Influence of Zinc and Humic Acid Application on Growth Parameter, Yield and Yield Components and Quality Traits of Black Gram (*Vigna mungo* L.)

ABSTRACT

A field experiment was conducted in *kharif* season during 2021-22 on the field at village Ap-Sonalagi Tq-Jath Dist- Sangli of Maharashtra through Department of Soil Science and Agricultural Chemistry College of Agriculture, Badnapur, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, with objectives, to study the influence of zinc and humic acid application on growth parameter, yield and yield components and quality traits of black gram (*Vigna mungo* L.) The field trial was conducted in Randomized Block Design with five treatments (T_1): RDF (25:50:00 N, P_2O_5, K_2O kg ha^{-1}), (T_2): RDF+ $ZnSO_4$ @ 25 kg ha^{-1}, (T_3): RDF+ $ZnSO_4$ @ 25 kg ha^{-1} + Humic Acid @ 5 kg ha^{-1}, (T_4): RDF+ $ZnSO_4$ @ 25 kg ha^{-1} + Humic Acid @ 10 kg ha^{-1}, (T_5) RDF+ $ZnSO_4$ @ 25 kg ha^{-1} + Humic Acid @ 15 kg ha^{-1} with four replications.According to the results obtained by the field investigation clearly indicated that the significantly higher plant height (44.50 cm), maximum number of branches $plant^{-1}$ (9.10), number of pods $plant^{-1}$ (26.15) and grain and straw yield (1305.00 and 2190.00 kg ha^{-1}) at harvest stage were observed in treatment (T_5) RDF+ $ZnSO_4$ @ 25 kg ha^{-1} + Humic Acid @ 15 kg ha^{-1}. In grain quality the results revealed that higher protein content (22.15%) and test weight (43.05 g) was also found in the same treatment i.e., (T_5) RDF+ $ZnSO_4$ @ 25 kg ha^{-1} + Humic Acid @ 15 kg ha^{-1} (22.15%).

Keywords: Zinc sulphate; humic acid; black gram; soil application; yield; climatic situations; deep root; black gram; pulse crop

1. INTRODUCTION

India is a premier pulse growing country. Pulses play an important role in Indian agriculture. Pulses have the capacity to fix atmospheric nitrogen and are well adapted to low fertility and limited soil moisture condition due to their deep root systems. Black gram (*Vigna mungo* L.) is one of the important pulse crop grown throughout the country. The crop is resistant to adverse climatic situations and recovers soil fertility by fixing atmospheric nitrogen in the soil. Black gram plays an important role in the Indian diet, as it covers vegetable protein and supplements in cereal based diet. (Agricultural statistics at a glance 2021). Zinc plays an important role in plant growth, it improves soil cation exchange capacity, nutrient uptake and soil reinforcement to improve tolerance against drought stress; it also optimizes fertilizer use efficiency [1]. It is needed for plant metabolic events, activates many enzymes and takes part in the metabolism of nucleic acid, lipids, proteins and carbohydrates [2]. Zinc perform as a cofactor for more than 300 enzymes and proteins which are engaged in nucleic acid metabolism, cell division, protein synthesis, gene transcription regulation and coordination of other biological mechanisms [3]. About 30% of world soils are deficient in available zinc [4] and it has emerged as an important plant nutrient limiting crop yields. In India nearly 42% of soils are deficient in available zinc [5] and it has emerged as the fourth most important nutrients after nitrogen, phosphorus, and potassium. The most efficient, commonly available and economically cheapest zinc source for correcting zinc deficiency in most crops and diverse soils is zinc sulphate hepta hydrate (ZnSO4.7H2O). Other inorganic sources of zinc include its chelates and mixtures [6]. Zinc enhances crop physiological productivity as well as photosynthetic potential. Furthermore, zinc is required for plant development and growth; it also increases seed germination and seedling vigor. Zinc increases the productivity of water usage, nodule formation mechanism and N-fixation in roots of leguminous crops.

