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Response of nitrogen, Sulphur and foliar application of zinc on yield and quality of greengram (*Vigna radiata* L.)

RS Muniswamy, Vikram Singh and Prasad Mithare

Abstract
The field experiment was conducted during *kharif* season of 2015 at Crop Research Farm SHUATS, Allahabad & the experiment consisted of two levels of nitrogen *viz.*, 15, 25 kg ha^{-1}, three levels of Sulphur viz., 0, 20, 40 kg ha^{-1} and two levels of 0.1% zinc spray at pre-flowering and pod initiation stage which laid out in Randomized Block Design (RBD) & replicated thrice. Application of 25 kg N ha^{-1} + 40 kg S ha^{-1} + 0.1% zinc (Pre flowering and Pod initiation) significantly increased yield & quality parameters viz, Maximum number of pods plant^{-1} (30.33), Test weight (41.68 g), Seed yield (8.89 q ha^{-1}), Stover yield (27.10 q ha^{-1}). Similarly application of 25 kg N ha^{-1} + 40 kg S ha^{-1} 0.1% zinc (Pre flowering and Pod initiation) recorded maximum harvest index (24.73 %), Protein content (24.83 %), Gross return (□ 44092.0 ha^{-1}), Net return (□ 24739.0 ha^{-1}) and B:C ratio (2.30) while lowest gross return (□ 29083.0 ha^{-1}), net return (Rs 11109.0 ha^{-1}) and B:C ratio (1.61) was obtained in treatment T_1 (control) respectively.

Keywords: Foliar spray, stover, one quadrate, kjeldahl's digestion, distillation procedure

Introduction
Pulses are commonly known as food legumes while are secondary to cereals in production and consumption in India. Pulses are an integral part of many diets across the globe and they have great potential to improve human health, conserve our soils, protect the environment and contribute to global food security. The United Nations, declared 2016 as international Year of Pulses (IYP) to heighten public awareness of the nutritional benefit of pulses as part of sustainable food production aimed at food security and nutrition. India is the largest producer and consumer of pulse contributes 25% of global production, 27% of world consumption and importer 14% of pulses in the world. The area under pulse has increased from 19 m ha^{-1} in 1950-51 to 25 m ha^{-1} in 2013-14, indicating an increase of 31 percent whereas production of pulse during the same period has increased from 8.41 million ha^{-1} to 19.27 million ha^{-1} an increase of over 100% GOI 2015 [1]. In 2014-15 17.20 million tones and estimate production for 2015-16 about 18.32 million tons Commodity Profile: DES, DAC&FW, & DoC 2015 [2]. Greengram is scientifically known as *Vigna radiata* (L.) and commonly known as moong in India. Greengram seeds are highly nutrition's with protein (23–24%), carbohydrates (60%), minerals, amino acids and vitamins. Nitrogen enhances the uptake of other nutrients and increasing nitrogen content in the crop which increases protein content of Greengram. Sulphur plays an important role in improving yield and quality of pulses.

Sulphur is known to promote nodulation in legumes thereby enhancing the N fixation & it's also constituent of free amino acid such as methionine, cysteine, and plays a vital role in protein synthesis Dhanushkodi *et al.,* 2009 [3]. Zinc is involved in Auxin metabolism like, tryptophan synthesis, protein synthesis, formation of nucleic acid and helps in utilization of nitrogen as well as phosphorus by plants. It also promotes nodulation and nitrogen fixation in leguminous crops Patel *et al.,* 2013 [4].

Foliar application of zinc greatly affects plant growth and crop production. Significant positive effect of zinc on seed and straw yield of mungbean as well as crude protein % found in the seeds Thslooth *et al.,* 2006 [5].

