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Effect of Secondary, Micro Nutrients and Naphthalene Acetic Acid (NAA) on Yield and Quality of Summer Blackgram [*Vigna mungo* (L.) Hopper]

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Abstract The experiment consisted of two levels of sulfur (20 and 40 kg ha^{-1}), zinc (2.5 and 5 kg ha^{-1}), molybdenum (1 kg ha^{-1}) and NAA (40 ppm) with 15 treatments replicated thrice in a randomized block design. Application of 40 kg S ha^{-1} + 5.0 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1} + 40 ppm NAA significantly increased yield and quality parameters viz., number of pods $plant^{-1}$ (31.46), seed yield (8.63 q ha^{-1}), stover yield (23.73 q ha^{-1}) and harvest index (36.39) while number of seeds pod^{-1}, test weight were non-significant. Similarly application of 40 kg S ha^{-1} + 5.0 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1} + 40 ppm NAA recorded highest protein content (24.73%) while lowest protein content was obtained in treatment T_1 (control) respectively.

Keywords Blackgram, NNA, Ppm, DAC and FW, (IYP).

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Introduction

Blackgram is scientifically known as *Vigna mungo* (L.) and commonly known as urd in India. Blackgram seeds are highly nutritious with protein (25-26%), carbohydrates (60%) , fat (1.5%), minerals, amino acids and vitamins. Sulfur is recognized as fourth major plant nutrient along with N, P, K, perform many important functions in the plant and plays an important role in improving yield and quality of pulses. Sulfur is also known to promote nodulation in legumes thereby enhancing the N fixation. It is a constituent of free amino acid such as methionine, cysteine and plays a vital role in protein synthesis [1]. Zinc plays an important role in the synthesis of protein and nucleic acid and helps in the utilization of the nitrogen and phosphorus in plant. It promotes root nodulation and nitrogen fixation in legume crop and it also plays a vital role in starch formation and protein content increased with the use of zinc application in the grains [2]. Molybdenum is one of the most recognized micronutrient elements as a constituent of nitrate reductase and nitrogenase enzymes, molybdenum directly influences nitrogen assimilation and its fixation in pulse crop. The main role of NAA rests with the efficient transport of sugars from the photosynthesizing parts of the plant (Source) to the developing grains (Sinks).

Materials and Methods

A field experiment was conducted during summer season 2015 at the Crop Research farm, Department of

Table 1. Effect of secondary, micro Nutrients and NAA on yield and attributes of blackgram.

	Treatments	No. of pods plant^{-1}	Seed yield (q ha^{-1})	Stover yield (q ha^{-1})	Harvest index (%)
T_1	Control	23.93	29.13	13.33	16.86
T_2	20 kg S ha^{-1}	24.53	30.53	13.4	16.93
T_3	40 kg S ha^{-1}	24.47	30.27	13.87	17
T_4	20 kg S ha^{-1} + 2.5 kg Zn ha^{-1}	25.2	31	13.93	17.4
T_5	40 kg S ha^{-1} + 2.5 kg Zn ha^{-1}	26.93	32.67	14.06	17.8
T_6	20 kg S ha^{-1} + 5.0 kg Zn ha^{-1}	25.2	31.07	14	17.53
T_7	40 kg S ha^{-1} + 5.0 kg Zn ha^{-1}	26.07	32.2	14.26	17.93
T_8	20 kg S ha^{-1} + 2.5 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1}	26.6	32.4	14.4	18.06
T_9	40 kg S ha^{-1} + 2.5 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1}	27.33	33.8	14.66	18.33
T_{10}	20 kg S ha^{-1} + 5.0 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1}	26.93	33.2	14.43	18.2
T_{11}	40 kg S ha^{-1} + 5.0 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1}	29.6	37.33	15.2	19.06
T_{12}	20 kg S ha^{-1} + 2.5 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1}+40 ppm NAA	27.87	34.47	14.73	18.53
T_{13}	40 kg S ha^{-1} + 2.5 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1}+40 ppm NAA	30.07	37.8	15.26	19.13
T_{14}	20 kg S ha^{-1} + 5.0 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1}+40 ppm NAA	28.8	36.87	14.8	18.66
T_{15}	40 kg S ha^{-1} + 5.0 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1}+40 ppm NAA	31	39.33	15.53	19.4
	CD at 5%	1.88	0.32	1.48	2.57
	CV (%)	4.69	2.97	4.35	4.91

