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RESEARCH ARTICLE

INHIBITORY EFFECTS OF CADMIUM ON SEED GERMINATION CHARACTERISTICS OF *VIGNA RADIATA* (L.) WILCZEK

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ABSTRACT

A cultivar screening test of greengram was conducted. Four cultivars of greengram were obtained from agricultural research station. Seeds were surface sterilized and evenly placed in petriplates. Seeds were irrigated with equal volume of different constituents of Cadmium chloride solution (5, 10, 25, 50 & 100 mgl^{-1}). One set of seeds were irrigated with distilled water was maintained as control (0 mgl^{-1}). The various seed germination characteristics of greengram like seed germination rate, seed germination index, vigour index, root length, shoot length and dry weight of seedlings were recorded on the 9th day after sowing of seeds. From the results obtained from the present investigation it was inferred that Cadmium inhibited the seed germination and seedling growth of greengram. There was a gradual decline in germination rate and seedling growth with progressive increase in Cadmium concentration. Among the four cultivars studied ADT-1 performed better under Cadmium treatment when compared to the rest of the cultivars.

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INTRODUCTION

Soil is a valuable and non-renewable resource essential for germination of seeds, survival and growth of plants thus supporting every live form on earth. However in the modern world, numerous soil pollutants restrict the growth of plants. Abiotic stress factors including salinity, drought, extreme temperatures, chemical toxicity and oxidative stress from the environment are the major causes of worldwide crop loss that pose serious threats to agricultural produce. With the ongoing technological advancements in industrialization and urbanization process, release of toxic contaminants like heavy metals in the natural resources has become a serious problem worldwide. Metal toxicity affects crop yields, soil biomass and fertility. Presence of heavy metals, like nickel, cobalt, cadmium, copper, lead, chromium and mercury in air, soil and water can cause bioaccumulation affecting the entire ecosystem and pose harmful health consequences in all life forms. The major sources of pollution in the state of Odisha in India are overburdens of mine, industrial effluent, fertilizers and pesticides, extra salts and elements that degrade the soil quality (Sahu *et al*., 2004). Due to their high atomic density of $4g/cm^3$ heavy metals are toxic even at low concentrations, Causing damage to the organism by accumulating and displacing vital nutrients in the tissues, thereby disrupting organ function. Some heavy metals are required for plant growth; however, at higher levels it becomes toxic to plants. Cadmium is a non-essential element that negatively affects plant growth and development. It is released into the environment by power station, heating systems metal working industry, urban traffic, mining activities. It is widely used in electro plating pigments, plastic stabilisers, Ni-Cd batteries. (Sanita di Toppi and Gabbrielli 1999) Cadmium could also enter the soil or water from spills or leaks at hazardous waste sites if large amounts of dissolved cadmium were present at the site where it was potentially available to rooted plants (Ozdener and Kutbay, 2009). Cadmium can be easily absorbed by plant roots and transported to shoots results in disorders in biochemical and physiological processes, and then affects plant growth and morphology (Sgherri *et al.,* 2002). Cadmium (Cd) is one of the important metal contamination and is considered as a major environmental problem. Cadmium is ubiquitous in soil. However, anthropogenic activities, such as mining, metal producing industry, use and disposal of batteries, electroplating units, application of phosphate fertilizers lead to dispension of cadmium (Alloway, 1995). Cadmium being a highly toxic metal pollutant of soils, inhibits root and shoot growth, yield production, affects nutrient uptake and is frequently accumulated by agriculturally important crops and then enters the food chain with significant potential to impair human

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health (di Toppi and Gabrielli, 1999). The present investigation has been undertaken to determine the effects of cadmium on the seed germination characteristics on the seed germination characteristics of green gram (*Vigna radiata* (L.) Wilczek).

MATERIALS AND METHODS

Seed materials

The certified seeds of greengram were purchased from Regional Pulse Research Station, Adudhurai. Seeds with uniform size, colour and weight were chosen for the experimental purpose.

