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RESEARCH ARTICLE

Effect of Zinc Sulphate as Soil Application and Seed Treatment on Green Gram (*Vigna radiata* L.)

Muhammad Usman*, Muhammad Tahir and Muhammad Atif Majeed
Department of Agronomy, University of Agriculture, Faisalabad, Pakistan

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***Corresponding Author:**
usmanagri@yahoo.com

ABSTRACT

A study was conducted to evaluate the impact of zinc sulphate as soil application and seed treatment on green gram. The trial was conducted at Agronomic Research Area, University of Agriculture, Faisalabad during spring 2012. Treatments were comprised of absolute control, RDF (recommended dose of fertilizer), RDF + $ZnSO_4$ soil application at the rate of 10, 15, 20, 25 kg ha^{-1} and RDF + $ZnSO_4$ seed treatment at the rate of 2, 4, 6, 8 g kg^{-1} of seed. The experiment was layed out in randomized complete block design (RCBD) having a net plot area of 5 m × 1.8 m with three replications. Crop variety NIAB-Mung 2006 was used as test crop. The crop was sown in 30 cm apart rows while plant to plant distance was maintained at 10 cm. Recommended dosage of fertilizer was applied at the rate of 23-58-30 NPK kg ha^{-1}. Whole of the phosphorus and potassium were applied at sowing while nitrogen was applied in two splits i.e.1/2 at sowing time and 1/2 at flowering. Data on yield and quality attributes was recorded by using standard procedures and analyzed statistically utilizing Fisher's analysis of variance technique and least significant difference test (LSD) was used to compare differences among treatments' means at 0.05 probability level. Results showed that significantly the maximum number of pods bearing branches per plant (9.07), number of nodules per plant (14.00), number of seeds per pod (10.33), 1000 seed- weight (46.37 g), seed yield (1208.7 kg ha^{-1}), biological yield (5738.0 kg ha^{-1}) and harvest index (18.20 %) were obtained where 20 kg ha^{-1} zinc sulphate was applied as soil application. Significantly the maximum plant height (55.13 cm) was obtained in that treatment where 15 kg ha^{-1} zinc sulphate was applied in the soil. Significantly the maximum protein contents (21.75 %) were obtained when 10 kg ha^{-1} zinc sulphate was applied in soil. It was concluded from experiment that better green gram yield was harvested with more net return when zinc sulphate was applied in soil at the rate of 20 kg ha^{-1}.

INTRODUCTION

Pulses are an important part of profitable agriculture in Pakistan because a large section of population has to rely on this as it is low priced source of protein (Usman et al., 2007). It is an ancient and well known crop among Asian countries for its dietary or nutritional value (Shanmugasundaram, 2004). It is also an admirable source of high quality and easily digestible protein with a seed protein content ranging from 18 to 25 percent. The total area under green gram cultivation in Pakistan is 136.1 thousand hectares, with total grain production of 89.3 thousand tones which illustrates that production is 4% less than last year (Government of Pakistan, 2012-13). This yield is greatly lower than most of the leading countries of the world.

Food security is major challenge and could only be accomplished by increasing crop productivity. Macro and micronutrients have fundamental role in crop nutrition and are important for attaining higher yields (Arif et al., 2006). Unavailability of crop nutrients is the major constraint in crop productivity. In most of the soils deficiency of both macro and micro nutrients have been reported, which could be achieved through numerous nutrient management practices (Ali et al., 2008).

