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Review

Response of Black Gram Cultivars to Chromium Stress

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Abstract: The Present investigation was performed to assess the response of black gram genotypes under chromium stress. Different concentrations of chromium Viz., 0,5, 10, 25, 50, 100 and 200mg l^{-1} were prepared and used for the germination studies. The germination Parameters Such as rate of germination, germination index, vigour index, tolerance index, root and shoot length, and dry matter production were recorded under chromium stress. There was a significant variation observed among the genotypes in the performance of seed germination characteristics. 5mgl-^{1} chromium concentration showed a positive effect over the seed germination characteristics of black gram genotypes. However the higher concentration of chromium showed the inhibitory effect over the germination characteristics of black gram.

Keywords: Chromium, Germination, Vigour index, Dry matter, Tolerance index

1. Introduction

Industrial growth an index of a country's economic growth. Industrialization and rapid urbanization have resulted in the problem of heavy metal Pollution. Heavy metals are the elements with specific gravity more than 5.0 and atomic weight ranging plan. Heavy metal contamination in soil results from anthropogenic activities as well as natural activities. Some heavy metals play an important role in plants as micronutrients (Singh et al., 2006) while other have simulating effect on plants in trace concentrations (Sanita et al, 2002)

Chromium is one of the important heavy metals and a constituent of many industrial effluents, especially in Tanneries. Most of the chromium is discharged is in trivalent form. Chromium is toxic to both animals and plants and is known to interfere with many biochemical mosses of the plants, besides causing report growth (EPA, 1978). Chromium interferes with several metabolic processes, causing toxicity to plants as exhibited by reduced seed germination on early seedling development (Sharma et al., 1995) root growth, biomass, chlorosis, photosynthetic impairing and finally mortality of the Plant (Scoccianti et al., 2006).

Even though there are some investigations (Mahadeswaraswamy and Theresa, 1992; Infan and Akinci, 2010) above the effect of chromium and seed germination. Seedling growth and biomass production in early grown stages, they are not adequate to know the mechanism of chromium toxicity in plants. So, the present investigation pertains to assess the response of black gram cultivars to chromium toxicity.

2. Materials and Methods

Genotypes of *Vigna mungo* (L) Hepper seeds were obtained from the Regional Rice Research station, Aaduthurai and Vamban, Tamil Nadu, India. Uniform seeds were selected and surface sterilized with 0.01% $HgCl_2$ solution for 2 minutes. Seeds were thoroughly washed. 20 seeds of black gram genotypes were equidistantly placed in Petri dishes lined with filter Paper. The seeds of five genotypes were irrigated with 0, 5, 10, 25, 50, 100 and 200mg l^{-1} concentrations of chromium respectively. Three replicates were maintained. The rate of seed germinated was recorded daily. On the 7^{th} day after sowing various seed germination characteristics, like rate of germination, of Germination index (Li et al., 2007), Vigour index (Abdul-Baki and Anderson,1973), Tolerance index (Turner and Marshal., 1972) seedling growth Parameters such as root and shoot length, number of lateral roots and Biomass were recorded.

3. Results Seed Germination Characteristics

The rate of germination varied significantly ($P<0.01$) among the genotypes of black gram according to the concentration of chromium applied. (Table 1). Seed germination rate declined with concomitant increase in metal concentration. However the 5mg l^{-1} chromium concentration increased the rate of germination in all the genotypes of black gram. The results are inconsistence with the findings of Peralta (2001) and Panday and Panday (2008).

The seedling Vigour index and Germination index was higher in 5mg^{-1} Chromium concentration at it declined gradually with the increase in Chromium concentration. Control plants showed higher Germination index and Vigour index (Tables 2 & 3) than the plant’s treated with elevated concentrations of Chromium. The findings is agreement with the earlier reports of Sharma et al., (2005).