Seed Germination

Healthy seeds (CO-6, CO-2, ADT-2, ADT-1) were selected and surface sterilized with 1% $Hgcl_2$ solution for two minutes. The seeds were thoroughly washed under tap water to remove mercuric chloride. Twenty five seeds were equidistantly placed in each petriplate lined with filter paper. Three replicates were maintained for each concentration including the control (5, 10, 25, 50 and 100 mgl^{-1}). Different concentrations of cadmium were prepared by dissolving cadmium chloride salts in distilled water. Each petriplate containing green gram seeds were irrigated at regular intervals with the respective concentrations of cadmium solution. Rate of seed germination were recorded daily. The protrusion of radical was taken as a criterion of germination. The various seed germination characteristics and seedling growth (root and shoot length and dry weight of seedlings) parameters were measured and recorded on 9th day after sowing seeds. The seed germination characteristics like SGI (Carley and Watson, 1963), VI (Abdul-Bakki and Anderson, 1973) and RTI (Tunner and Marshal, 1972) were calculated by adopting the following formulas suggested by various researchers.

Growth Measurements

The plant samples were collected on 9th day after sowing. Three plants from each replicates of pot were analyzed for the various growth parameters. The following growth parameters: length and fresh weight of shoot and root were measured using standardized procedures, dry weight was determined after drying of plant material in an oven 70ºC.

RESULTS AND DISCUSSION

The percentage of germination of green gram revealed significant differences among the cultivars studied. The percentages of germination were high in control (0 mgl^{-1}). However, the germination rate was reduced when the seeds were grown in heavy metal (Cadmium) solution. The seed germination was suppressed completely at 200 mgl^{-1} cadmium concentration. The inhibition of seed germination increased with increasing concentration of cadmium. The result of present study lends support from the findings of Morzek and

Table 1. Effect of cadmium on germination percentage of green gram (*Vigna radiata* (L.) Wilczek.) cultivars

Cultivar	Germination percentage				
	0 mgl^{-1}	10 mgl^{-1}	25 mgl^{-1}	50 mgl^{-1}	100 mgl^{-1}
ADT-1	82	70 (-14.63)	65 (-20.73)	60 (- 26.85)	50 (-39.02)
ADT-3	85	75 (-11.76)	70 (-17.65)	65 (-23.53)	59 (-30.59)
ADT-5	89	80 (-10.11)	75 (-11.76)	70 (-21.35)	61 (-31.46)
TN-9	95	90 (-5.26)	79 (-16.84)	72 (-24.21)	65 (-31.58)
VBN-1	100	93 (-7.00)	80 (-20.00)	75 (-25.00)	69 (-31.00)

F Test value for the variance between the cultivars54.10**
F Test value for the variance between the concentrations 32.03**
** - Significant at 1 percent level.
Percentage of reduction over control values are given in parentheses.

Table 2. Seed germination index of green gram (*Vigna radiata* (L.)Wilczek.) cultivars under cadmium exposure

Cultivar	Seed germination index				
	0 mgl^{-1}	10 mgl^{-1}	25 mgl^{-1}	50 mgl^{-1}	100 mgl^{-1}
ADT-1	852	782 (-8.21)	640 (-24.88)	506 (-40.61)	332 (-61.03)
ADT-3	861	798 (-7.32)	665 (-22.76)	514 (-40.30)	349 (-59.46)
ADT-5	875	825 (-5.71)	678 (-22.51)	538 (-38.51)	463 (-47.08)
TN-9	873	843 (-3.44)	689 (-21.08)	559 (-35.97)	481 (-44.90)
VBN-1	898	870 (-3.12)	796 (-11.36)	672 (-25.17)	493 (-45.10)

F – Test value for the variance between the cultivars 89.56**
F- Test value for the variance between the concentrations 64.17**
** - Significant at 1 percent level
Percentage of reduction over control values are given in parentheses.

Table 3. Vigour index of green gram (*Vigna radiate* (L.)Wilczek.) cultivars due to cadmium treatments

Cultivar	Vigour index				
	0 mgl^{-1}	10 mgl^{-1}	25 mgl^{-1}	50 mgl^{-1}	100 mgl^{-1}
ADT-1	1028.26	898.17 (-12.65)	752.12 (-26.85)	630.15 (-38.72)	532.36(-48.22)
ADT-3	1106.20	978.16 (-11.57)	842.18 (-23.87)	789.26 (-28.65)	692.31 (-37.41)
ADT-5	1157.56	1026.84 (-11.29)	982.15 (-15.15)	802.24 (-30.69)	702.16 (-39.34)
TN-9	1228.62	1105.54 (-10.02)	1005.17 (-18.19)	952.32 (-22.49)	850.19 (-30.80)
VBN-1	1274.40	1240.15 (-2.69)	1119.25 (-12.17)	1020.02 (-19.96)	904.23 (-29.05)

F – Test value for the variance between the cultivars 258.026**
F- Test value for the variance between the concentrations 222.105**
** - Significant at 1 percent level
Percentage of reduction over control values are given in parentheses.