Nutrient deficiency is a major factor of lower yield of pulses (Quddus et al., 2011). Mostly macronutrients are applied and micronutrients are ignored. Micronutrients

play a vigorous role in proper growth and development of all the field crops (Farooq et al., 2012). Out of the total cultivated land of the world, 30 percent is deficient in zinc (Khourgami and Fard, 2012). Reduced application of zinc has resulted in less zinc content in the seeds as well as reduced yields (Cakmak, 2009). Micronutrients applied in combination with *Rhizobium* increased growth and yield of mung bean (Ahmad et al., 2013). Zinc sulphate is a major source of Zn and sulfur and is being used worldwide (Aye, 2011). There are three methods for application of micronutrients which are: soil application, seed treatment and foliar application (Johnson et al., 2005). Foliar application is usually considered as costly because it needs high cost equipment's. For green gram, zinc application of 1.5 kg ha^{-1} was found optimum (Quddus et al., 2011) and this dose can increase plant height, primary branches, functional leaves, dry matter, nodule number, nodule weight per plant and seed yield (Thalooth et al., 2006). Hameed et al. (2013) also reported the seed priming enhance the seed germination and seedling growth.

Keeping in view the above mentioned facts, the following study was carried out to check the effect of soil application and seed treatment of zinc sulphate on yield and quality of green gram under Faisalabad conditions.

MATERIALS AND METHODS

The proposed study was conducted at the Agronomic Research Area, University of Agriculture, Faisalabad to check the effect of soil application and seed treatment of zinc sulfate on yield and quality of green gram under Faisalabad conditions. The experiment was laid out in randomized complete block design (RCBD) with three replications having net plot size of 5 m x 1.8 m. The green gram variety NIAB-Mung 2006 was used as test crop with seed rate of 30 kg ha^{-1}. $ZnSO_4$ (21% Zinc) will be used. Seeds were coated with $ZnSO_4$ by using Arabic gum. Crop will be sown during last week of March 2012. The experiment was comprised of the following treatments:

Treatments

T_0 = Absolute Control
T_1 = RDF (Recommended dose of fertilizer)
T_2 = RDF + Soil application of $ZnSO_4$ at the rate of 10 kg ha^{-1}
T_3 = RDF + Soil application of $ZnSO_4$ at the rate of 15 kg ha^{-1}
T_4 = RDF + Soil application of $ZnSO_4$ at the rate of 20 kg ha^{-1}
T_5 = RDF + Soil application of $ZnSO_4$ at the rate of 25 kg ha^{-1}
T_6 = RDF +Seed Treatment with $ZnSO_4$ at the rate of 2 g kg^{-1} of Seed
T_7 = RDF + Seed Treatment with $ZnSO_4$ at the rate of 4 g kg^{-1} of Seed
T_8 = RDF + Seed Treatment with $ZnSO_4$ at the rate of 6 g kg^{-1} of Seed
T_9 = RDF + Seed Treatment with $ZnSO_4$ at the rate of 8 g kg^{-1} of Seed

Crop was sown in a well prepared soil with hand drill maintaining row to row distance of 30 cm and plant to plant distance 10 cm. Plant population was maintained by thinning after the emergence count. All other practices were kept normal and uniform for all the treatments. Weeds were controlled in the field using Weedicide spray. Irrigations were applied at critical growth stages; first three weeks after germination, second at flowering and third at pod formation keeping in mind the rainfall. Crop was harvested when 80 to 90 percent pods were ripened. After sun drying, threshing was done. The soil samples were taken before sowing and after harvesting of crop for analysis. Recommended dose of fertilizer was applied at the rate of 23-58-30 NPK kg ha^{-1} using urea, DAP and sulphate of potash as the sources. Number of plants m^{-2} was measured with the help of a quadrate. R x R distance for green gram is 30 cm so the quadrate was not give us an estimate of a meter square as it was cover 0.90 m^{-2} so we was convert the number of plants obtained in 0.90 m^{-2} into one m^{-2} using unitary method.

RESULTS AND DISCUSSION

Plant height reflects the vegetative growth behavior of crop plant in response to applied inputs. Regarding zinc sulphate levels (Table 1), significantly the maximum plant height (55.13 cm) was recorded in the plots where zinc sulphate was applied at the rate of15 kg ha^{-1} (T_3) which is statistically at par with the treatments where 20 kg ha^{-1} (T_4) and 25 kg ha^{-1} (T_5) zinc sulphate was applied in the soil. However, it is also statistically at par with the treatment where 4 g kg^{-1} zinc sulphate (T_7) was applied as seed treatment. Markedly lowest plant height i.e. 41.80 cm was witnessed in plots where there was no application of zinc sulphate (T_0). Zinc activates certain enzymes which are responsible for the cell division and elongation which is major source of increase in plant height (Nadergoli et al., 2011). Ali and Mahmoud (2013) also reported that application of zinc significantly increased the yield related traits. Zinc actively takes part in auxin production which increases the cell size and number thus increases the plant height (Dashadi et al., 2013).