Humic substances are the most widely distributed organic products of biosynthesis on the face of the earth, increasing the amount of carbon present in all living organisms by approximately one order of degree magnitude [7]. Humic ingredients are natural organic poly electrolytes existing in the soil humus and stabilized soil organic matter in the soil. Humic acid increases plant growth and nutrient uptake and stress tolerance in plants [8]. Potassium humate is a better source of humic acid. Its stimulation of plant growth is a function of nutrients supplies to the plant. A clear significantly optimistic trend was observed in maximizing plant height, stem diameter and root length by increasing the concentration of potassium humate [9]. Humic acid is the most complex form of organic material and it is a ready source of carbon and nitrogen. It is known as the black gold of agriculture and is increasingly becoming popular for use in agriculture. The application of humic acid in leguminous plants has important effects on plant growth which increases photosynthetic activity [10]. Humic acid stimulates plant growth through the incorporation of major and minor elements, enzyme activation or inhibition which resulting increase in protein synthesis [11]. Humic acid is also perfect for increase the plant growth through chelating various nutrients subsequent increase in production of hormone. Humic acid formed from humic substances, known as humus, is a common plant biostimulant that helps to plant growth and development through nutrition, hormones, and elicitor paths.

2. MATERIALS AND METHODS

A field experiment was conducted in *kharif* season during 2021-22 at village Ap- Sonalagi Tq-Jath Dist- Sangli of Maharashtra through Department of Soil Science and Agricultural Chemistry College of Agriculture, Badnapur, VNMKV, Parbhani, to study the influence of zinc and humic acid application on growth parameter, yield and yield components and quality traits of black gram (*Vigna mungo* L.).After completion of preparatory tillage operations, the experimental units were laid out as per plan in randomized block design (RBD) with five treatments. The layout consists of 20 experimental plots in four replications. The treatments comprises (T_1): RDF (25:50:00 N, P_2O_5, K_2O kg ha^{-1}), (T_2): RDF+ $ZnSO_4$ @ 25 kg ha^{-1}, (T_3): RDF+ $ZnSO_4$ @ 25 kg ha^{-1} + Humic Acid @ 5 kg ha^{-1}, (T_4): RDF+ $ZnSO_4$ @ 25 kg ha^{-1} + Humic Acid @ 10 kg ha^{-1}, (T_5) RDF+ $ZnSO_4$ @ 25 kg ha^{-1} + Humic Acid @ 15 kg ha^{-1}.

Black gram seed variety 'BDU- was sown 08 July, 2021. The sowing was done by dibbling with 2 seeds per hill at a distance of row to row 30 cm and plant to plant 10 cm (30 cm x 10 cm) at about 3.0 cm depth as per randomly replicated plot having size 4.5 x 4.0 m^2 and 3.9 x 3.6 m^2 in gross and net plot size respectively . All the plots were fertilized with recommended dose of the NPK. Dose of the NPK for black gram was worked out according to the present recommendation of Black gram crop. The 100 (%) NPK dose in kg ha^{-1} worked out was 25:50:00 for Black gram crop. The sources used for applying N, P, Zn were urea, single super phosphate, ZnSO4. The crop was raised with all the standard package of practices and protection measures also timely carried out as they required. The crop of net plot area was harvested at physiological maturity stage on 08 September 2021. The crop was harvested by uprooting the plants and kept for sun drying on threshing floor for few days. After sun drying of harvested plants of net plot area are threshed by threshing machine.

Five plants from each plot were randomly selected and used for recording biometric observations viz. plant height (cm), number of branches at harvest $plant^{-1}$, number of root nodules at flowering stage $plant^{-1}$, root length (cm) at harvest, and number of pods plant-1, grain and straw yield of black gram at harvest stage. Quality parameter like test weight value and protein content (%) were recorded. The data collected from the above observation were analysed statistically by the procedure prescribed by Panse and Sukhatme [12].

3. RESULTS AND DISCUSSION

3.1 Growth Contributing Parameter of Black Gram as Influenced by the Application of Zinc and Humic Acid

3.1.1 Plant height (cm) at harvest

The height of black gram monitored at harvest stage of the crop. The observations recorded under different treatments are presented in Table 1. Significant variation was observed on the plant height of black gram with all the treatments over treatment (T_1). The plant height was statistically significant and highest in treatment T_5 (44.50 cm) RDF+ $ZnSO_4$ @ 25 kg ha^{-1} + Humic Acid @ 15 kg ha^{-1} as compared to the all treatments including RDF treatment T_1. It was statistically at par with treatment T_4) RDF+$ZnSO_4$ @ 25 kg ha^{-1} + Humic Acid @ 10 kg ha^{-1} (44.10 cm). Treatment T_1 RDF (25:50:00 N, P_2O_5, K_2O kg ha^{-1}) recorded lowest plant height (34.35 cm) among all treatments followed by treatment T_2 (37.80 cm) which was at par with T_3 (40.67 cm).

