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RESEARCH ARTICLE

GERMINATION CHARACTERISTIC OF GREEN GRAM UNDER COPPER EXPOSURE

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ABSTRACT

The present investigation has been carried out to assess the effect of copper on the seed germination characteristic of green gram. Various concentration of copper were prepared and utilized for the germination purpose. The seeds were germinated under the exposure of different concentrations of copper. The percentage of germination, vigour index, tolerance index and seedling growth parameters increased at low concentrations of copper. However the germination rate and seedling growth were adversely affected at higher concentration of copper.

INTRODUCTION

Pollution by heavy metal is one of the key environmental problem in the world today. Heavy metals have influence on the plants as abiotic stress factor causing changes in the physiological (Garg and Singla, 2011), morphological and biochemical level (Ozdender and Kutbay, 2011) The limit of toxicity and sensitivity of plants to heavy metals is determined by soil conditions and cultivated plant species (Pantsar-Kallio and Mannian, 1977). The major environmental problems crops out for waste disposal, either from water pollutants or air pollutants (Lagerwerff and Specht, 1970). Fribery *et al.* (1974) that these pollutants had a high concentration of heavy metals. High heavy metal availability induces an ion stress in plants clearly distinct from salt stress. The primary toxicity mechanism of the different metal ions may be as different as their chemical properties, especially valence, ions radius and capacity to form organic complexes. Nevertheless, an excess of these metal ions or of soluble metal chelates may induces a series of biochemical and physiological alternations in plants which present some common characteristics. Membrane damage alternation of enzyme activities and the inhibition of of root growth are considered characteristics features of heavy metal stress (Lopp, 1981). Copper is also one of the essential micronutrients for plant growth. It is involved in numerous physiological functions as a component of several enzymes, mainly those which participate in electron flow catalyze redox reactions in mitochondria and chloroplasts (Hansch and Mendal, 2009). Excess copper can cause chlorosis, inhibition of root growth and damage to plasma membrane permeability leading to ion leakage (Bouazizi *et al*. 2010). Thus the aim of the present study was to determine the effect copper on green gram plant at different concentrations.

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Germination Studies

Copper and zinc salts were dissolved in distilled water/borewell water (field experiment) to obtain various concentrations of Copper (0, 5, 10, 25, 50 and 100 mgl^{-1}). It was prepared and used for germination studies and field experiments. The germination studies were carried out according to the Top paper method recommended by International Seed Test Association (1976). Healthy seeds of green gram cultivars were selected and surface sterilized with 0.1% mercuric chloride solution for two minutes. The seeds were washed thoroughly for 30 minutes under running water to avoid surface contamination. Fifty seeds of each cultivar were equispacially arranged in each petriplate lined with filter paper. An equal volume of various concentration of copper, zinc and combined form of copper and zinc solution (viz., 0, 5, 10, 25, 50 and 100 mgl^{-1}) were watered into the respective plates. Seeds germinated in distilled water (0 mg l^{-1}) served as control. Five replicates were maintained for each concentration including control and for all the five cultivars. The petriplates were incubated in a Yorco seed germinator at $28^0 \pm 2^0$C. The number of seeds germinated in each treatment and control were counted daily upto the 9th day and the germination percentage was calculated. The protrusion of radical through the seed coat was taken as criterion for germination.

Morphological parameters

Various morphological parameters like shoot length, root length and number of lateral roots were recorded on the 9th day of the treatment. For measurement of seedling growth, five seedlings from each plate were selected at random for each concentration and control. Germination Study (11) was conducted with the selected tolerant and susceptible cultivars which were also used to record morphological parameters and analyse the biochemical constituents.

Germination Percentage

Germination refers to the initial emergence of the radicle by visual observation. It was calculated by using the formula.

$$\text{Germination of percentage} = \frac{\text{Number of seeds germinated}}{\text{Total number of seeds sown}} \times 100$$

Speed of Germination Index (SGI)

It was calculated by using the formula given by Carley and Watson (1968).

SGI=(9x1G)+(8x2G)+(7x3G)+(6x4G)+(5x5G)+(4x6G)+(3x7 G)+(2x8G)+(1x9G).

Where the number of days=9; number of seeds=50; and 1G, 2G…9G are seeds germinated on 1st, 2nd…9th day and so on.

Vigour Index (VI)

Vigour index of the seedling was calculated by using the formula proposed by Abdul-Baki and Anderson (1973). Length of embryonic axis of seedling on the 10th day after sowing was measured for calculation of vigour index.

Vigour Index = Germination percentage x Length of the embryonic axis.

Tolerance Index (TI)

Tolerance index of cadmium was calculated by using the formula suggested by Turner and Marshal (1972)

$$\text{Tolerance Index} = \frac{\text{Mean length of longest root in the treatment}}{\text{Mean length of longest root in the control}}$$

RESULTS AND DISCUSSION

The cultivars of germination showed a varied response to copper exposure. The increase in copper concentration resulted in the reduction of germination percentage and germination index (Table 1 & 2) similar reduction in germination percentage and germination index was also reported by

Table 1. Effect of Copper on germination percentage of green gram

Concentration mgl^{-1}	Cultivar			
	ADT-1	CO-2	VBN-3	VBN-10
0	92	93	95	90
5	97 (+5.43)	97 (+4.30)	98 (+3.16)	95 (+5.55)
10	98 (+6.52)	99 (+6.45)	100 (+5.26)	96 (+9.50)
25	85 (-7.61)	88 (-5.37)	92 (-3.16)	81 (-10)
50	76 (-17.39)	79 (-15.05)	85 (-10.53)	72 (-20)
100	67 (-27.17)	72 (-22.58)	77 (-10.53)	60 (-33.33)