Various levels of zinc sulphate as soil application and seed treatment had significant effect on the number of pod bearing branches of green gram. The comparison of treatment means revealed (Table 1) that significantly the maximum number of pod bearing branches per plant (9.07) were recorded in the plots where zinc sulphate

Table 1: Effect of zinc sulphate as soil application and seed treatment on growth and yield of green gram (*Vigna radiata* L.)

Treatments		Plant height (cm)	No. of pod bearing branches	No. of seeds per pod	1000 seed weight (g)	Seed yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest Index (%)
T_0	Absolute Control	41.80 e	5.53 c	7.73 d	37.79 f	711.3 f	5109.7 f	14.32 e
T_1	RDF (Recommended dose of fertilizer)	44.00 de	5.73 bc	7.93 d	38.52 ef	743.0 f	5184.7 ef	14.33 e
T_2	RDF + Soil application of $ZnSO_4$ at the rate of 10 kg ha^{-1}	48.00 bcd	6.80 bc	8.73 bcd	42.18 bcd	855.3 de	5334.7 cde	16.04 bcd
T_3	RDF + Soil application of $ZnSO_4$ at the rate of 15 kg ha^{-1}	55.13 a	7.87 ab	9.73 ab	44.59 ab	1081.3 b	5580.3 ab	17.71 a
T_4	RDF + Soil application of $ZnSO_4$ at the rate of 20 kg ha^{-1}	52.83 ab	9.07 a	10.33 a	46.37 a	1208.7 a	5738.0 a	18.20 a
T_5	RDF + Soil application of $ZnSO_4$ at the rate of 25 kg ha^{-1}	50.37 abc	7.40 abc	9.40 abc	44.59 ab	988.3 c	5507.0 bc	17.11 ab
T_6	RDF + Seed Treatment with $ZnSO_4$ at the rate of 2 g kg^{-1} of Seed	45.30 cde	6.33 bc	8.13 cd	40.11 def	783.3 ef	5254.7 def	14.91 de
T_7	RDF + Seed Treatment with $ZnSO_4$ at the rate of 4 g kg^{-1} of Seed	49.93 abcd	6.93 abc	8.80 bcd	44.59 ab	905.0 d	5399.7 cd	16.76 abc
T_8	RDF + Seed Treatment with $ZnSO_4$ at the rate of 6 g kg^{-1} of Seed	47.33 bcde	6.67 bc	8.57 bcd	44.59 ab	819.3 e	5284.0 de	15.51 cde
T_9	RDF + Seed Treatment with $ZnSO_4$ at the rate of 8 g kg^{-1} of Seed	46.27 cde	6.27 bc	8.40 bcd	44.59 ab	784.3 ef	5297.0 de	14.91 de
	LSD	6.0142	2.178	0.6779	2.5783	76.105	185.66	1.5483

was applied as soil application at the rate of20 kg ha^{-1} (T_4) which is statistically equal to the treatments where 15 kg ha^{-1} (T_3) and 25 kg ha^{-1} (T_5) zinc sulphate was applied in the soil. However, it is also statistically at par with the treatment where 4 g zinc sulphate (T_7) kg^{-1} of seed was applied as seed treatment. Significantly the minimum number of pod bearing branches per plant (5.53) were observed in plots where no zinc sulphate / no fertilizer (T_0) was applied. Pod bearing branches is a phenomenon of plant growth and zinc has ability to produce plant growth regulators (Auxins, IAA) (Taliee et al., 2000). The growth and development of green gram might be regulated by these compounds. Nadergoli et al. (2011) stated that application of zinc sulphate helps in more pod bearing branches as it contributes to the formation of stamens as well as pollens.