Materials and Methods
A field experiment was conducted during kharif season of 2015 at the Crop Research farm, Department of Agronomy, Allahabad School of Agricultural, Sam Higginbottom University of Agriculture Technology and Sciences, Allahabad. The experiment site lies between 25-27° N latitude, 8.5°E Longitude and 98 meters altitude. The climate is characterized by the alternate

hot rainy season from late June to early September with mean temperature of 38°C. 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 ppm), and Zn (0.50 ppm) during the experimental year. The experiment was down in randomized block design (RBD) with three levels of S (0, 20 and 40 kg S ha^{-1}) and N (15 and 25 kg N ha^{-1}) and two levels of 0.1% zinc spray viz., at pre-flowering and pod initiation stage with 13 treatments and 3 replications respectively. The summer mungbean variety Samrat was sown in rows, 30 cm apart using 20 kg seeds ha^{-1} on 10 June in 2015. The crop was thinned after complete germination to maintain a plant to plant spacing of 10 cm apart. A common dose of Phosphorus and Potassium at 40:30 kg ha^{-1} was applied through di-ammonium phosphate and Murate of potash, respectively. Whereas Nitrogen, Sulphur and Zinc were applied through urea, gypsum and zinc sulphate (Foliar Spray) as per treatment and incorporated in soil & followed by irrigation to ensure microbial activities to hasten oxidation of sulphur. Irrigation was scheduled at 10 days interval during vegetative growth & total of 3 irrigations were applied at critical stages of the crop. However other normal cultural practices were followed timely as; weeding at 25 DAS was done respectively. One quadrate (1 m^2) was harvested in every plot for the determination of results and data was subjected to statistical analysis separately by using analysis of variance technique. 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. The treatment consisted of T_1 - (control), T_2 - 15 kg N ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering), T_3 - 15 kg N ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering and initiation), T_4 - 15 kg N ha^{-1} + 20 kg S ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering), T_5 - 15 kg N ha^{-1} + 20 kg S ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering and Pod initiation), T_6 - 15 kg N ha^{-1} + 40 kg S ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering), T_7 - 15 kg N ha^{-1} + 40 kg S ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering and Pod initiation), T_8 - 25 kg N ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering), T_9 - 25 kg N ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering and Pod initiation), T_{10} - 25 kg N ha^{-1} + 20 kg S ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering), T_{11} - 25 kg N ha^{-1} + 20 kg S ha^{-1} 0.1% $ZnSO_4$ (Pre flowering and Pod initiation), T_{12} - 25 kg N ha^{-1} + 40 kg S ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering), T_{13} - 25 kg N ha^{-1} + 40 kg S ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering and Pod initiation). The difference among treatment means was compared by using least significant difference test at 5% probability levels.

Results and Discussion

Yield Attributes

The observations regarding yield attributes of green gram, viz., Number of pods $plant^{-1}$, Number of seeds pod^{-1}, Test weight (g) were influenced by every increment dose of sulphur and this beneficial effect was seen during all the seasons and also may be due to synchronized availability of essential plants nutrients to the crop especially NPK for a longer period during its growth & reproductive stages. Treatment T_{13} 25 kg nitrogen ha^{-1} + 40 kg sulphur ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation) recorded the maximum; Number of pods $plant^{-1}$ (30.33), Test weight (41.68 g), where as lowest attributes was recorded in Treatment T_1 (control). However, Number of seeds pod^{-1} and Test weight (g) were found non-significant different among treatment (Table 1) and (Fig 1). The probable reason may be due to beneficial effect of Nitrogen, Sulphur and Zinc (Foliar spray). There was progressive increase in the number of pods $plant^{-1}$ with every increment dose of sulphur and this beneficial effect was seen during all the seasons. Sulphur at 40 kg ha^{-1} exhibited its superiority by registering the highest number of pods $plant^{-1}$ which was on par with 30 kg ha^{-1} and the factor which are directly responsible for ultimate grain production pods $plant^{-1}$, grains pod^{-1}, 1000 grain weight and seed weight $plant^{-1}$ were increased almost significantly due to increased supply of sulphur up to 60 kg ha^{-1} were expressed by Mir *et al.* 2013 [6] and Similar results were also reported by Patel *et al.* 2013 (4), Srinivasan *et al.* 2001 [7], Choudary *et al*., 2014 [8]. Whereas Tripathi et al. 2012 [9] reveled that spraying of zinc was found to be significant in influencing the yield attributes such as number of pods $plant^{-1}$, pod length, number of seeds pod^{-1} and 100 grain weight.

