stresses. Zinc enriched seeds can perform better with respect to seed germination, seedling health, crop growth and finally yield advantage.

Boron (B) is very important in cell division and in pod and seed formation Reproductive growth, especially flowering, fruit and seed set is more sensitive to B deficiency than vegetative growth absorption of nutrigen (N), phosphorus (P), potassium (K) and its deficiency changed the equilibrium of optimum of those three macronutrients.

An adequate supply of available boron is required especially during flowering and seed development Enzyme systems, growth hormone (Auxins) and the synthesis of nucleic acids and plays an important role in the intake and use of water by plants (Patel *et al*., 2014) [11]. Plants emerged from seeds with low concentrations of zinc could be highly sensitive to biotic and abiotic stresses. Zinc enriched seeds can perform better with respect to seed germination, seedling health, crop growth and finally yield advantage.

Materials and Methods

A field experiment was conducted during *Zaid* season of 2023 at Crop Research Farm Department of Agronomy, Naini Agriculture Institute, Sam Higginbottom University of Agriculture Sciences and Technology. To determine "Effect of zinc and boron on Growth and Yield of greengram" The result revealed that treatment 9 [15 kg/ha zinc + 1.5 kg/ha boron] recorded significantly higher plant height (42.57 cm), higher nodules/plant (17.27), higher branches/plant (6.70), higher plant dry weight (16.88 g), higher crop growth rate (23.18 g/m²/day), higher relative crop growth rate (0.1358), higher pods/plant (14.2), higher seeds/pod (12.51), higher test weight (39.05), higher seed yield (1.37 t/ha) and higher stover yield (3.20t/ha), higher harvest index (30.41%). the aforesaid treatment also recorded maximum gross return (₹105746.96/ha), net return (₹74906.96/ha) and B:C ratio (2.43).

Results and Discussion

A. Growth Parameters

Plant height (cm)

The data on plant height recorded at various growth stages i.e. branching, flowering and at harvest are presented in Table 1. The height of green gram plants was recorded periodically at an interval of 15 days beginning from 15 DAS up to maturity stage. As revealed by the data, plant height was increased with increasing days from sowing to harvest and the maximum increment was noticed between 45 to 60 DAS. The plant height was recorded at 15 DAS and at harvest, is presented in Table 1.

Although the analysis of plant height was found to be statistically non-significant from 15 to 30 days, but there was a significant increase in the plant height from 15 to 60 days due to different treatments. The plant height increased slowly till 30 DAS which soared to the highest at harvest of the crop in all the treatments.

At 45 DAS, significantly higher plant height (32.67cm) was recorded with the treatment along with the treatment T_9 [15 kg/ha Zinc + 1.5 kg/ha Boron] followed by the treatment T_7 [15 kg/ha Zinc + 0.5 kg/ha Boron] with the application of (631.17 cm). Significantly lower plant height (26.40cm) was recorded with the control.

At 60 DAS, significantly higher plant height (42.57 cm) was recorded with the treatment along with the treatment T_9 [15 kg/ha Zinc + 1.5 kg/ha Boron] followed by treatment with the application of T_7 (65.14 cm). The minimum growth of the all the treatment with the application of control recorded the significantly lower plant height (32.53cm).

The probable reasons for higher plant height at 30, 45 and 60 DAS might be due to the fact that seed inoculation with organic fertilizers which is coated uniformly on green gram seed coat, leads to better uptake and translocation of plant nutrients to growing plants. The other reason may be due to the fact that inoculation benefitted the plants by providing atmospheric Nitrogen and rendering the insoluble phosphorus into available form. The enhanced availability of Phosphorus favored Nitrogen fixation and rate of photosynthesis and consequently led to better plant height and branches per plant. The application of Zinc and Boron another reason might be congenial environment ensured proper utilization of nutrient, moisture, space and solar radiation which resulted in better photosynthesis ultimately leading to higher plant height. These findings are in accordance with the findings of Patel *et al*., (2014) [11].

Ranches/plant

Observation on number of branches per plant of green gram was influence by different organic fertilizers and plant geometry at various intervals during the year was statistically analaysis and has been presented in table 2.

At 45 DAS there was significant difference between the treatments and maximum number of branches/ plant (6.70) was observed the treatment T_9, [15kg/ha Zinc + 1.5 kg/ha Boron] whereas the minimum number of branches per plant (3.93) was observed in treatment control.

