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EFFECT OF ZINC SULPHATE ON GROWTH AND YIELD OF INDUCED MUTANTS OF GREEN GRAM

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ABSTRACT

A green house experiment was conducted at Agra to investigate the effect of different concentrations of zinc sulphate on early seedling growth parameters, biochemical parameters and yield of five induced mutants of green gram (Vigna radiate) during Kharif season of 2008 and 2009. The results indicated a substantial decrease in the growth and yield of green gram mutants with different concentrations of zinc sulphate over control. Among them, Tall mutant I and Tetrafoliate mutant I showed the resistance against the adverse effect of zinc sulphate in terms of their performances in growth, yield and biochemical parameters. Nitrogen, Chlorophyll content and yield of green gram mutants decreased with zinc sulphate over control. The higher concentration of zinc sulphate had more adverse effect on these parameters as compared to lower concentrations.There was a marked increase in zinc content with its application.

Key words: Zinc sulphate, growth, yield, mutants, green gram

INTRODUCTION

Zinc in high concentrations inhibit seed germination, the growth and development of plants, and disturb many biochemical and physiological processes, for instance, injure cell membranes, reduce transpiration, cause breakdown of the protein synthesis, damage the photosynthetic apparatus and inhibit photosynthetic rate, affect the activity of several enzymes, raise lipid peroxidation (Ahmad and Ashraf, 2011). Zinc concentrations in seeds are a function of heavy metal content in environment. When the soil is zinc contaminated, plants will take up metals via root system. Zinc is one of the most important environmental pollutants, particularly in areas with high anthropogenic pressure. Their excess in environment can cause serious problems to all organisms and the heavy metals excessive bioaccumulation in the food chain is highly dangerous (Hussain *et al.*, 2010). In the present study, attempt has been made to investigate the effect of different concentrations of $ZnSO_4$ on the growth parameters i.e. seed germination, seedling biomass (fresh and dry weight), chlorophyll and nitrogen content of five induced mutants (Tetrafoliate mutant I, II and Tall mutant I, II, III) of green gram.

MATERIAL AND METHODS

A green house experiment was conducted during kharif season of 2008 and 2009 at the Department of Seed Technology, Raja Balwant Singh College, Agra, India. Mutant seeds were collected from the Department of Plant sciences, Rohelkhand University, Bareilly. The pots were filled with the soil and the pot surface was sterilized by 4% formaldehyde spray. Recommended dose of nitrogen, phosphorus and potassium was applied in each pot at the time of sowing. The mutant seeds were sown in different pots. Zinc sulphate (1000 mg/l) was procured from Merck and solutions of various concentrations (80, 90 and 100%) were prepared by diluting the standards and distilled water is worked as control for irrigation at the interval of 3 days. Chlorophyll content in plants was determined by adopting procedure of Hiscox and Israelstam (1979) using dimethyl sulfoxide. Nitrogen content was estimated by following the procedure of Lindner (1944). Zinc content in plants was determined by atomic absorption spectrophoto meter in di-acid digest. Growth parameters (plant height and dry weight) yield attributes (pod length, pods/plant and seeds/pod) and yield of grain were recorded at maturity.

RESULTS AND DISCUSSION

Out of five mutants, only two mutants (Tall mutant III and Tetrafoliate mutant I) showed good performance in respect of early seedling growth parameters under various concentrations of zinc sulphate. Tall mutant I had higher germination percentage under all the concentrations of zinc sulphate as compared to other mutants. The seedlings of Tetrafoliate mutant I produced higher fresh weight as well as maximum dry matter production. The germination percentage was reduced under higher concentrations of zinc sulphate as reported by Ahmad *et al.* (2011a). Zinc sulphate generally inhibits normal physiological processes. This could be due to their interfernce with activities of a number of enzymes essential for normal metabolic and developmental processes as well as due to its direct interaction with proteins pigments, etc. (Ahmad *et al.* 2008). There was an inhibition in the fresh weight of seedling in all mutants.

Table 1: Effect of zinc sulphate concentrations on germination, fresh dry matter, chlorophyll and nitrogen content in green gram plants

$ZnSo_4$ (%)	Germination %	Fresh Weight (gm)	Dry Weight (gm)	Chlorophyll content (mg g^{-1})	Nitrogen (%)	Zinc (mgKg^{-1})
Tetrafoliate Mutant-I						
Control (D.W.)	100	2.123±0.22	0.241±0.045	1220.72±19.96	3.3±0.1	23.5
80%	100	1.370±0.80	0.149±0.017	1010.54±24.50	3.5±0.3	25.0
90%	95	1.264±0.12	0.125±0.013	990.15± 35.30	3.2±0.1	27.0
100%	75	1.049±0.09	0.091±0.008	978.95±23.99	3.1±0.2	29.5
Tetrafoliate Mutant-II						
Control (D.W.)	100	1.483±0.16	0.210±0.031	1142.82±36.42	3.0±0.2	23.0
80%	100	0.819±0.10	0.112±0.012	996.38±38.61	3.3±0.1	23.8
90%	90	0.718±0.01	0.096±0.008	960.98±40.56	3.1±0.3	26.5
100%	70	0.519±0.01	0.059±0.007	930.85±17.42	3.0±0.2	29.0
Tall Mutant-I						
Control (D.W.)	100	1.625±0.12	0.240±0.045	1218.92±18.45	3.2±0.1	23.2
80%	100	0.920±0.18	0.115±0.131	1032.65±38.14	3.7±0.4	23.5
90%	95	0.917±0.13	0.097±0.015	981.88±75.96	3.5±0.1	25.7
100%	80	0.518±0.19	0.061±0.008	890.77±65.82	3.1±0.2	28.0
Tall Mutant-II						
Control (D.W.)	100	2.120±0.20	0.209±0.031	1140.74±35.85	3.0±0.2	22.8
80%	100	0.967±0.18	0.113±0.015	986.35±24.79	3.4±0.1	23.4
90%	95	0.962±0.16	0.098±0.017	960.56±34.81	3.2±0.1	25.1
100%	85	0.550±0.05	0.060±0.005	948.68±46.95	3.0±0.4	27.9
Tall Mutant-III						
Control (D.W.)	100	1.480±0.10	0.215±0.018	1230.24±12.14	3.1±0.4	23.4
80%	95	0.916±0.03	0.115±0.011	1182.92±36.85	3.5±0.1	25.0
90%	90	0.913±0.11	0.127±0.013	1160.25±18.96	3.2±0.2	26.1
100%	80	0.515±0.16	0.095±0.008	920.38±29.14	3.0±0.1	27.2