Yield

The observations regarding yield of green gram, viz, Significant and highest grain yield (8.89 q ha^{-1}), straw yield (27.10 q ha^{-1}) and harvest index (24.73) was recorded in treatment T_{13} 25 kg nitrogen ha^{-1} + 40 kg sulphur ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation) while lowest grain yield (5.77 q ha^{-1}), straw yield (20.78 q ha^{-1}) was recorded in treatment T_1 and lowest and harvest index (21.63) was recorded in treatment T_3, however Treatment T_{12} 25 kg nitrogen ha^{-1} + 40 kg sulphur ha^{-1} + 0.1% $ZnS0_4$ (Pre flowering) and T_{11} 25 kg nitrogen ha^{-1} + 20 kg sulphur ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation) were statistically at par with treatment T_{13} respectively (Table 2) and (Fig 2). The probable reason may be due to beneficial effect of nitrogen, sulphur and zinc. Effective translocation and distribution of photosynthates from source to sink, which in turn resulted into elevated stature of yield attributes, which of course was due to favourable weather conditions such as rainfall distribution, evaporation and relative humidity prevailed during the crop growth period. Similar findings were also reported by Patel *et al.* 2013 [4] progressive increase in yield due to the sulphur application, might be attributed to the cumulative effect of yield attributes and root volume coupled with higher nutrients uptake, more photosynthesis which could have translated effectively to grain, thereby increasing the grain yield (21.61 q ha^{-1}). Among the different source of sulphur gypsum recorded the highest Stover yield (30.70 q ha^{-1}). Ram *et al*. 2013 (10) the highest seed yield (13.69 and 14.40 q ha^{-1}) was observed in combination with 40 kg S ha^{-1} and 10 kg Zn ha^{-1} which was significantly superior over rest of the combinations. Similarly Malik *et al.*2003 [11] reported application of nitrogen up to 25 kg ha^{-1} significantly increased grain and Stover yield of mungbean either of the year. It might be due to essentiality of nutrient for plant growth. Roy *et al.* 2013 [12] 0.1% Zinc spray treatment was found to be effective to increase number of pods $plant^{-1}$, number of grains pod^{-1}, dry matter and grain yield.

Quality analysis

Protein content (%)

The observation regarding protein content in seed is being presented in the (Table 3) and (Fig 3). Highest protein content (24.83 %) were recorded in treatment T_{13} 25 kg nitrogen ha^{-1} + 40 kg sulphur ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation), while lowest protein content (22.56 %) was recorded in treatments T1 (control), however Treatment T_{12} 25 kg nitrogen ha^{-1} + 40 kg sulphur ha^{-1} + 0.1% $ZnS0_4$ (Pre flowering) and T_{11} 25 kg nitrogen ha^{-1} + 20 kg sulphur ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation) were statistically at par with treatment T_{13} respectively (Table 3) and (Fig 3). The probable reason may be due to beneficial effect of nitrogen, sulphur and zinc. Sulphur help in the synthesis of chloroplast protein resulting in greater photosynthetic efficiency which in turn translated in terms of increase in yield. It was also 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 2004 [13].

Economics

The highest gross return (44092 ha^{-1}), net return (24739 ha^{-1}) and B:C ratio (2.30) was observed in treatment T_{13} 25 kg nitrogen ha^{-1} + 40 kg sulphur ha^{-1} +0.1% $ZnSO_4$ (Pre flowering & Pod initiation), while lowest gross return (29083 ha^{-1}), net return (11109 ha^{-1}) and B:C ratio (1.61) was observed in treatment T_1 (control), however T_{12} 25 kg nitrogen ha^{-1} + 40 kg sulphur ha^{-1} + 0.1% ZnS04 (Pre flowering) and T_{11} 25 kg nitrogen ha^{-1} + 20 kg sulphur ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation) were statistically at par with treatment T_{13} (Table 3) and (Fig 4).