Agronomy, Allahabad School of Agricultural, Sam Higginbottom Institute of Agriculture Technology and Sciences, Allahabad. The soil was sandy loam in texture having a pH (7.3), EC (0.26), organic carbon (0.40%), available N (250 kg ha^{-1}), P (13.50 kg ha^{-1}), K (313 kg ha^{-1}), S (13.93 kg ha^{-1}), and Zn (0.50 pp,) during the experimental year. The experiment was laid down in randomized block design (RBD) with two levels of sulfur (20 and 40 kg S ha^{-1}) and zinc (2.5 and 5 kg Zn ha^{-1}) and one level of Molybdenum (1 kg ha^{-1}) and NAA (40 ppm) with 15 treatments and 3 replications. The treatment consisted of T_1 : (control), T_2 : 20 kg S ha^{-1}, T_3 : 40 kg S ha^{-1}, T_4 : 20 kg S ha^{-1} + 2.5 kg Zn ha^{-1}, T_5 : 40 kg S ha^{-1} + 2.5 kg Zn ha^{-1}, T_6 : 20 kg S ha^{-1} + 5.0 kg Zn ha^{-1}, T_7 : 40 kg S ha^{-1} + 5.0 kg Zn ha^{-1}, T_8 : 20 kg S ha^{-1} + 2.5 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1}, T_9 : 40 kg S ha^{-1} +2.5 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1}, T_{10} : 20 kg S ha^{-1} S ha^{-1} + 5.0 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1}, T_{11} : 40 kg S ha^{-1} + 5.0 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1}, T_{12} : 20 kg S ha-1 + 2.5 kg Zn ha-1 + 1.0 kg Mo ha^{-1} + 40 ppm NAA, T_{13} : 40 kg S ha^{-1} + 2.5 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1} + 40 ppm NAA, T_{14} : 20 kg S ha^{-1} + 5.0 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1} + 40 ppm NAA, T_{15} : 40 kg S ha^{-1} + 5.0 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1} + 40 ppm NAA. Sulfur, zinc, molybdenum, and NAA were applied through gypsum, zinc sulfate,ammonium molybdate and α–Naphthalene acetic acid as per treatment and incorporated in soil followed by irrigation to ensure microbial activities to hasten oxidation of sulfur. To reduce the weed infestation, one hand weeding was carried out at 25 DAS. A total of 3 irrigations were applied at critical stages of the crop. In order to determine protein in seeds Kjeldahl's digestion and distillation procedure was followed to determine nitrogen in seeds. Then the protein content of the grain was determined by multiplying the nitrogen content of grain by 6.25. Year wise data was subjected to statistical analysis separately by using analysis of variance technique. The difference among treatment means was compared by using least significant difference test at 5% probability levels.

Results and Discussion

Yield and yield attributes

The observations regarding yield attributes are being presented in Table 1 and Figure 1. A perusal of data in Table 1 reveals that among the yield attributes number of pods per plant^{-1} grain yield (q ha^{-1}), stover yield (q ha^{-1}) and harvest index (%) was observed statistically significant difference between the treatments while, no of seeds per pod^{-1}, test weight (g), was observed no significant difference between the treatments.

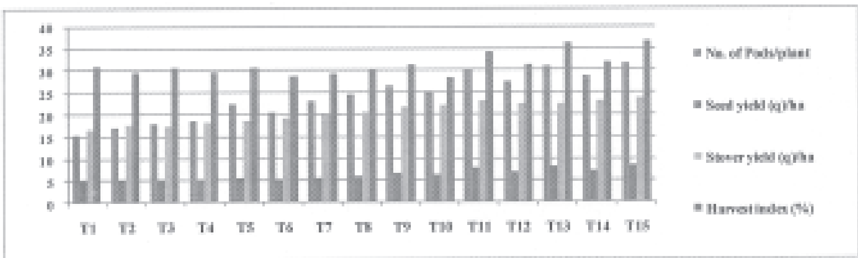

Fig. 1. Effect of secondary, micro nutrients and NAA on yield of blackgram.

Maximum number of pods plant^{-1} (31.46) were recorded in treatment T_{15} (40 kg sulfur ha^{-1}+ 5.0 kg zinc ha^{-1} + 1.0 kg molybdenum ha^{-1} + 40 ppm NAA) while, minimum number of pods plant^{-1} (15.33) were recorded in treatment T_1 (control). However, treatment T_{11} was found to be statistically at par to treatment T_{15}.