The increase in plant height might be due to increase in the availability of nutrients with the soil application of different concentrations of zinc and humic acid over the RDF treatment T_1. Zinc application in soil contributed in increase in plant height probably owing to its influence on auxin synthesis, nodulation and N fixation, which promoted plant growth and development.

Table 1. Effect of zinc and humic acid application on plant height of black gram

Treatments	Plant height (cm) at harvest
T1: RDF (25:50:00 N, P2O5, K2O kg ha^{-1})	34.35
T2 : RDF+ZnSO4 @ 25 kg ha^{-1}	37.80
T3 : RDF+ZnSO4 @ 25 kg ha^{-1} + Humic Acid @ 5 kg ha^{-1}	40.67
T4 : RDF+ZnSO4 @ 25 kg ha^{-1} + Humic Acid @ 10 kg ha^{-1}	44.10
T_5 : RDF+ZnSO4 @ 25 kg ha^{-1} + Humic Acid @ 15 kg ha^{-1}	44.50
SE(m)±	**1.01**
CD at 5%	**3.12**

The results are in accordance with the finding of Kumar et al. [13] with application of 25 kg Zn significantly increased the plant height (49.51 cm). According to Singaroval et al. [14], humic acid has growth promoting effect; secondly it could be the cause of establishment and improvement in soil conditions. Similar findings were obtained by Pradhan et al. [15] due to application of ZnSO4 @ 25 kg ha^{-1} in black gram recorded maximum plant height (26.23 cm). According to Sritharan et al. [16] reported that application of humic acid @ 15 Kg ha^{-1} significantly increased the plant height (43.62) over control in green gram.

3.1.2 Number of branches at harvest plant^{-1}

The number of branches plant^{-1} of black gram was recorded at harvest stage and presented in Table 2. It was observed that there was significantly more number of branches plant^{-1} were observed in treatment T_5 (9.10) RDF+ $ZnSO_4$ @ 25 kg ha^{-1} + Humic Acid @ 15 kg ha^{-1} which was found statistically at par with treatment T_4 (8.90) RDF+ $ZnSO_4$ @ 25 kg ha^{-1} + Humic Acid @ 10 kg ha^{-1}. However, treatment T_1 (5.30) RDF (25:50:00 N, P_2O_5, K_2O kg ha^{-1}) recorded less number of branches plant^{-1} among all the treatments followed by treatment T_2 (6.25) and treatment T_3 (7.50). The increase in number of branches plant^{-1} might be due the soil application of zinc and humic acid. Humic acid which stimulated the metabolic and physiological activities of the plant, eventually reached maximum branches.

Similar findings were reported by Jape et al. [17] the use of humic acid was found to be efficient in boosting the number of branches plant^{-1} in groundnut. The results were also confirmed with the findings of Pradhan et al. [15] due to application of $ZnSO_4$ @ 25 kg ha^{-1} was recorded maximum number of branches (4.67) in black gram.

3.1.3 Number of root nodules at flowering stage plant^{-1}

The influence of soil application of zinc and humic acid on the number of root nodules of black gram was recorded at the flowering stage. The data presented in Table 2. More number of root nodules plant^{-1} were observed in treatment T_5 (27.10) RDF+ $ZnSO_4$ @ 25 kg ha^{-1} + Humic Acid @ 15 kg ha^{-1} which was at par with treatment T_4 (26.75) RDF+ $ZnSO_4$ @ 25 kg ha^{-1} + Humic Acid @ 10 kg ha^{-1}. However, treatment T_3 (23.98) and treatment T_2 (22.67) were found at par with each other. Treatment T_1 (20.10) RDF (25:50:00 N, P_2O_5, K_2O kg ha^{-1}) recorded less number of root nodules plant^{-1} among all treatments. The use of humic acid had a positive impact and specific for nodule. Humic acid has high cation exchange capacity inhibits the leaching of nutrients. The increase in number of nodules per plant may be due to favourable effects of micronutrient in improving the soil fertility through positive effects on physical, chemical and biological soil properties.

Similar results were noted by as Dash et al. [18] who reported that number of root nodules, found to be significantly higher with application of RDF + Zn 5 kg ha^{-1}. Findings of Dandge et al. [19] were also similar to ours treatments, which had recorded highest number of nodules (32.17) as well as fresh and dry weight of nodules with application of (100% RDF + 6% humic acid).