Post-harvest nutrients status of soil

The observations regarding total available nutrients (kg ha^{-1}) after harvest of Greengram is presented in (Table 4) and (Fig 5). According to data pertaining to available nitrogen revels that application of nitrogen, sulphur and foliar application of zinc on yield and quality of Greengram had significantly influence on available soil nitrogen status after harvest of the crop. Data indicated that significantly higher available Nitrogen (240 kg ha^{-1}), Phosphorus (15.00 kg ha^{-1}), Potassium (347 kg ha^{-1}), Sulphur (13.41 ppm), has recorded in treatment T_{13} 25 kg nitrogen ha^{-1} + 40 kg sulphur ha^{-1} +0.1% $ZnSO_4$ (Pre flowering & Pod initiation) whereas highest available Zinc (0.47 ppm), Iron (10.04 ppm), Manganese (6.09 ppm) and Copper (0.87 ppm) was recorded in treatment T_{11} 25 kg nitrogen ha^{-1} + 20 kg sulphur ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation). However treatment T_{12} 25 kg nitrogen ha^{-1} + 40 kg sulphur ha^{-1} + 0.1% ZnS04 (Pre flowering) and T_9 25 kg nitrogen ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation) are statistically at par with T_{13}. The probable this could be attributed to sulphur which is a constituent of three essential amino acids (Cysteine, Cystine and Methionine). Sulphur is a constituent of ferrodoxin-containing Nitrogenase, which takes part in the biological nitrogen fixation resulting highest number of nodules $plant^{-1}$ and nitrogen content in the soil. Similar finding was also reported by Khan *et al* 2014 [14]

Table 1: Response of Nitrogen, Sulphur and Foliar Application of Zinc on Yield Attributes Viz, No. of Pods $Plant^{-1}$, No. of Seeds Pod^{-1} and Test Weight (g).

	Treatments	No. of Pods $Plant^{-1}$	No. of Seeds Pod^{-1}	Test Weight (g)
T_1	Control	22.23	9.15	38.70
T_2	15 kg nitrogen ha^{-1} + 0.1% ZnS04 (Pre flowering)	22.77	9.36	38.05
T_3	15 kg nitrogen ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation)	23.47	10.09	39.22
T_4	15 kg nitrogen ha^{-1} + 20 kg sulphur ha^{-1} + 0.1% ZnS04 (Pre flowering)	24.20	8.73	37.55
T_5	15 kg nitrogen ha^{-1} + 20 kg sulphur ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation)	24.60	10.20	38.63
T_6	15 kg nitrogen ha^{-1} + 40 kg sulphur ha^{-1} + 0.1% ZnS04 (Pre flowering)	25.57	9.68	40.37
T_7	15 kg nitrogen ha^{-1} + 40 kg sulphur ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation)	26.23	10.33	38.92
T_8	25 kg nitrogen ha^{-1} + 0.1% ZnS04 (Pre flowering)	27.03	10.26	38.35
T_9	25 kg nitrogen ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation)	27.77	9.91	38.22
T_{10}	25 kg nitrogen ha^{-1} + 20 kg sulphur ha^{-1} + 0.1% ZnS04 (Pre flowering)	27.47	8.94	39.67
T_{11}	25 kg nitrogen ha^{-1} + 20 kg sulphur ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation)	28.63	8.86	40.55
T_{12}	25 kg nitrogen ha^{-1} + 40 kg sulphur ha^{-1} + 0.1% ZnS04 (Pre flowering)	29.40	11.22	40.72
T_{13}	25 kg nitrogen ha^{-1} + 40 kg sulphur ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation)	30.33	10.33	41.68
F-test		S	NS	NS
SEd(±)		0.60	0.21	1.19
CD (P=0.05)		1.24	0.44	1.12

Table 2: Response of Nitrogen, Sulphur and Foliar Application of Zinc on Grain yield, Straw yield and Harvest Index