Highest grain yield (8.63 q ha^{-1}) was recorded in treatment T_{15} (40 kg sulfur ha^{-1} + 5.0 kg zinc ha^{-1} + 1.0 kg molybdenum ha^{-1} + 40 ppm NAA) while, lowest grain yield (5.13 q ha^{-1}) were recorded in treatment T_1 (control). However treatment T_{13} was found to be statistically at par to treatment T_{15}.

Highest stover yield (23.73q ha^{-1}) was recorded in treatment T_{15} (40 kg sulfur ha^{-1} + 5.0 kg zinc ha^{-1} + 1.0 kg molybdenum ha^{-1} + 40 ppm NAA) while, lowest stover yield (16.62 q ha^{-1}) was recorded in treatment T_1 (control). However treatment T_{14}, T_{11} and T_{13} were found to be statistically at par to treatment T_{15}.

Highest harvest index (36.39%) was recorded in treatment T_{15} (40 sulfur ha^{-1} + 5.0 kg zinc ha^{-1} + 1.0 kg molybdenum ha^{-1} + 40 ppm NAA) while, lowest harvest index (28.44%) was recorded in treatment T_{10} (20 kg sulfur ha^{-1} + 5.0 kg zinc ha^{-1} +1.0 kg molybdenum ha^{-1}). However treatment T_{13} and T_{11} were found to be statistically at par to treatment T_{15}. The probable reason may be due to beneficial effect of sulfur, zinc, molybdenum and NAA. Similar findings were also reported by Dhanushkodi et al. [1] the factor which are directly responsible for ultimate grain production pods/plant, were increased almost significantly due to increased supply of 40 kg S ha^{-1} + 5.0 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1} + 40 ppm NAA. Closer results are confined with Marko et al. [3] NAA at 40 ppm was found to be effective in increase number of pods per plant, number of grains per pod, dry matter and grain yield. Similar results were reported by Kadam et al. [4].

Quality analysis

Protein content (%)

The observation regarding protein content in seed are being presented in the Table 2 and Figure 2. High-

Table 2. Effect of secondary, micro nutrients and NAA on protein content (%) of blackgram.

	Treatments	Protein (%)
T_1	Control	21.97
T_2	20 kg S ha^{-1}	22.17
T_3	40 kg S ha^{-1}	22.13
T_4	20 kg S ha^{-1}+ 2.5 kg Zn ha^{-1}	22.53
T_5	40 kg S ha^{-1}+ 2.5 kg Zn ha^{-1}	22.33
T_6	20 kg S ha^{-1}+ 5.0 kg Zn ha^{-1}	22.47
T_7	40 kg S ha^{-1} + 5.0 kg Zn ha-^{1}	22.47
T_8	20 kg S ha^{-1} + 2.5 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1}	22.87
T_9	40 kg S ha^{-1} + 2.5 kg Zn ha^{-1} +1.0 kg Mo ha^{-1}	24.07
T_{10}	20 kg S ha^{-1} + 5.0 kg Zn ha^{-1} +1.0 kg Mo ha^{-1}	23.33
T_{11}	40 kg S ha^{-1} + 5.0 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1}	23.93
T_{12}	20 kg S ha^{-1} + 2.5 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1} +40 ppm NAA	23.27
T_{13}	40 kg S ha^{-1} + 2.5 kg Zn ha^{-1}+ 1.0 kg Mo ha^{-1} + 40 ppm NAA	24.67
T_{14}	20 kg S ha^{-1} + 5.0 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1} + 40 ppm NAA	24.13
T_{15}	40 kg S ha^{-1} + 5.0 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1} 40 ppm NAA	24.73
	CD at 5%	0.47
	CV (%)	1.21

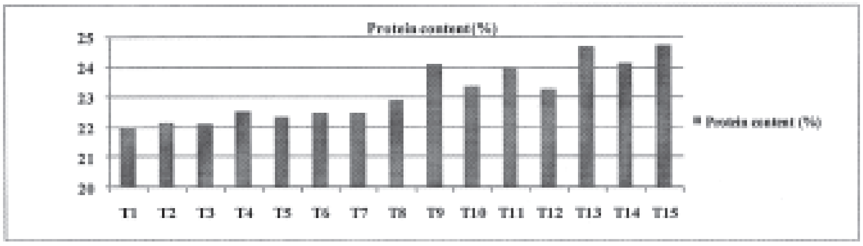

Fig. 2. Effect of secondary, micro nutrients and NAA on protein content (%) of blackgram.