A similar retardation in fresh weight under the influence of various industrial effluents has been reported by Aydinalp and Marinova (2009). The dry weight gradually decreased with increase in concentration of the zinc sulphate as compared to control. A similar retardation in dry weight under the influence of various industrial effluents has been reported by Ahmad *et al.*, (2011a and 2011b). The chlorophyll and nitrogen content was higher in Tall mutant I than those of other mutants. There was a reduction in Chlorophyll content with increasing concentration of zinc sulphate.Chlorophyll reduction under the influence of heavy metals was also reported by Jun *et al.* (2008). Heavy metals in high concentrations inhibit seed germination, the growth and development of plants, and disturb many biochemical and physiological processes, for instance, injure cell membranes, reduce transpiration, because breakdown of the protein synthesis, damage the photosynthetic apparatus and inhibit photosynthetic rate, affect the activity of several enzymes, raise lipid peroxidation (Raziuddin *et al.* 2011). Zinc content in plants increased with increasing concentration of zinc sulphate solution (Sharma *et al.* 2014). There was a decrease in the mean values of the yield attributes in all the mutants with increasing concentration of heavy metals.The minimum and maximum values of these yield attributes were recorded under 100% zinc sulphate solution and control, respectively. The higher values of yield attributes were recorded under Tall mutant I as compared to other mutants. The maximum grain yield of all the mutants was recorded under control and minimum under 100% of zinc sulphate. Tall mutant I and Tetrafoliate mutant I showed the resistance against different concentrations of heavy metals as their performance was better in respect of growth characters, yield attributes, grain and straw production. A similar retardation in the yield attributes by the influence of heavy metals was reported by Shafi *et al.* (2010).

It may be concluded that Tetrafoliate I and Tall mutant I showed the better performances in relation to growth, biochemical as well as yield parameters under the different concentrations of zinc sulphate.

Table 2: Effect of zinc sulphate concentrations on growth, yields attributes and yield of green gram mutants

$ZnSo_4$ (%)	Plant height (cm)	Pod length (cm)	No. of Pods/Plant	No. of Seeds/pod	Yield/plant (gm)
Tetrafoliate Mutant-I					
Control (D.W.)	63.81±1.6	5.21±0.8	12.56±0.2	8.12±0.1	14.32±0.8
80%	61.81±1.9	4.88±0.3	10.41±0.9	6.47±0.7	12.17±0.3
90%	57.06±1.2	4.27±0.9	9.06±0.4	5.88±0.3	11.41±0.7
100%	53.28±1.4	3.81±0.1	8.49±0.1	5.21±0.8	10.92±0.9
Tetrafoliate Mutant-II					
Control (D.W.)	60.42±1.1	5.04±0.2	12.21±0.3	8.16±0.4	14.58±0.3
80%	59.10±1.8	4.91±0.5	10.51±0.8	6.53±0.9	12.32±0.1
90%	54.25±1.3	4.31±0.3	9.16±0.5	5.97±0.1	11.46±0.8
100%	51.48±1.6	3.91±0.7	8.61±0.1	5.21±0.3	10.94±0.9
Tall Mutant-I					
Control (D.W.)	66.40±1.2	6.69±0.1	14.07±0.6	10.46±0.2	17.36±0.1
80%	65.08±1.5	5.79±0.3	11.86±0.9	8.92±0.9	15.91±0.9
90%	61.65±1.3	5.19±0.9	11.21±0.1	8.31±0.5	15.25±0.7
100%	57.36±1.9	4.91±0.8	10.91±0.2	7.89±0.3	14.33±0.5
Tall Mutant-II					
Control (D.W.)	62.87±1.7	6.07±0.3	13.92±0.1	10.42±0.1	17.22±0.1
80%	62.49±1.2	5.51±0.6	11.61±0.8	8.86±0.7	15.81±0.3
90%	59.70±1.1	5.09±0.1	11.09±0.3	8.16±0.3	15.12±0.6
100%	56.86±1.8	4.81±0.5	10.81±0.2	7.81±0.5	14.21±0.5
Tall Mutant-III					
Control (D.W.)	58.89±1.3	5.11±0.1	12.10±0.8	8.04±0.9	14.16±0.4
80%	57.46±1.7	4.86±0.8	10.36±0.5	6.41±0.3	12.01±0.2
90%	53.38±1.5	4.26±0.6	9.01±0.7	5.60±0.6	11.07±0.9
100%	51.05±1.8	3.81±0.3	8.41±0.1	5.08±0.2	10.41±0.5

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