	Treatments	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest Inde (%)
T_1	Control	5.77	20.78	27.77
T_2	15 kg nitrogen ha^{-1} + 0.1% ZnS04 (Pre flowering)	5.98	21.20	28.23
T_3	15 kg nitrogen ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation)	6.02	21.82	27.60
T_4	15 kg nitrogen ha^{-1} + 20 kg sulphur ha^{-1} + 0.1% ZnS04 (Pre flowering)	6.29	22.00	28.58
T_5	15 kg nitrogen ha^{-1} + 20 kg sulphur ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation)	6.57	22.78	28.88
T_6	15 kg nitrogen ha^{-1} + 40 kg sulphur ha^{-1} + 0.1% ZnS04 (Pre flowering)	6.98	23.09	30.13
T_7	15 kg nitrogen ha^{-1} + 40 kg sulphur ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation)	7.02	23.98	29.28
T_8	25 kg nitrogen ha^{-1} + 0.1% ZnS04 (Pre flowering)	7.22	24.30	29.49
T_9	25 kg nitrogen ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation)	7.10	25.55	27.80
T_{10}	25 kg nitrogen ha^{-1} + 20 kg sulphur ha^{-1} + 0.1% ZnS04 (Pre flowering)	7.90	26.03	30.51
T_{11}	25 kg nitrogen ha^{-1} + 20 kg sulphur ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation)	8.12	26.99	30.71
T_{12}	25 kg nitrogen ha^{-1} + 40 kg sulphur ha^{-1} + 0.1% ZnS04 (Pre flowering)	8.57	26.99	31.74

T_{13}	25 kg nitrogen ha^{-1} + 40 kg sulphur ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation)	8.89	27.10	32.82
F-test		S	S	S
SEd(±)		1.54	7.23	0.79
CD (P=0.05)		3.17	14.81	1.62

Table 3: Response of Nitrogen, Sulphur and Foliar Application of Zinc on Protein Content (%), Gross Returns (□ ha^{-1}), Net Returns gross return (□ ha^{-1}) and B: C Ratio

	Treatments	**Protein Content (%)**	**Gross Returns (□ ha^{-1})**	**Net Returns (□ ha^{-1})**	**B:C Ratio**
T_1	Control	22.56	29083	11109	1.61
T_2	15 kg nitrogen ha^{-1} + 0.1% ZnS04 (Pre flowering)	22.96	30112	12134	1.67
T_3	15 kg nitrogen ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation)	22.76	30386	12328	1.68
T_4	15 kg nitrogen ha^{-1} + 20 kg sulphur ha^{-1} + 0.1% ZnS04 (Pre flowering)	22.89	31605	13057	1.70
T_5	15 kg nitrogen ha^{-1} + 20 kg sulphur ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation)	22.91	33005	14377	1.77
T_6	15 kg nitrogen ha^{-1} + 40 kg sulphur ha^{-1} + 0.1% ZnS04 (Pre flowering)	22.97	34882	15761	1.82
T_7	15 kg nitrogen ha^{-1} + 40 kg sulphur ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation)	24.17	35201	16000	1.83
T_8	25 kg nitrogen ha^{-1} + 0.1% ZnS04 (Pre flowering)	23.43	36201	18071	1.99
T_9	25 kg nitrogen ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation)	24.00	35800	17590	1.96
T_{10}	25 kg nitrogen ha^{-1} + 20 kg sulphur ha^{-1} + 0.1% ZnS04 (Pre flowering)	23.37	39648	20948	2.12
T_{11}	25 kg nitrogen ha^{-1} + 20 kg sulphur ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation)	24.75	41060	22280	2.18
T_{12}	25 kg nitrogen ha^{-1} + 40 kg sulphur ha^{-1} + 0.1% ZnS04 (Pre flowering)	24.22	42614	23341	2.21
T_{13}	25 kg nitrogen ha^{-1} + 40 kg sulphur ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation)	24.83	44092	24739	2.30
F-test		S	--	--	--
SEd(±)		0.23	--	--	--
CD (P=0.05)		0.48	--	--	--

Table 4: Response of Nitrogen, Sulphur and Foliar Application of Zinc on Post-harvest nutrients status of soil