Table 1: Rate of seed germination of *Vingo mungo* genotypes on exposure to Chromium toxicity

Concentration (mgl^{-1})	**Genotypes**				
	ADT-1	**ADT-3**	**ADT-5**	**VBN-1**	**VBN-3**
O mgl-^{1}	92	95	95	96	96
5 mgl-^{1}	94 (-12.17)	97 (+2.10)	98 (+3.16)	100 (+4.16)	99 (+3.12)
10 mgl-^{1}	89 (-3.26)	90 (-5.26)	92 (-3.16)	95 (-1.04)	93 (3.12)
25 mgl-^{1}	79 (-14.13)	81 (-14.74)	84 (-11.58)	89 (-7.29)	86 (-10.42)
50 mgl-^{1}	69 (-25.00)	72 (24.21)	75 (-21.05)	80 (-16.67)	78 (-18.75)
100 mgl-^{1}	57 (38.04)	60 (-36.84)	64 (-32.63)	70 (-27.08)	66 (-31.25)
200 mgl-^{1}	46 (-50.00)	53 (-44.21)	57 (-40.00)	61 (-36.46)	58 (-39.58)

F - Test value for the variance between the cultivars 8482.97**
F- Test value for the variance between the concentrations 5.11**
** - Significant at 1 Percent level
0mgl^{-1}
Control Percentage of reduction over control values are given in Parentheses.

Table 2: Speed of Seed germination index of *Vingo mungo* genotypes on exposure to Chromium Stress

Concentration (mgl^{-1})	**Genotypes**				
	ADT-1	**ADT-3**	**ADT-5**	**VBN-1**	**VBN-3**
O mgl-^{1}	462	467	470	487	476
5 mgl-^{1}	479 (+3.68)	483 (++3.31)	492 (+4.47)	512 (+4.88)	498 (+4.62)
10 mgl-^{1}	415 (-10.17)	430 (-8.22)	448 (-4.68)	468 (-3.90)	455 (-4.41)
25 mgl-^{1}	403 (-12.77)	422 (-9.63)	432 (-8.08)	453 (-6.98)	441 (-7.35)
50 mgl-^{1}	368 (-20.35)	376 (19.49)	3.93 (-21.05)	420 (-13.76)	407 (-14.49)
100 mgl-^{1}	339 (-26.62)	353 (-24.41)	370 (-21.28)	398 (-18.27)	382 (-19.74)
200 mgl-^{1}	321 (-30.52)	336 (-28.05)	352 (-25.11)	372 (-23.61)	361 (-24.16)

F - Test value for the variance between the cultivars 270.82**
F - Test value for the variance between the concentrations 52.95**
** - Significant at 1 Percent level
0mgl-^{1}
Control Percentage of reduction over control values are given in Parentheses.

Table 3: Response of *Vigna mungo* genotypes to tolerance index due to Chromium stress

Concentration (mgl-1)	**Genotypes**				
	ADT-1	**ADT-3**	**ADT-5**	**VBN-1**	**VBN-3**
O mgl-1	-	-	-	-	-
5 mgl-1	890	898	912	962	936
10 mgl-1	785	801	812	854	825
25 mgl-1	670	696	702	732	716
50 mgl-1	512	556	576	606	590
100 mgl-1	426	452	468	498	481
200 mgl-1	306	319	340	378	352

F - Test value for the variance between the cultivars 282.87**
F - Test value for the variance between the concentrations 66.65**
** - Significant at 1 Percent level
0mgl-1
Control Percentage of reduction over control values are given in Parentheses.

Chromium treatments at 5, 10, 25,100 and 200 mg^{-1} Produced tolerance index values in the genotype of black gram. (Table 4). The tolerance index under chromium exposure showed lower values at 100mgl^{-1} and 200mgl^{-1} in black gram seedlings as compared to control and 5mg^{-1} chromium concentration. Similar observations was reported by Scoccianti et al., (2006).

Table 4: Vigour index of *Vigna mungo* genotypes as affected by Chromium concentrations

Concentration (mgl-1)	**Genotypes**				
	ADT-1	**ADT-3**	**ADT-5**	**VBN-1**	**VBN-3**
O mgl-1	1162.82	1179.70	1201.26	1249.20	1226.15
5 mgl-1	120.46 (-3.32)	1220.32 (+3.44)	1256.32 (+4.58)	1312.22 (+5.04)	1286.20 (+4.90)
10 mgl-1	912.36 (-21.54)	930.19 (-21.15)	959.12 (-20.16)	1042.15 (-16.57)	1002.18 (-18.27)
25 mgl-1	816.17 (-29.81)	832.65 (-29.48)	856.76 (-28.68)	957.18 (-23.38)	938.70 (-23.44)
50 mgl-1	735.52 (-36.75)	752.18 (-36.24)	782.35 (-34.87)	817.46 (-34.46)	802.16 (-34.58)
100 mgl-1	518.68 (-55.39)	546.32 (-53.69)	578.15 (-51.87)	612.18 (-50.99)	596.28 (-51.37)
200 mgl-1	345.19 (-70.31)	372.74 (-68.40)	390.17 (-67.52)	420.72 (-66.32)	401.76 (-67.23)

F - Test value for the variance between the cultivars 1571.04**
F - Test value for the variance between the concentrations 155.18**
** - Significant at 1 Percent level
0mgl-1
Control Percentage of reduction over control values are given in Parentheses.