3.1.4 Root length (cm) at harvest

The data presented in Table 3 revealed that the influence of zinc and humic acid on root length (cm) which was measured at harvest stage of black gram. Soil application of zinc and humic acid significantly influenced root length (cm) in treatment T_5 (26.25 cm) RDF+ZnSO4 @ 25 kg ha^{-1} + Humic Acid @ 15 kg ha^{-1}) was found superior than the rest of the treatments and in terms of statistics it was at par with treatment T_4 (25.85 cm) RDF+$ZnSO_4$ @ 25 kg ha^{-1} + Humic Acid @ 10 kg ha^{-1}. However, treatment T_3 (23.75 cm) and treatment T_2 (22.70 cm) were found statistically at par to each other. The treatment T_1 (20.30 cm) RDF (25:50:00 N, P_2O_5, K_2O kg ha^{-1}) recorded lowest root length as compared to all treatments. This increase in root length could be attributed to the use of humic acid which had improved the plant's root development and resulted in maximum root growth.

According to Jack, A. and Hartwigsenand, M.R. [20] found increase in internal root growth, primarily from the lower hypocotyl and resulted in increased total length of lateral root and enhanced rhizobium activity in legumes. This may be cause of effective nutrient management in the green gram ecosystem by rational application of humic acid along with micro and macronutrients. Similar results are also noted by Meganid et al*.* [21] recorded maximum root length (24.08 cm) in common bean plants.

Table 2. Effect of zinc and humic acid application on number of branches at harvest plant^{-1} and number of root nodules at flowering stage plant^{-1}

Treatments	Number of branches plant^{-1}	Number of root nodules plant^{-1}
T_1: RDF (25:50:00 N, P2O5, K2O kg ha^{-1})	5.30	20.10
T_2 : RDF+ZnSO4 @ 25 kg ha^{-1}	6.25	22.67
T_3 : RDF+ZnSO4 @ 25 kg ha^{-1} + Humic Acid @ 5 kg ha^{-1}	7.50	23.98
T_4 : RDF+ZnSO4 @ 25 kg ha^{-1} + Humic Acid @ 10 kg ha^{-1}	8.90	26.75
T_5 : RDF+ZnSO4 @ 25 kg ha^{-1} + Humic Acid @ 15 kg ha^{-1}	9.10	27.10
SE(m)±	**0.20**	**0.81**
CD at 5%	**0.61**	**2.48**

Table 3. Effect of zinc and humic acid application on root length (cm) and number of pods plant^{-1} at harvest

Treatments	Root length (cm) at harvest	Number of pods plant^{-1}
T_1: RDF (25:50:00 N, P2O5, K2O kg ha^{-1})	20.30	17.30
T_2 : RDF+ZnSO4 @ 25 kg ha^{-1}	22.70	20.22
T_3 : RDF+ZnSO4 @ 25 kg ha^{-1} + Humic Acid @ 5 kg ha^{-1}	23.75	22.80
T_4 : RDF+ZnSO4 @ 25 kg ha^{-1} + Humic Acid @ 10 kg ha^{-1}	25.85	25.70
T_5 : RDF+ZnSO4 @ 25 kg ha^{-1} + Humic Acid @ 15 kg ha^{-1}	26.25	26.15
SE(m)±	0.66	**0.66**
CD at 5%	2.03	**2.03**

3.2 Yield Contributing Parameter of Black Gram as Influenced by the Application of Zinc and Humic Acid

3.2.1 Number of pods plant^{-1}

The data was collected and presented in Table 3 on number of pod plants^{-1} of black gram. Plants with a certain number of pods were affected by zinc and humic acid application to soil along with RDF. It was revealed that there was a continuous rise in number of pods plants^{-1} in black gram due to the soil application of zinc and humic acid. Significantly higher number of pods plant^{-1} were observed in treatment T5 (26.15) RDF+ ZnSO4 @ 25 kg ha^{-1} + Humic Acid @ 15 kg ha^{-1} as compared to all treatments including RDF i.e. T1. Which was found statistically at par with treatment T4 (25.70) RDF+ ZnSO4 @ 25 kg ha^{-1} + Humic Acid @ 10 kg ha^{-1} followed by treatment T3 (22.80) and treatment T2 (20.22). However, Treatment T1 (17.30) RDF (25:50:00 N, P2O5, K2O kg ha^{-1}) recorded the lowest number of pods plant^{-1}. These results could be attributed to application of humic acid which was a strong source of nitrogen and phosphorus for early-stage growth, greater blooming and ultimately an increase in pod number and also improvement in the pod bearing capacity. Soil application of zinc and humic acid also increased vegetative and reproductive growth of the black gram resulting in higher number of pods $plant^{-1}$.