At 60 DAS, significant difference found among the all treatments and maximum number of branches per plant (6.73) treatment T^9 [15 kg/ha Zinc + 1.5kg/ha Boron] and the minimum number of branches per plant (3.87) was observed in treatment control.

The number of branches is a genetically controlled factor so it differed significantly among three factors under study. The inter-row spacing affected the branches, which might be due to better availability of light, moisture nutrients, etc. in case of varying spacing. These results are in agreement with those of Gajera and Padbhushan R. (2014) [14] who stated significant differences for this character among inter row spacing.

Number of nodules/ plant (No.)

Table 3 shows that number of nodules/plant of Greengram recorded at 30 DAS, 45 DAS and 60 DAS as influenced by different levels of zinc and boron. Number of nodules/plant of Greengram increased significantly and progressively with increase in different levels of zinc and boron at 30DAS, 45 DAS and 60 DAS.

At 30 DAS, maximum (17.27) number of nodules/plant was recorded with application of T_9 (15 kg/ha zinc + 1.5 kg/ha boron). While (T_8) (15 kg/ha zinc + 1.0 kg/ha boron) (17.23) was statically at per with T_9 (15 kg/ha zinc + 1.5 kg/ha boron) (17.27).

At 45 DAS, maximum (34.67) number of nodules/plant was recorded with application of T_9 (15 kg/ha zinc + 1.5 kg/ha boron).

At 60 DAS, maximum (24.13) number of nodules/plant was recorded with application of T_9 (15 kg/ha zinc + 1.5 kg/ha boron).

The significant and higher number of nodules/plant was observed with the application of zinc (15 kg/ha) might be due to better proliferation of roots and increased nodulation due to higher zinc availability which leads to higher plant growth (Kudi *et al*., 2018) [15]. Further, the application of boron (1.5 kg/ha) promoted the nodule due to direct involvement of boron in nodulation, symbiotic nitrogen fixation and help in retaining cell wall and membrane integrity of nodules. These results were in conformity with those of Das *et al*., (2016) [34].

Plant dry weight (g/plant)

Data (Table 3) on dry matter accumulation (Per meter row length) at different growth intervals as affected by various treatments showed that the peak dry matter accumulation was recorded from 60 DAS to at harvest. The dry matter accumulation was found highest in the treatment where treatment 7, 14.95 (g/cper plant) and treatment 9 also was superior among all the treatment applied which was being at par with and both these treatments showed significantly higher dry matter accumulation over rest of the treatments. The control recorded significantly lower dry matter accumulation at all the growth stages.

At 30 DAS, there was significant difference between the treatments and maximum dry matter accumulation (2.94 cm) was observed the treatment of T_9 [15 kg/ha Zinc + 1.5 kg/ha Boron] whereas the minimum dry matter accumulation (2.51) was observed in treatment T_8. [12 kg/ha Zinc + 1.5 kg/ha Boron].

At 45 DAS there was significant difference between the treatments and maximum dry matter accumulation (13.37) was observed the treatment T_9 [15 kg/ha Zinc + 1.5 kg/ha Boron] whereas the minimum dry matter accumulation of the treatment (8.99) was observed in treatment control.

At 60 DAS there was significant difference between the treatments and maximum dry matter accumulation (16.88) was observed the treatment 9 [15 kg/ha Zinc + 1.5 kg/ha Boron. Minimum dry matter accumulation (11.07) was observed in treatment control.

Similar fertilizer conducted by Bera and ghosh (2015) and concluded dry matter accumulation, were significantly more with treatment recommended dose of fertilizer (25: 50N:P2O5 kg ha^{-1}).

Crop Growth Rate (C.G.R.) ($g/m^2/day$)

Data (Table 3) on crop growth rate at different growth intervals as affected by various treatments showed that the peak v was recorded from 60 DAS to at harvest. The crop growth rate was found highest in the treatment where treatment 4, 10.61 and treatment 7 (9.80) also was superior among all the treatment applied which was being at par with and both these treatments showed no significantly higher crop growth rate over rest of the treatments. The control (5.96) recorded no significantly lower crop growth rate at all the growth stages.