The effect of zinc sulphate as soil application and seed treatment was significant on the number of seeds per pod. The comparison of treatments means reflected (Table 1) that significantly the maximum numbers of seed per pod (10.33) were recorded in the plots where zinc sulphate was applied at the rate of 20 kg ha^{-1} (T_4) which is statistically at parity with the treatments where 15 kg ha^{-1} (T_3) and 25 kg ha^{-1} zinc sulphate (T_5) was applied in the soil. However, significantly minimum numbers of seed per pod (7.73) were observed in plots where no zinc sulphate / no fertilizer (T_0) were applied. These results are in accordance with Nadergoli et al. (2011) who reported that zinc sulphate application increased the number of seeds per pod in green gram. This increase might be due to the formation of stamens as well as pollens. These results are in accordance with Awlad et al. (2003) and Teixeira et al. (2004).

The comparison of treatments means showed (Table 1) that significantly the maximum 1000-seed weight (46.37 g) of green gram was recorded in the plots where zinc sulphate as soil application was applied at the rate of 20 kg ha^{-1} (T_4) which was statistically at par with the treatments where 15 kg ha^{-1} (T_3) and 25 kg ha^{-1} zinc sulphate (T_5) was applied in the soil. However, significantly the minimum 1000-seed weight (37.79 g) was observed in plots where no zinc sulphate / no fertilizer (T_0) were applied. This increase in 1000-seed weight might be due to optimum dose of zinc sulphate, which affected the cell division, sugar and starch formation which increased the seed weight and size and thereby 1000-seed weight. Zinc has a significant effect on yield attributing characters like number of pod bearing branches per plant, pods per plant and 1000-seed weight. Khorgamy and Farina (2009) reported that zinc had significant effect on 1000 seed weight of chickpea. These results matched with Rathi et al. (2009) who reported that thousand seed weight of black gram increased by the optimum dose of zinc.

Biological yield is the total biomass produced by a crop from a unit area. The comparison of treatment means showed (Table 1) that the maximum biological yield (5738.0 kg ha^{-1}) of green gram was recorded in the plots where zinc sulphate as soil application was applied at the rate of 20 kg ha^{-1} (T_4) which is statistically at par with the treatments where 15 kg ha^{-1} (T_3) and 25 kg ha^{-1} zinc sulphate (T_5) was applied in the soil. However, significantly lowest biological yield i.e. 5109.7 kg ha^{-1} was observed in plots where there was

no application of zinc sulphate or fertilizer (T_0). Increase in biological yield may be due to optimum dose of zinc sulphate (20 kg ha^{-1}), which significantly enhanced straw and grain yield in chick pea. Valenciano et al. (2010) stated that it might be due to optimum dose of zinc sulphate, which significantly affected the grain formation and vegetative growth in chick pea and thereby increases the biological yield. These results are in consistent with (Khorgamy and Farina, 2009).

Harvest index determines the amount of photosynthates being translocated to the economic parts of plant. Data regarding harvest index showed (Table 1) that the maximum harvest index (18.20%) of green gram was recorded in the plots where zinc sulphate as soil application was applied at the rate of 20 kg ha^{-1} (T_4) which was statistically at par with the treatments where 15 kg ha^{-1} (T_3) and 25 kg ha^{-1} zinc sulphate (T_5) was applied in the soil. However, significantly the minimum harvest index (14.32 %) was observed in plots where no zinc sulphate / no fertilizer (T_0) were applied. These results were in confirmation to the conclusion made by (Valenciano et al., 2010). He founded that the mature plants, receiving Zn, B and molybdenum, had a greater total dry matter production and harvest Index. Zinc fertilizer had a significant effect on harvest index (Khorgamy and Farina, 2009).

CONCLUSION

It was concluded from the results that soil application of zinc sulphate at the rate of 20 kg ha^{-1} was the best option to obtain higher green gram yield.

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