est protein content (24.73%) were recorded in treatment T_{15} (40 kg sulfur ha^{-1} + 5.0 kg zinc ha^{-1}+ 1.0 kg molybdenum ha^{-1} + 40 ppm NAA), while lowest protein content (21.97) was recorded in treatments T_1 (control). However treatment T_{14}, T_{11} and T_{13} were found to be statistically at par to treatment T_{15}. The probable reason may be due to beneficial effect of sulfur, zinc, molybdenum and NAA. Sulfur in the synthesis of chloroplast protein resulting in greater photosynthetic efficiency which in turn translated in terms of increase in yield. Deo and Khaldelwal [5] reported similar results in summer moong and chickpea, respectively.

Maximum increase of 24.8% in protein content was obtained when 6 kg Zn and 30 kg S ha^{-1} were applied together; the increase was 7.1% over control (23.21%). It was observed that as the levels of S increased from 0 to 30 kg ha^{-1}, there was a significant increase in the protein yield in grain. These findings are in confirmation with those of Singh and Yadav [6]. Zinc application also increased the protein yield significantly over control. Maximum protein yield was recorded with 30 kg S applied in combination with 6 kg Zn ha^{-1}.

Available nutrients in soil after harvest of blackgram

The observations regarding total available nutrients after harvest (kg ha^{-1}) of blackgram is presented in Table 3 and Figure 3. According to data pertaining to available nitrogen revel that application of secondary, micro nutrients and naphthalene acetic acid (NAA) had significantly influence on available soil nitrogen status after harvest of the crop. Data indicated that significantly higher available nitrogen after blackgram crop was recorded with treatment T_{15} 40 kg S ha^{-1} + 5.0 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1} + 40 ppm NAA and lowest nitrogen after blackgram crop was recorded in (control). However treatment T_{11}, T_{13} and T_9 are on par with T_{15}. This could be attributed to sulfur is a constituent of ferrodoxin-containing nitrogenase, which takes part in the biological nitrogen fixation resulting the highest number of nodules

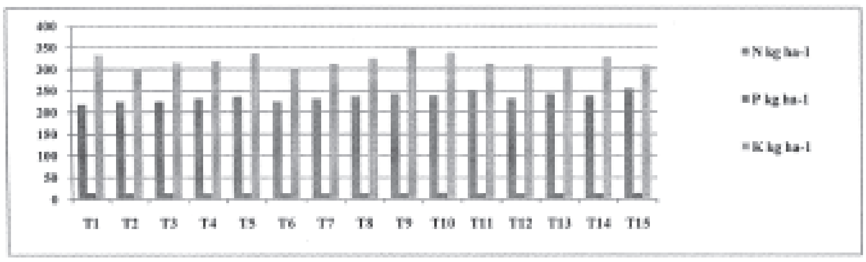

Fig. 3. Effect of secondary, micro nutrients and NAA on available nutrients (NPK) after harvest of blackgram.

Table 3. Available nutrients pre harvest of blackgram.

	Treatments	N kg ha^{-1}	P kg ha^{-1}	K kg ha^{-1}	S ppm	Zn ppm	Fe ppm	Mn ppm	Cu ppm
T_1	Control	212	14.65	333	13.36	0.51	10.01	6.02	0.87
T_2	20 kg S ha^{-1}	218	14.50	302	13.40	0.50	10.01	6.03	0.86
T_3	40 kg S ha^{-1}	218	14.30	315	13.41	0.50	10.01	6.06	0.85
T_4	20 kg S ha^{-1} + 2.5 kg Zn ha^{-1}	225	14.00	319	13.40	0.49	10.02	6.00	0.85
T_5	40 kg S ha^{-1} + 2.5 kg Zn ha^{-1}	225	14.10	336	13.39	0.51	10.01	6.09	0.84
T_6	20 kg S ha^{-1} + 5.0 kg Zn ha^{-1}	218	13.50	301	13.38	0.49	10.01	6.04	0.84
T_7	40 kg S ha^{-1} + 5.0 kg Zn ha^{-1}	225	13.50	313	13.40	0.51	10.00	6.04	0.85
T_8	20 kg S ha^{-1} + 2.5 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1}	231	14.40	325	13.37	0.50	10.02	6.01	0.84
T_9	40 kg S ha^{-1} + 2.5 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1}	237	14.60	347	13.38	0.51	10.04	6.07	0.84
T_{10}	20 kg S ha^{-1} + 5.0 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1}	231	15.00	338	13.37	0.48	10.04	6.00	0.83
T_{11}	40 kg S ha^{-1} + 5.0 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1}	240	13.80	312	13.38	0.51	10.01	6.02	0.85
T_{12}	20 kg S ha^{-1} + 2.5 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1} + 40 ppm NAA	231	14.00	310	13.39	0.52	10.00	6.00	0.84
T_{13}	40 kg S ha^{-1} + 2.5 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1} + 40 ppm NAA	237	14.20	305	13.41	0.47	10.03	6.02	0.83
T_{14}	20 kg S ha^{-1} + 5.0 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1} + 40 ppm NAA	231	14.00	329	13.40	0.51	10.01	6.04	0.84
T_{15}	40 kg S ha^{-1} + 5.0 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1} + 40 ppm NAA	238	14.60	309	13.38	0.49	10.02	6.00	0.83