At 30 DAS, there was significant difference between the treatments and maximum crop growth rate (23.18 $g/m^2/day$) was observed the treatment of T_9 [15 kg/ha Zinc + 1.5 kg/ha Boron] whereas the minimum crop growth rate (21.99) was observed in treatment T_8.

At 45 DAS, there was significant difference between the treatments and maximum crop growth rate (9.80) was observed the treatment T_6, whereas the minimum crop growth rate of the treatment (9.44) was observed in treatment control.

Kudi *et al*. (2018) [15] revealed that the use of 0.5 kilogram boron per hactare on summer greengram enhanced the plant height, branches/plant, number of leaves per plant, number of pods per plant, grains per pod, grain yield than the lower dose 1.5 kg boron/ha Data (Table 3) on relative growth rate at different growth intervals as affected by various treatments showed that the peak relative growth rate was recorded from 60 DAS to at harvest. The relative growth rate was found highest in the treatment where treatment 7, 0.10.61 and treatment 9 also was superior among all the treatment applied which being at par with and both these treatments was showed non-significantly higher relative growth rate over rest of the treatments. The control 0.0247 recorded non-significantly lower relative growth rate at all the growth stages.

At 30 DAS, there was non-significant difference between the treatments and maximum relative growth rate (0.0829) was observed the treatment of T_9 [15 kg/ha Zinc + 1.5 kg/ha Boron], whereas the minimum relative growth rate (0.0568) was observed in treatment T_4.

At 45 DAS, there was non-significant difference between the treatments and maximum relative growth rate (0.1334) was observed the treatment T_1 whereas the minimum relative growth rate of the treatment (0.1358) was observed in treatment control.

Ravindran and Silviya (2017) [28] Green gram (*Vigna radiata* L.) is an imperative legume crop in Asia. Zinc (Zn) deficiency is a yield-limiting factor for a variety of field crops across the world. To increase zinc concentration in edible portions of food crops, foliar application of zinc containing solutions might be sustainable.

Relative Growth Rate (g/g/day)

Data (Table 3) on relative growth rate at different growth intervals as affected by various treatments showed that the peak relative growth rate was recorded from 60 DAS to at harvest. The relative growth rate was found highest in the treatment where treatment 7, 0.10.61 and treatment 9 also was superior among all the treatment applied which being at par with and both these treatments was showed non-significantly higher relative growth rate over rest of the treatments. The control 0.0247 recorded non-significantly lower relative growth rate at all the growth stages.

At 30 DAS, there was non-significant difference between the treatments and maximum relative growth rate (0.0829) was observed the treatment of T_9 [15 kg/ha Zinc + 1.5 kg/ha Boron], whereas the minimum relative growth rate (0.0568) was observed in treatment T_4.

At 45 DAS, there was non-significant difference between the treatments and maximum relative growth rate (0.1334) was observed the treatment T1 whereas the minimum relative growth rate of the treatment (0.1358) was observed in treatment control.

Ravindran and Silviya (2017) [28] Green gram (*Vigna radiata* L.) is an imperative legume crop in Asia.

Zinc (Zn) deficiency is a yield-limiting factor for a variety of field crops across the world. To increase zinc concentration in edible portions of food crops, foliar application of zinc containing solutions might be sustainable.

Yield Attributes

Number of pods per plant

The data on number of pods per plant of Green gram was presented in Table 3. Number of pods per plant during 60 DAS and at harvest was significantly affected due to different treatments while at 30 DAS number of pods per plant rate was significantly affected due to any treatments.

At 60 DAS, there was significant difference between the treatments and number of pods per plant (14.2) was observed the treatment T_9, [15 kg/ha Zinc + 1.5 kg/ha Boron] whereas the minimum number of pods per plant (9.8) was observed in treatment control.

Seeds/pod

At harvest significantly superior number of seeds/plant (12.51) was recorded in treatment T_9 [15 kg/ha Zinc + 0.5 kg/ha Boron] and the minimum seeds per pods were treatment control and value of the treatment (7.60) Similar, result found that maximum number of seeds per pod (7.80) was found to be maximum in treatment combination with 30 × 10 c per plant +40 kg/ha of phosphorus as compared to rest of the treatments which is beneficial for Green gram production

Test weight

At harvest significantly superior test weight (g) was recorded of the treatment in treatment T_9 and the value of the test weight maximum (39.05 g). At harvest significant minimum test weight (32.56) of the treatment no T0 were statistically par with control. Similar, investigation undertaken by Upadhyay and Singh, Anita Singh. (2016) [33] and concluded that test weight was higher in application of 60 kg P and 45 kg S/ha in green ram.