F – Value for the variance between treatments – 284.32, F – Value for the variance between cultivars – 2627.84

Table 2. Effect of Copper on seed germination index of green gram

Concentration mgl^{-1}	Cultivar			
	ADT-1	CO-2	VBN-3	VBN-10
0	695	712	730	652
5	715 (+2.88)	736 (+3.37)	742 (+1.64)	686 (+5.21)
10	721 (+3.74)	742 (+4.21)	760 (+4.11)	710 (+8.90)
25	652 (-6.19)	690 (-3.09)	712 (-2.47)	621 (-4.75)
50	598 (-13.96)	621 (-12.78)	650 (-10.96)	552 (-15.34)
100	521 (-25.04)	550 (-22.75)	581 (-20.41)	501 (-23.16)

F – Value for the variance between treatments – 112984.83, F – Value for the variance between cultivars – 19262.97

Table 3. Effect of vigour index of green gram by inducing copper

Concentration mgl^{-1}	Cultivar			
	ADT-1	CO-2	VBN-3	VBN-10
0	992.50	1021.02	1071.20	976.12
5	1012.15 (+1.98)	1050.70 (+2.91)	1092.45 (+1.98)	989.40 (+1.36)
10	1052.50 (+6.05)	1098.50 (+7.59)	1128.30 (+5.33)	1015.05 (+3.99)
25	930.15 (-6.28)	987.50 (-3.28)	995.20 (-7.09)	881.20 (-9.72)
50	801.70 (-19.22)	843.50 (-17.39)	882.05 (-17.66)	750.41 (-23.12)
100	652.68 (-34.24)	912.58 (-10.62)	750.28 (-29.96)	602.50 (-38.28)

F – Value for the variance between treatments – 14197559.31, F – Value for the variance between cultivars – 62010.96

Table 4. Tolerance index of green gram by copper exposure

Concentration mgl^{-1}	Cultivar			
	ADT-1	CO-2	VBN-3	VBN-10
0	-	-	-	-
5	0.745	0.701	0.795	0.716
10	0.762	0.789	0.820	0.732
25	0.785	0.801	0.835	0.768
50	0.610	0.650	0.572	0.585
100	0.560	0.596	0.620	0.540

F – Value for the variance between treatments – 0.142, F – Value for the variance between cultivars – 11.308

Table 5. Effect of copper on the root length of green gram

Concentration mgl^{-1}	Cultivar			
	ADT-1	CO-2	VBN-3	VBN-10
0	10.78	11.05	11.78	10.21
5	11.21 (+3.98)	11.95 (+8.14)	12.01 (+1.95)	10.85 (+6.26)
10	11.92 (+10.57)	12.12 (+9.68)	12.52 (+6.28)	11.20 (+9.69)
25	9.20 (-14.65)	9.89 (-10.49)	10.50 (-10.86)	8.92 (-12.63)
50	8.52 (-22.60)	8.92(-19.27)	9.79 (-16.97)	7.70 (-24.58)
100	7.12 (-33.95)	7.58 (-31.40)	8.72 (-25.97)	6.98 (-31.63)

F – Value for the variance between treatments – 8.278, F – Value for the variance between cultivars – 2.208

Table 6. Effect of copper on the soot length of green gram

Concentration mgl^{-1}	Cultivar			
	ADT-1	CO-2	VBN-3	VBN-10
0	3.78	4.01	4.12	3.62
5	4.20 (+11.1)	4.78 (+19.20)	4.95(+20.45)	4.01 (+10.77)
10	4.45 (+17.72)	4.94 (+23.19)	5.16 (+25.24)	4.20 (+16.02)
25	3.52 (-6.89)	3.89 (-2.99)	4.01 (-2.66)	3.23(-10.77)
50	3.21 (-3.98)	3.65 (-8.97)	3.78 (-8.25)	2.98 (-17.67)
100	2.92 (-3.23)	3.05 (-23.94)	3.25 (-21.11)	2.75(-24.03)

F – Value for the variance between treatments – 57.72, F – Value for the variance between cultivars – 8.10

Saravanan *et al*. (1996) in *Vigna radiata*, Alangin *et al*. (2009) in Wheat and Rakhee sinha *et al*. (2012) in *Vigna mungo* cultivars. The effect of copper an vigour index and tolerance index are presented in table (3 & 4). Both of these parameters declined with increase in metal concentration. The lower concentrations (5 and 10 mgl^{-1}) produced growth promoting effect. The reduction in vigour index and tolerance under metal treatment in the present study is in agreement with the findings of Saravana *et al*. (2000), Heidari and Surani (2011) and Tantrey and Agnihotri (2012). Besides seed germination, reduction in seedling growth was also observed in the present study. Lerda (1992) reported that reduction in root length under heavy metal stress could be due to reduction in mitotic cell division. Accumulation of metals with in roots reduces the mitotic rate by biochemistry metaphase in meristematic cells and this by reduces the root and shoot length of the seedlings (Shurijah and Hishashi, 1992). Among the cultivar studied the VBN-3 cultivar performed much better under copper exposure, thus it removed to be tolerant to copper treatments. All the cultivars studied showed better germination and seedling growth at lower concentrations (5 and 10 mgl^{-1}) when compared with control. However the further inovance in copper concentration resulted in reduction all the parameters.

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