	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	218	14.00	305	13.11	0.48	10.01	6.01	0.81
T_2	15 kg nitrogen ha^{-1} + 0.1% ZnS04 (Pre flowering)	225	14.00	309	13.10	0.49	10.02	6.00	0.81
T_3	15 kg nitrogen ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation)	225	14.10	316	13.19	0.51	10.01	6.02	0.83
T_4	15 kg nitrogen ha^{-1} + 20 kg sulphur ha^{-1} + 0.1% ZnS04 (Pre flowering)	218	13.90	301	13.08	0.49	10.01	6.04	0.82
T_5	15 kg nitrogen ha^{-1} + 20 kg sulphur ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation)	225	13.90	313	13.20	0.51	10.00	6.04	0.84
T_6	15 kg nitrogen ha^{-1} + 40 kg sulphur ha^{-1} + 0.1% ZnS04 (Pre flowering)	231	14.05	325	13.27	0.49	10.02	6.01	0.84
T_7	15 kg nitrogen ha^{-1} + 40 kg sulphur ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation)	237	14.60	309	13.28	0.51	10.02	6.04	0.84
T_8	25 kg nitrogen ha^{-1} + 0.1% ZnS04 (Pre flowering)	231	14.50	338	13.27	0.50	10.01	6.00	0.83
T_9	25 kg nitrogen ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation)	235	14.40	312	13.29	0.51	10.03	6.02	0.85
T_{10}	25 kg nitrogen ha^{-1} + 20 kg sulphur ha^{-1} + 0.1% ZnS04 (Pre flowering)	231	14.00	310	13.31	0.48	10.01	6.00	0.84
T_{11}	25 kg nitrogen ha^{-1} + 20 kg sulphur ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation)	238	14.70	325	13.36	0.51	10.03	6.02	0.83
T_{12}	25 kg nitrogen ha^{-1} + 40 kg sulphur ha^{-1} + 0.1% ZnS04 (Pre flowering)	238	14.60	329	13.40	0.52	10.01	6.04	0.86
T_{13}	25 kg nitrogen ha^{-1} + 40 kg sulphur ha^{-1} + 0.1% $ZnSO_4$ (Pre flowering & Pod initiation)	240	14.80	347	13.41	0.52	10.03	6.08	0.86

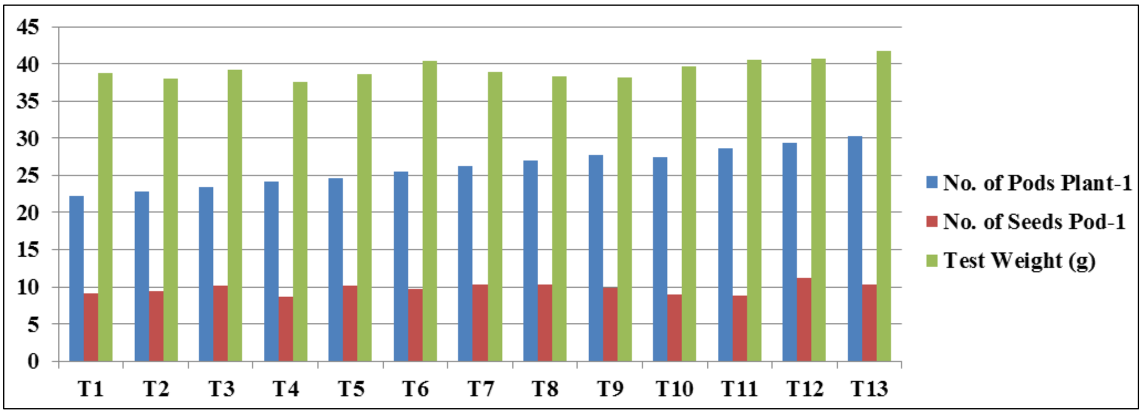

Fig 1: Response of Nitrogen, Sulphur and Foliar Application of Zinc on Yield Attributes Viz, No. of Pods $Plant^{-1}$, No. of Seeds Pod^{-1} and Test Weight (g)