Table 4. Effect of cadmium on root length (cm plant^{-1}) green gram (*Vigna radiata* (L.)Wilczek.) cultivars

Cultivar	Root length				
	0 mgl^{-1}	10 mgl^{-1}	25 mgl^{-1}	50 mgl^{-1}	100 mgl^{-1}
ADT-1	5.80	4.40 (-24.13)	4.20 (-27.59)	3.40 (-41.37)	2.80 (-51.72)
ADT-3	6.00	5.50 (-8.33)	4.70 (-21.66)	4.02 (-33.00)	3.20 (-46.67)
ADT-5	6.30	5.80 (-7.93)	5.02 (-20.31)	4.30 (-31.74)	3.70 (-41.26)
TN-9	7.57	6.22 (-17.83)	5.60 (-26.02)	5.15 (-31.97)	4.56 (-39.76)
VBN-1	7.85	7.50 (-4.45)	7.36 (-6.24)	6.76 (-13.88)	4.98 (-36.56)

F – Test value for the variance between the cultivars 45.13**
F- Test value for the variance between the concentrations38.44**
** - Significant at 1 percent level
Percentage of reduction over control values are given in parentheses.

Table 5. Shoot length (cm plan of green gram (*Vigna radiata* (L.) Wilczek.) cultivars under cadmium treatments

Cultivar	Shoot length				
	0 mgl^{-1}	10 mgl^{-1}	25 mgl^{-1}	50 mgl^{-1}	100 mgl^{-1}
ADT-1	14.00	13.50 (-3.57)	12.26 (-12.43)	10.34 (-26.14)	9.92 (-29.14)
ADT-3	14.20	13.70 (-3.52)	12.20 (-14.00)	10.68 (-24.70)	10.08 (-29.00)
ADT-5	14.50	13.82 (-4.68)	12.50 (-13.70)	11.00 (-24.13)	10.36 (-28.55)
TN-9	15.20	14.98 (-1.44)	14.15 (-6.90)	13.00 (-14.40)	12.00 (-21.05)
VBN-1	15.42	15.10 (-2.07)	14.50 (-5.97)	13.40 (-13.09)	12.75 (-17.31)

F – Test value for the variance between the cultivars 28.71**
F- Test value for the variance between the concentrations31.56**
** - Significant at 1 percent level
Percentage of reduction over control values are given in parentheses.

Table 6. Dry weight of green gram (*Vigna radiata*(L.)Wilczek.) cultivars under cadmium exposure

Cultivar	Dry weight				
	0 mgl^{-1}	10 mgl^{-1}	25 mgl^{-1}	50 mgl^{-1}	100 mgl^{-1}
ADT-1	0.190	0.180 (-5.26)	0.174 (-8.42)	0.150 (-21.05)	0.135 (-28.94)
ADT-3	0.204	0.192 (-5.89)	0.185 (-9.31)	0.162 (-20.59)	0.152 (-25.49)
ADT-5	0.223	0.210 (-5.82)	0.197 (-11.66)	0.170 (-23.77)	0.160 (-28.25)
TN-9	0.245	0.241 (-1.63)	0.208 (-15.10)	0.182 (-25.71)	0.168 (-31.43)
VBN-1	0.249	0.245 (-1.60)	0.220 (-11.65)	0.195 (-21.69)	0.178 (-28.51)

F – Test value for the variance between the cultivars 142.10**
F- Test value for the variance between the concentrations158.79**
** - Significant at 1 percent level
Percentage of reduction over control values are given in parentheses.

Funicelli (1982) and Shafiq and Iqbal (2005). The other seed germination characteristics such as seed germination index, vigour index and root tolerance index showed the same pattern of response to cadmium treatment as in the case of germination percentage of seeds. There was a gradual decline in all these parameters with increase in cadmium concentration in all the cultivars when compared with control. However, there was a variation among the cultivars response against cadmium concentrations. The cultivar ADT-1 showed better values than the rest of the cultivars studied. The reduction in seed germination rate and other seed germination characteristics of green gram can be attributed to the break down of stored food materials (Kalimuthu and Siva, 1990).