The results are in accordance with Vigneshvarraj et al. [22] who assessed the effect of ZnSO4 @ 25 kg ha^{-1} on number of pods $plant^{-1}$(25.33). Similar results were reported by Sritharan et al. [16] who concluded that the application of ZnSO4 @ 0.5% and Humic Acid @ 20 kg ha^{-1} was recorded higher pod numbers (28.14). Nandini et al. [23] studied the effect of humic acid (Humic Acid @ 15 kg ha^{-1}) on number of pods $plant^{-1}$ (26.13) of black gram.

3.2.2 Grain yield (q ha^{-1})

The grain yield (kg ha^{-1}) of black gram was recorded at harvest stage of the crop. Observations under different treatments of soil application of zinc and humic acid are presented in Table 4. Statistically significant variation was observed in different treatment s of soil application of zinc and humic acid on grain yield (kg ha^{-1}) of black gram.The maximum grain yield (kg ha^{-1}) was observed in the treatment T5 (1305.00 kg ha^{-1}) RDF+ ZnSO4 @ 25 kg ha^{-1} + Humic Acid @ 15 kg ha^{-1} which was superior among all the treatments including RDF treatment i.e T1, Which was found at par with treatment T4 (1295.00 kg ha^{-1}) followed by treatment T3 (1140.00 kg ha^{-1}) and T2 (1050.00 kg ha^{-1}). However, significantly lowest grain yield (kg ha^{-1}) was observed in treatment T1 (980.00 kg ha^{-1}) RDF (25:50:00 N, P2O5, K2O kg ha^{-1}) as compared to all treatments.

The data clearly indicated that addition of soil application of zinc and humic acid with RDF was found to be beneficial for maintaining the fertility of the soil as well as subsequently improving the productivity potential of black gram. This may be attributed to fast photosynthesis or nutrient transfer to the grain. Also, same results were noted by Nandini et al. [23] concluded that addition of humic Acid @ 15 kg ha^{-1} increased the grain yield of black gram (1319 kg ha^{-1}) over the control. Usman et al. [24] conducted field experiment for study the effect of RDF+ ZnSO4 @ 20 kg ha^{-1} on green gram and recorded maximum yield (1208.07 kg ha^{-1}).

3.2.3 Straw yield (Kg ha^{-1})

The data regarding to stover / straw yield (kg ha^{-1}) of black gram interpreted in Table 4. Stover / straw yield (kg ha^{-1}) was found statistically significant in the treatment T5 (2190.00 kg ha^{-1}) RDF+ ZnSO4 @ 25 kg ha^{-1} + Humic Acid @ 15 kg ha^{-1} was found superior as compared to the all treatments. Which was at par with treatment T4 (2115.00 kg ha^{-1}) RDF+ ZnSO4 @ 25 kg ha^{-1} + Humic Acid @ 10 kg ha^{-1} However, treatment T3 (1895.00 kg ha^{-1}) and T2 (1887.50 kg ha^{-1}) were found at par with each other. The lowest stover / straw yield was found in treatment T1 (1698.75 kg ha^{-1}). RDF (25:50:00 N, P2O5, K2O kg ha^{-1}) Soil application of humic acid (HA) when externally supplied was observed to increase crop growth and ultimately increased the stover yield kg ha^{-1}.

Similar findings were made by Wasmatkar et al. [25] with the application of 5 kg Zn ha^{-1} recorded higher straw yield (2472 kg ha^{-1}) than control.

3.3 Seed Quality Contributing Parameter of Black Gram as Influenced by the Application of Zinc and Humic Acid

3.3.1 Test weight (gm)

The effect of zinc and humic acid on the test weight (g) of black gram presented in Table 2 revealed that there was a continuous increase in the test weight of black gram due to soil application of zinc and humic acid. The test weight (g) was significantly highest in treatment T_5 (43.05 g) RDF+$ZnSO_4$ @ 25 kg ha^{-1} + Humic Acid @ 15 kg ha^{-1} which was found at par with treatment T_4 (42.20 g) RDF+ $ZnSO_4$ @ 25 kg ha^{-1} + Humic Acid @ 10 kg ha^{-1} followed by treatment T_3 (40.35 g) and T_2 (38.30 g). However, treatment T_1 (36.30 g) RDF (25:50:00 N, P_2O_5, K_2O kg ha^{-1}) recorded lowest test weight among the all treatments. The increased rate of photosynthesis and symbiotic activity stimulated better vegetative and reproductive growth of crop, resulting in higher test weight (g) of black gram. This could be one reason why humic acid application increased seed weight due to improved nutrient mobilization to seed.