3.1. Seeding Growth Parameters

The seedling growth Parameters like root and shoot length, number of lateral roots and Root/shoot ratio increased at 5mg-^{1} chromium concentration (Table 5).

Table 5: Root/Shoot ratio of *vigna mungo* genotypes as affected by chromium exposure

Concentration (mgl^{-1})	**Genotypes**				
	ADT-1	**ADT-3**	**ADT-5**	**VBN-1**	**VBN-3**
O mgl-^{1}	0.427	0.431	0.435	0.440	0.437
5 mgl-^{1}	0.432 (+1.16)	0.434 (+0.70)	0.438 (+0.68)	0.448 (+1.82)	0.444 (+1.58)
10 mgl-^{1}	0.421 (-1.40)	0.423 (-1.86)	0.428 (-1.61)	0.437 (-0.68)	0.431 (-1.37)
25 mgl-^{1}	0.417 (-2.34)	0.420 (-2.55)	0.423 (-2.76)	0.435 (-1.14)	0.428 (-2.06)
50 mgl-^{1}	0.410 (-3.98)	0.415 (-3.71)	0.420 (-3.45)	0.429 (-2.50)	0.424 (-2.97)
100 mgl-^{1}	0.404 (-5.39)	0.411 (-4.64)	0.417 (-4.14)	0.425 (-3.41)	0.421 (-3.66)
200 mgl-^{1}	0.399 (-6.56)	0.408 (-5.34)	0.414 (-4.83)	0.421 (-4.32)	0.417 (-4.58)

F - Test value for the variance between the cultivars 101.36**
F - Test value for the variance between the concentrations 71.69**
** - Significant at 1 Percent level
0mgl-^{1} Control
Percentage of reduction over control values are given in Parentheses.

The root and shoot length (Tables 6&7) was significantly reduced by 46%and 45% in the ADT-1 genotypes of *Vigna mungo*. There was across decline of 46& 89% in root growth with rising concentrations of chromium as compared with control. However the 5mgl^{-1} Chromium concentration Promoted the root and shoot length 4% to 7% respectively. The results lends support from Zayed and Terry (2003) and Infan and Akinci (2010). Morphological symptoms like wilting and necrosis of leaf margins, stunted growth of root and stem were noticed at elevated concentrations of chromium above 10mgl^{-1}. Root growth was more sensitive to chromium treatments. The root length was highly reduced. Browning of roots and the number of lateral roots was reduced. As root and shoot length were drastically reduced under concomitant increase in the level of chromium exposure. The results are inconformity with the reports of Chatterjee and Chatterjee (2000).

Table 6: Root length of *Vigna mungo* genotypes in response to chromium stress

Concentration (mgl^{-1})	Genotypes				
	ADT-1	**ADT-3**	**ADT-5**	**VBN-1**	**VBN-3**
O mgl-^{1}	5.46	5.72	5.96	6.29	6.16
5 mgl-^{1}	5.58 (-+2.20)	5.85 (-2.22)	6.15 (-3.18)	6.56 (+4.29)	6.42 (+4.22)
10 mgl-^{1}	5.18 (-5.13)	5.38 (-5.94)	5.70 (-4.36)	6.02 (-4.29)	5.78 (-6.17)
25 mgl-^{1}	4.42 (-19.05)	4.70 (-17.83)	5.06 (-15.10)	5.78 (-8.11)	5.19 (-15.75)
50 mgl-^{1}	3.90 (-28.57)	4.20 (-26.57)	4.52 (-24.16)	5.42 (-13.83)	4.76 (-22.73)
100 mgl-^{1}	3.26 (-40.29)	3.60 (-37.06)	3.97 (-33.39)	4.68 (-25.60)	4.20 (-31.82)
200 mgl-^{1}	2.90 (-46.89)	3.10 (-45.80)	3.32 (-44.29)	4.32 (-31.32)	3.68 (-40.26)

F - Test value for the variance between the cultivars 290.72**
F - Test value for the variance between the concentrations 85.22**
** - Significant at 1 Percent level
$0mgl^{-1}$ Control
Percentage of reduction over control values are given in Parentheses.