The root and shoot length of green gram cultivars were significantly reduced under varying cadmium concentrations. The variation in root and shoot length among the cultivars was significant. The ADT-1 cultivar showed high root and shoot length under cadmium treatment. However, the maximum root and shoot length of green gram seedlings was recorded in control plants of all the cultivars. There was a gradual decline in root and shoot length of green gram seedlings with progressive increase in cadmium concentration. Cadmium is highly toxic and it affects the root metabolism resulting in the reduction of root size and number of lateral roots. The root reduction was more pronounced than the shoot reduction. Seedling growth reductions of cadmium treated green gram plants has the support of the earlier reports which say that due to higher accumulation of cadmium results in reduction in the availability of nutrients due to which there is a reduction in seedling growth (Wu and Zhang, 2002; Khan *et al.,* 2007; Ahmad *et al.,* 2009).

The dry weights of green gram seedlings were found to be high at controls in all the cultivars. It was found out in this research on green gram seedlings exposed to cadmium decrease the dry weight of seedlings in parallel to increase in concentration. Findings of the present research related to decrease in seedling dry weight are in consonance with those of Shahla Faizan *et al.,* (2012) and Oncel *et al.,* (2000). The cultivars showed a great variation among them in response to cadmium treatments. The cultivar ADT-1 showed better seed germination characteristics seedling growth and dry weight of seedling when compared with rest of the cultivars studied. The order of tolerance found in the present study is ADT-1 > CO-6 > ADT-2 > CO-2

REFERENCES

Abdul Baki, A.A. and J.D., Anderson, 1973. Vigour determination of soybean seed by multiple criteria. *Crop Sci*., 3: 630-633.

Ahmad, I., M.Naeem, N.A.Khan and Samiullah, 2009. Effects of cadmium stress upon activities of antioxidative enzymes, photosynthetic rate and production of phytochelatives in leaves and chloroplasts of wheat

cultivars differing in yield potential. Photosynthetica., 47: 146-151.

Alloway, B.J., 1995. Heavy metals in soils. 2nd ed. Blacke Academic and Professional Publishers, London, 368.

Carley, H.E. and R.D., Watson, 1968. Effect of aqueous plant extract upon seed germination. *Bot. Gaz*.,129(1): 57-62.

Dass, D., and R.N.Kaul, 1992. Greening wasteland through waste water. National Wasteland Development Board, Ministry of Environment and Forest, Govt. of India, New Delhi, p.33.

Di Toppi., S.L., and R.Gabrielli, 1999. Response to cadmium in higher plants. Environ. Exp. Bot., 41: 105-130.

Kalimuthu, K., and S.R.Siva, 1990. Physiological effects of heavy metals on *Zea mays* (maize) seedlings. Ind. J. Plant. Physiol., 120 (2): 319-323.

Khan, N.A., Samiullal, S.Singh and R.Nazar, 2007. Activities of antioxidative enzymes, sulphur assimilation, photosynthetic activity and growth of wheat cultivars differing in yield potential under cadmium stress. J. Agro. Crop. Sci., 193: 435-444.

Morzek, E. and N.A.Funicelli, 1982. Effect of lead and on germination of *Spartiana alterniflora* seeds at various salinities. *Env. Exp. Bot.*, 22: 23-32.

Oncel, I., Y.Keles and A.S.Ustun, 2000. Interactive effects of temperature and heavy metal stress on growth and some biochemical compounds in wheat seedlings. Env. Poll., 107: 315-320.

Ozdener Y., Kutbay H.G. 2009. Toxicity of copper, cadmium, nickel, lead and zinc on seed germination and seedling growth in Erucasativa. Fresen. Environ. Bull. 18, (1), 26.

Sahu SK, Pradhan KC, Sarangi Soil Pollution in Orissa. Orissa Review. 2004

Shafiq, M. and M.Z.Iqbal, 2005. The toxicity effects of heavy metals on germination and seedling growth of *Cassia siamea. J. New Seeds.* 7: 95-105.

Shahla Faizan, S.Kausar and R.Perveen, 2012. Variation in growth, physiology and yield of four chickpea cultivars exposed to cadmium chloride. J. Env. Biol., 33: 1137-1142.

Turner, R.G. and C.Marshall, 1972. Accumulation of zinc by sub-cellular fraction of root of *Agrostis tennuis* in relation to zinc tolerance. *New Phytol.*, 71: 671-676.

Wu, F.B., G.P.Zhang, and J.S. Yu, 2003. Interaction of cadmium and four micro elements for uptake and translocation in different barley genotypes. *Comm. Soil Sci. Plant.* 34: 2003-2020.

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