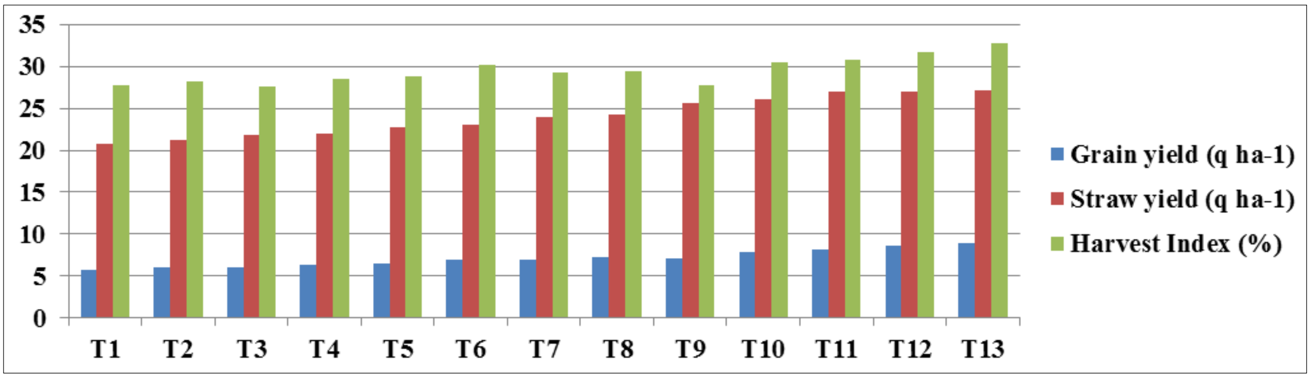

Fig 2: Response of Nitrogen, Sulphur and Foliar Application of Zinc on Grain yield, Straw yield and Harvest Index

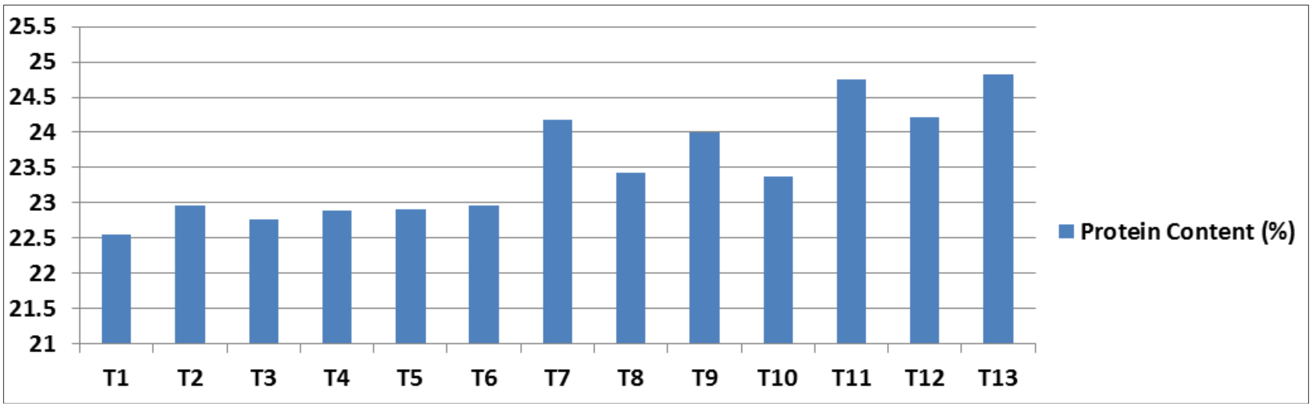

Fig 3: Response of Nitrogen, Sulphur and Foliar Application of Zinc on Protein Content (%)