Table 7: Shoot length of *Vinga mungo* genotypes in response to chromium treatments

Concentration (mgl^{-1})	Genotypes				
	ADT-1	**ADT-3**	**ADT-5**	**VBN-1**	**VBN-3**
O mgl-^{1}	12.78	13.26	13.70	14.28	14.08
5 mgl-^{1}	13.38 (+4.69)	13.86 (+4.52)	14.26 (+3.93)	15.32 (+7.28)	14.69 (+4.33)
10 mgl-^{1}	12.30 (-3.75)	12.72 (-4.07)	13.32 (-2.85)	13.78 (-3.50)	13.40 (-4.83)
25 mgl-^{1}	10.60 (-17.06)	11.20 (-15.53)	11.96 (-12.70)	13.29 (-6.93)	12.12 (13.92)
50 mgl-^{1}	9.50 (-25.66)	10.13 (-23.60)	10.75 (21.53)	12.62 (-11.62)	11.23 (-20.24)
100 mgl-^{1}	8.06 (-36.93)	8.75 (-34.01)	9.52 (-30.51)	11.02 (-22.83)	9.98 (-29.12)
200 mgl-^{1}	7.26 (-43.19)	7.59 (-42.76)	8.02 (-41.46)	10.26 (-28.15)	8.83 (-37.29)

F - Test value for the variance between the cultivars 145.57**
F - Test value for the variance between the concentrations 35.22**
** - Significant at 1 Percent level
0mgl-^{1} Control
Percentage of reduction over control values are given in Parentheses.

The root /shoot ratio also delivered at higher concentrations of Chromium (Table 8). Root /Shoot ratio and dry weight of seedlings showed a gradual decrease with increase in metal concentration. Similar trend was also reported by many workers i.e. Ferrandez et al., (2002) in radish, Toresday et al., (2004) in *Convolulus arvenisis*, and Sankar Ganesh et al., (2009) in Soybean cultivars due to chromium treatment.

Table 8: Seedling Biomass of *Vigna mungo* genotypes in response to chromium treatments

Concentration (mgl^{-1})	**Genotypes**				
	ADT-1	**ADT-3**	**ADT-5**	**VBN-1**	**VBN-3**
O mgl-^{1}	.0.102	0.107	0.112	0.121	0.117
5 mgl-^{1}	0.104 (+1.96)	0.110 (+2.73)	0.120 (+7.14)	0.132 (+9.09)	0.125 (+6.84)
10 mgl-^{1}	0.092 (-9.80)	0.096 (-10.28)	0.102 (-8.93)	0.112 (-7.44)	0.107 (-8.55)
25 mgl-^{1}	0.083 (-18.63)	0.087 (-18.69)	0.095 (-15.18)	0.106 (-12.40)	0.099 (-15.38)
50 mgl-^{1}	0.071 (-25.49)	0.078 (-27.10)	0.084 (-25.00)	0.096 (-20.66)	0.088 (-24.79)
100 mgl-^{1}	0.062 (-39.21)	0.069 (-35.51)	0.076 (-32.14)	0.085 (-29.75)	0.079 (32.48)
200 mgl-^{1}	0.051 (-50.00)	0.058 (-45.79)	0.065 (-41.96)	0.072 (40.49)	0.068 (-41.88)

F -Test value for the variance between the cultivars 565.76**
F -Test value for the variance between the concentrations 157.81**
** - Significant at 1 Percent level
0mgl-^{1} Control
Percentage of reduction over control values are given in Parentheses.

It is apparent from the current investigation that increasing concentrations of chromium impact drastic influences on the seed germination and seedling growth of groundnut genotypes. Among this study the Black gram variety ADT-1 genotype is more tolerant followed by ADT-3 ADT-5, VBN-1 and VBN-3. This might be an indication of sensitivity of plants on early development to chromium. The order of tolerance among the genotypes studied to chromium treatment is follows: ADT-1 ADT-3 ADT-5 VBN-1 and VBN-3

The toxic influence of chromium need more research and it should be focused on growth and development of Plant cultivated in unregulated waste amended agriculture soils to avoid from food security problems. Results of the findings can be useful an indicator of metal tolerance to some extent for cultivation of this genotype in metal contaminated area. The cellular and molecular basis of thermo protection of heavy metals needs critical investigation. An improved knowledge in these crucial areas will help to elucidate the molecular mechanisms that lie beyond metal tolerance and homeostasis.

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