plant^{-1} and nitrogen to the soil. Similar finding was also reported by Khan et al. [2]. Zinc increases the number of nodules it might be due to the enhanced and established good root system which favors more number of nodules plant^{-1}. Molybdenum is one of the most recognized nutrient elements considered to be essential for plant growth as a constituent of nitrate reductase and nitrogenase enzymes, molybdenum directly influences nitrogen assimilation and its fixation in pulse crop close findings are confined with Biswas et al. [7]. According to data pertaining in available phosphorus revel that application of secondary, micro nutrients and naphthalene acetic acid (NAA) had no influence on available soil phosphorus status after harvest of the crop. Data indicated that significantly higher available phosphorus after blackgram crop was recorded with treatment T_1 (control) and lowest phosphorus after blackgram crop was recorded in T_{15} 40 kg S ha^{-1} + 5.0 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1} + 40 ppm NAA.

According to data pertaining to available Potassium revel that application of secondary, micro nutrients and naphthalene acetic acid (NAA) had no influence on available soil potassium status after harvest of the crop. Data indicated that significantly higher available potassium after blackgram crop was

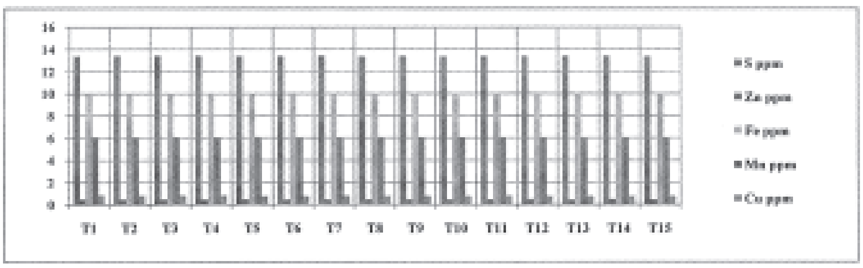

Fig. 4. Effect of secondary, micro nutrients and NAA on available nutrients (S, Zn, Fe, Mn and Cu) after harvest of blackgram.

recorded with treatment T_1 (control) and lowest phosphorus after blackgram crop was recorded in T_{15} 40 kg S ha^{-1} + 5.0 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1} + 40 ppm NAA. The observations regarding total available nutrients after harvest (kg ha^{-1}) of blackgram is presented in Table 3 and Fig 4. According to data pertaining to available secondary and micro nutrients status after harvest of the blackgram crop. Data indicated that there is no significant difference in the treatments. Highest available sulfur, zinc, iron and copper after harvest of blackgram crop was recorded with Treatment T_1 (control) and lowest nutrients status was recorded in T_{15} 40 kg S ha^{-1} + 5.0 kg Zn ha^{-1} + 1.0 kg Mo ha^{-1} + 40 ppm NAA. Whereas highest manganese was recorded in T_3 and lowest in T_{15} after harvest of balckgram.

Conclusion

It may be concluded that among the different treatments T_{15}(40 kg sulfur ha^{-1} + 5.0 kg zinc ha^{-1} + 1.0 kg molybdenum ha^{-1} + 40 ppm (NAA) was found to be the best for obtaining highest seed yield, stover yield and protein content in blackgram.

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