Similar findings were obtained by Yadav et al. [26] who revealed that, maximum test weight of black gram (36.78 g) was obtained by application of ZnSO4 @ 5 kg ha^{-1}. Similarly, Thakur et al. [27] observed effect of zinc 0.5% on test weight (46.9 g) of black gram.

3.3.2 Protein content (%)

The observation data on protein content (%) is represented in Table 2. Significantly higher protein content (%) was found in treatment T5 (22.15%) RDF+ ZnSO4 @ 25 kg ha^{-1} + Humic Acid @ 15 kg ha^{-1} which was found at par with treatment T4 (22.05%) RDF+ $ZnSO_4$ @ 25 kg ha^{-1} + Humic Acid @ 10 kg ha^{-1}. However, treatment T1 (19.25%) RDF (25:50:00 N, P2O5, K2O kg ha^{-1}) was found inferior as compared to all treatments followed by treatment T2 (20.23%) and T3 (21.35%). The soil application of Zinc and humic acid is one of the reasons for the raise in protein content. Humic acid has direct and indirect impacts on plant growth, as it changes membranes and improves transport of nutritional element, improved photosynthesis and micronutrient solubilization resulting in improved protein synthesis.

Similar findings had also been noted by Yadav et al*.* [26] application of ZnSO4 @ 5 kg ha^{-1} recorded higher protein content (21.55%). Thenmozhi et al. [11] discovered that using humic acid at @ 20 kg ha^{-1} in combination with 100 percent RDF improved the crude protein content (21.02%) of groundnut. Tripura et al. [28] also reported increased protein content (24.75%) in cowpea.

Table 4. Effect of zinc and humic acid application on grain yield (Kg ha^{-1}) and stover yield (q ha^{-1}) in black gram

Treatments	Grain yield (Kg ha^{-1})	Stover yield (Kg ha^{-1})
T_1: RDF (25:50:00 N, P2O5, K2O kg ha^{-1})	980.00	1698.75
T_2 : RDF+ZnSO4 @ 25 kg ha^{-1}	1050.00	1887.50
T_3 : RDF+ZnSO4 @ 25 kg ha^{-1} + Humic Acid @ 5 kg ha^{-1}	1140.00	1895.00
T_4 : RDF+ZnSO4 @ 25 kg ha^{-1} + Humic Acid @ 10 kg ha^{-1}	1295.00	2115.00
T_5 : RDF+ZnSO4 @ 25 kg ha^{-1} + Humic Acid @ 15 kg ha^{-1}	1305.00	2190.00
SE(m)±	**35.31**	**59.99**
CD at 5%	**108.80**	**184.86**

Table 5. Effect of zinc and humic acid application on Test weight (gm) an protein content (%) in black gram

Treatments	Test weight (g)	Protein content (%)
T_1: RDF (25:50:00 N, P2O5, K2O kg ha^{-1})	36.30	19.25
T_2 : RDF+ZnSO4 @ 25 kg ha^{-1}	38.30	20.23
T_3 : RDF+ZnSO4 @ 25 kg ha^{-1} + Humic Acid @ 5 kg ha^{-1}	40.35	21.35
T_4 : RDF+ZnSO4 @ 25 kg ha^{-1} + Humic Acid @ 10 kg ha^{-1}	42.20	22.05
T_5 : RDF+ZnSO4 @ 25 kg ha^{-1} + Humic Acid @ 15 kg ha^{-1}	43.05	22.15
SE(m)±	**0.91**	**0.13**
CD at 5%	**2.81**	**0.41**

4. CONCLUSION

It can be concluded that a significant impact on the black gram by the application of Zinc @ 25 kg ha^{-1} and humic acid@ 15 kg ha^{-1} along with recommended dose of NPK (25:50:00 kg ha-1) (T_5) and found effective to its advantageous effect on improved growth attributes, grain yield attributes and seed quality of black gram.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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