Seed yield (t/ha)

Highest (1.37 t/ha) seed yield (t/ha) was obtained with application of treatment 9 [15 kg/ha Zinc + 1.5 kg/ha Boron].

performed a field experiment on summer greengram, to study The effect of various boron levels and observed that seed yield and yield attributes significantly increase with increasing zinc up 15 kg/ ha.

Stover Yield (t/ha)

The perusal of the data of stover yield (t/ha) was recorded at harvest, is presented in Table 2 the data revels that there was a no significant difference among the treatments of stover yield.

No Significant and higher stover yield (6.37 t/ha) was recorded in treatment 9 [15 kg/ha Zinc + 1.5 kg/ha Boron]. However, treatment 3 [9 kg/ha Zinc + 1.5 kg/ha Boron] was found statistically at par.

No Significant and higher straw yield was with the application of zincmay be due to incorporation of Boron increases the availability of plant nutrients and helps in formation of organic acids through decomposition process, which develops native nutrients within the soil and increases their availability to plants for better vegetative growth and leads to increase in straw yield. Similar findings were reported by Further, significant and higher straw yield was with application of urea may be it improves plant metabolic processes, leaf photosynthetic area, it ultimately results in greater nutrient uptake by the plant, increasing seed and straw yield in green gram. Similar results were reported by Kumar, Shubham & Debbarma, Victor. (2023) [16].

Harvest index (%)

Maximum harvest index (%) was obtained with application of T_9 [15 kg/ha Zinc + 1.5 kg/ha Boron] (30.41%) while minimum (30.25%) harvest index (%) was obtained with application of T_1 [9 kg/ha Zinc + 1.5 kg/ha Boron].

Zinc also converts ammonia to nitratein crops which contribute to yield. Boron is a required for many physiological processes and plant growth, also adequate nutrition is a critical for increase yields and harvest index quality of crops. A field experiment was conducted with ten treatments to study the effect of boron (B) and zinc (Zn) in Inceptisols. Growth parameters *viz*., plant height, branches per plant and dry matter yield were significantly influenced due to treatments effects.

Table 1: Effect of zinc and boron on growth attributes

S. No	Treatment combination	Treatment combination	Branche/Plant 30-45 DAS	Nodules/plant 30-45 DAS	Dry weight (g/plant)	Crop growth rate ($g/m^2/day$) 30-45 DAS	Relative growth rate (g/g/day) 30-45 DAS
1	9 kg/ha Zinc + 0.5 kg/ha Boron	33.30	4.27	6.67	12.19	18.27	0.1334
2	9 kg/ha Zinc + 1.0 kg/ha Boron	34.40	4.40	8.07	13.04	18.77	0.1298
3	9 kg/ha Zinc + 1.5 kg/ha Boron	35.37	4.80	10.53	14.01	19.04	0.1250
4	12 kg/ha Zinc + 0.5 kg/ha Boron	36.17	5.07	12.27	14.60	19.32	0.1209
5	12 kg/ha Zinc + 1.0 kg/ha Boron	37.17	5.67	13.40	15.01	19.86	0.1185
6	12 kg/ha Zinc + 1.5 kg/ha Boron	38.60	5.93	16.03	15.58	20.51	0.1165
7	15 kg/ha Zinc + 0.5 kg/ha Boron	40.17	6.23	16.40	16.12	20.26	0.1106
8	15 kg/ha Zinc + 1.0 kg/ha Boron	41.77	6.53	17.23	16.45	21.99	0.1065
9	15 kg/ha Zinc + 1.5 kg/ha Boron	42.57	6.70	17.27	16.88	23.18	0.1010
10	Control:- 20:40:20 kg/ha	32.53	3.93	5.17	11.07	17.38	0.1358
	F test	S	S	S	S	NS	S
	SEm(±)	3.05	0.40	1.26	0.86	1.01	0.0032