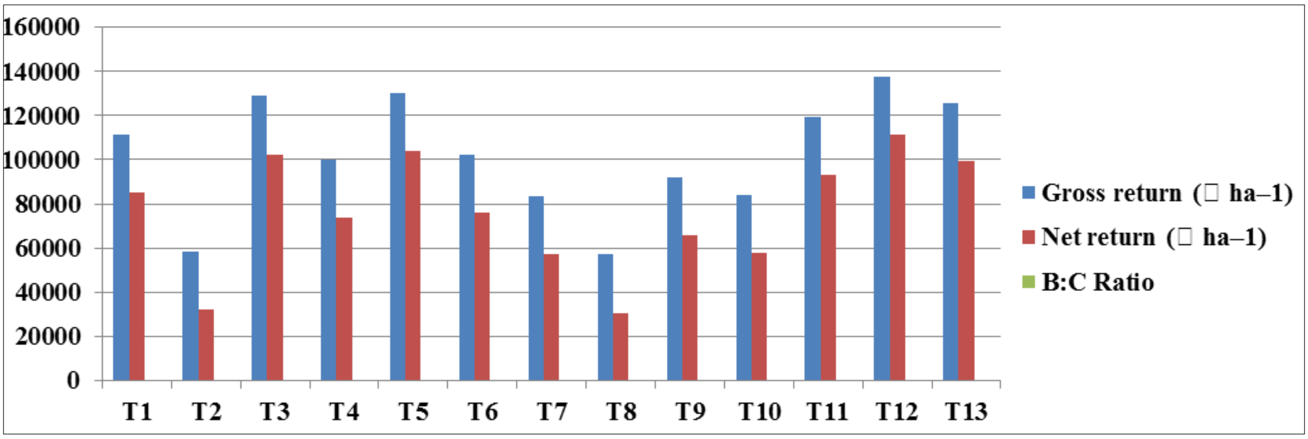

Fig 4: Response of Nitrogen, Sulphur and Foliar Application of Zinc on Gross Returns (□ ha^{-1}), Net Returns gross return (□ ha^{-1}) and B: C Ratio

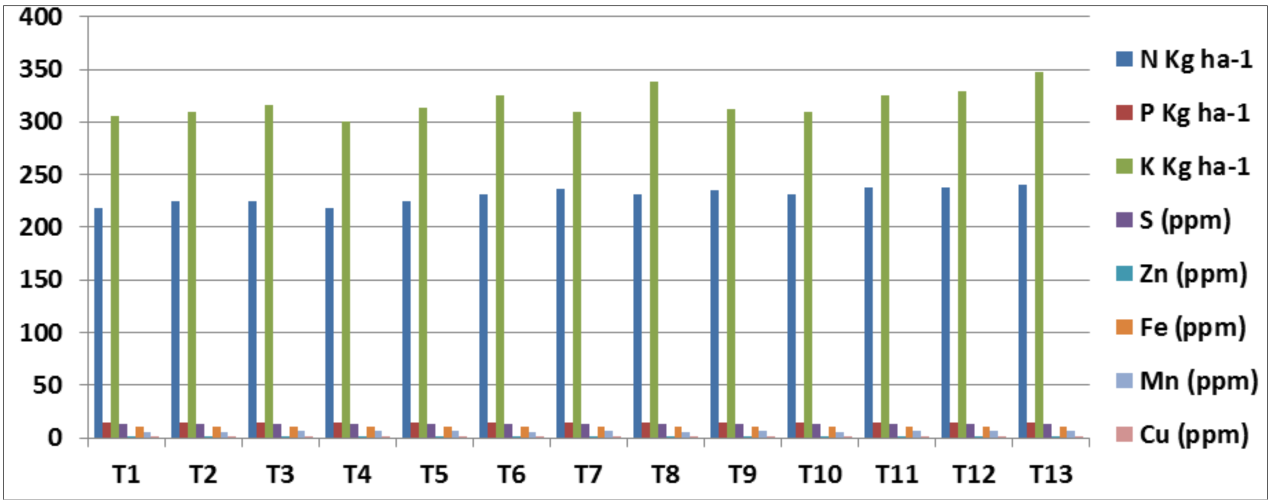

Fig 5: Response of Nitrogen, Sulphur and Foliar Application of Zinc on Post-harvest nutrients status of soil

Conclusion

The data pertaining to the different treatments, it may be concluded that by using 25 kg nitrogen ha^{-1} + 40 kg sulphur ha^{-1} +0.1% $ZnSO_4$ (Pre flowering & Pod initiation) was found to be the best for obtaining highest Seed yield, Stover yield and benefit cost ratio, over control. Since the findings are based on the research done in one season it may be repeated for conformation**.**

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