Table 2: Effect of zinc and boron on growth yield attributes

S. No.	Treatment combination		Pods/plant	Seeds/pods	Test (g)weight	Seed Yield (t/ha)	Stover Yield(t/ha)	Harvest Index (%)
1	9 kg/ha Zinc + 0.5 kg/ha Boron		10.47	10.11	7.89	1.21	2.90	29.65
2	9 kg/ha Zinc + 1.0 kg/ha Boron		8.87	6.96	8.40	1.08	3.20	25.27
3	9 kg/ha Zinc + 1.5 kg/ha Boron		12.47	11.12	8.05	1.29	3.10	29.89
4	12 kg/ha Zinc + 0.5 kg/ha Boron		10.47	7.54	7.35	1.09	2.77	28.29
5	12 kg/ha Zinc + 1.0 kg/ha Boron		7.8	6.27	7.12	0.77	2.71	22.83
6	12 kg/ha Zinc + 1.5 kg/ha Boron		9.6	8.70	8.50	1.03	2.62	28.44
7	15 kg/ha Zinc + 0.5 kg/ha Boron		9.73	8.16	8.32	1.12	2.57	30.25
8	15 kg/ha Zinc + 1.0 kg/ha Boron		7.73	8.33	7.50	0.87	2.78	23.54
9	15 kg/ha Zinc + 1.5 kg/ha Boron		14.2	12.51	7.20	1.37	3.06	30.41
10	Control:- 20:40:20 kg/ha	.	9.8	7.60	32.56	1.2	2.68	30.06
		F test	S	S	S	S	NS	S
		SEm(±)	0.63	0.54	0.39	0.08	0.19	1.31
		CD (P=0.05)	1.88	1.14	1.17	0.27		3.92

Table 3: Effect of zinc and boron on growth yield of economics

S. No.	Treatment combinations	Cost of cultivation (INR/ha)	Gross return (INR/ha)	Net return (INR/ha)	B:C
1.	9 kg/ha Zinc + 0.5 kg/ha Boron	31798	93377.48	63437.488	2.12
2.	9 kg/ha Zinc + 0.5 kg/ha Boron	32194	82500.01	52560.01	1.76
3.	9 kg/ha Zinc + 1.5 kg/ha Boron	32954	96661.92	66221.92	2.18
4.	12 kg/ha Zinc + 0.5 kg/ha Boron	32419	83268.42	53128.42	1.76
5.	12 kg/ha Zinc + 1.0 kg/ha Boron	32819	59890.44	29750.44	0.99
6.	12 kg/ha Zinc + 1.5 kg/ha Boron	33219	79838.86	49198.09	1.61
7.	15 kg/ha Zinc + 0.5 kg/ha Boron	33044	86399.86	56059.86	1.85
8.	15 kg/ha Zinc + 1.0 kg/ha Boron	33444	67752.52	37412.52	1.23
9.	15 kg/ha Zinc + 1.5 kg/ha Boron	33844	105746.96	74906.96	2.43
10.	Control:- 20:40:20 kg/ha	28719	92195.88	63455.88	2.21

J. Economics

Data pertaining to the cost of cultivation, gross returns, net returns and B: C ratio as influenced by various treatment are presented in Table 3

Cost of cultivation (INR/ha)

Maximum Cost of cultivation (33844 INR/ha) was recorded in treatment 9 [15 kg/ha Zinc + 1.5 kg/ha Boron] as compared to other treatment.

Gross return (INR/ha)

Maximum Gross return (105746.96 INR/ha) was found to be highest in treatment 9 [15 kg/ha Zinc + 1.5 kg/ha Boron] as compared to other treatment.

Net return (INR/ha)

Maximum Net return (74906.96 INR/ha) was found to be highest in treatment 9 [15 kg/ha Zinc + 1.5 kg/ha Boron] as compared to other treatment.

Benefit cost ratio (B: C)

Maximum Benefit Cost Ratio (2.43) was found to be highest in treatment 9 [15 kg/ha Zinc + 1.5 kg/ha Boron] as compared to other treatment.

Maximum benefit cost ratio was recorded with the application of zinc might be due better seed and stover yield are essential in realizing the higher yield and reduction cost of cultivation. Further, increased in benefit cost ratio with application of boron may be due to improving productivity, seed quality and yield attribute. These findings are similar with those of Kumari and Mahawar (2022) [9].

Conclusions

It is concluded that application of, 15 kg/ha Zinc + 1.5 kg/ha Boron recorded highest seed yield and benefit cost ratio

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