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SCREENING OF GROUNDNUT CULTIVARS FOR TOLERANCE TO ALUMINIUM TOXICITY

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ABSTRACT
The aluminium toxicity is one of the major growth limiting factor that affects plant in most of the acidic soils which is detrimental to plants, limiting growth and productivity. Two cultivars of groundnut i.e. SB-11 and W-55 were screened under control and different concentrations of aluminium viz., 10 ppm, 50 ppm and 100 ppm. The results have revealed that the initial decrease in germination percentage in both cultivars was recovered as germination hours increased especially with lower doses of aluminium treatments. Increase in moisture percentage with all aluminium treatments after 48 hours stimulated seed germination as well as shoot growth in both the cultivars especially cv. SB-11 showed better performance to aluminium toxicity. The inhibition of root growth and browning of root tips were noticed in both the studied cultivars. A qualitative determination test with the use of hematoxylene also indicated the Al tolerant nature of cv. SB-11.

INTRODUCTION

The problem of soil acidity is becoming acute in the world. About 43% of worlds tropical land is classified as an acidic soil (Magnovaea, 1998). According to Foy (1984), in acidic soil major problem is aluminium toxicity and is manifested in many ways such as drought stress, oxygen deficiency, waterlogging, high bulk density and disturbance in mineral nutrition in different plants. Aluminium toxicity reduces plant growth mainly of plants that grown in acidic soil (Carver and Ownby, 1995; Jayasundara *et al*., 1998). As root and shoot are main targets of aluminium toxicity, the primary symptoms observed on roots (Foy and Fleming, 1978). Aluminium toxicity reduces the size and number of leaves (Thornton *et al*., 1986) and Al in shoot causes cellular and ultra structural changes in leaves, increased rates of diffusion resistance, reduction in stomatal aperture, decreased photosynthetic activity which ultimately causes chlorosis and necrosis of leaves, degradation of thylakoid, induction in lignin deposition, reduction in water uptake and uptake transport metabolism of several essential minerals (Ma *et al*., 1997; Sarkunan *et al*., 1984).

Germination represents a dynamic period in the life cycle of the crop plants that makes the transition from a metabolically quiescent to an active and growing entity. There are very few attempts are available on the influence of aluminium on germination. According to Nosko *et al*., (1988) seed germination is apparently not influenced by Al, but the growth in new root and establishment of seedling was affected by Al. Thus the present investigation was undertaken to examine the Al tolerance in groundnut cultivars.

MATERIALS AND METHODS

Seeds of two cultivars of groundnut i.e. SB-11 and W-55 were collected from Agricultural Research Station, Karad. The seeds were first surface sterilized with 1% sodium hypochloride for two mins. Petri-plates were sterilized with absolute alcohol and lined with filter paper at bottom. Twenty healthy and uniform seeds were placed in each Petri-plate. The desired treatments were given by adding 15cm^3 of aqueous treatment solutions (water-control, 10 ppm, 50 ppm and 100 ppm aluminium as aluminium sulphate). Petri plates were incubated in a BOD incubator at 26 ± 2ºC in dark and investigations were covered at different stages of germination from 24 to 120 hr The emergence of radical from seed coat was acknowledged as criterion for germination and accordingly germination percentage, seedling growth and moisture content were analyzed. The qualitative determination of Al tolerance was investigated following the method of Rincon and Gonzales (1992) and Ownby (1993).

RESULTS AND DISCUSSION

The results showed inhibition in germination percentage for first 24 hr in both cv. SB-11 and W-55 (Table 1). However in cv. SB-11 the performance of seed germination improves with germination period than cv. W-55. It was recovered upto 120 hr except the higher concentration *i.e.* 100 ppm Al treatment which reduced seed germination percentage in both the cultivars of groundnut. The results find support from the work of Narayanan and Saymala (1989). They found reduced germination percentage in pigeon pea by 100 ppm Al-level.

Similarly Bhamburdekar (2002) noticed the initial reduction in germination percentage recovers in later stages of germination by all different Al concentrations ranging from 5 to 50 ppm. In *Vigna sps* the germination percentage were not affected by aluminium and chromium (Jamal *et al*., 2006). The results of the present investigation are contrary to the findings of Neogy *et al*.,(2000). They studied that seed germination declined with increased Al concentration but lower concentrations of Al promotes seed germination. However, according to Rout *et al*., (2001) Al stimulate seed germination, development of new roots and seedling establishment.

The emergence of radical was not evident up to 24 hr of seed germination. But thereafter, both cultivars differ in response to Al treatments. In cv. SB-11 the increment in root length is significant with 10 ppm and 100 ppm Al treatments whereas stimulation in shoot length was noticed with all Al concentrations. In contrast to it, in cv. W-55 inhibition in root and shoot length was noticed by Al and it was more significant with 10 ppm Al. Browning of root tips was also observed in both groundnut cultivars. The inhibition of root growth has been reported by some workers (Kochiana, 1995 and Elison *et al*., 1998). According to Asp *et al*., (1988) shoot growth and seedling growth was mostly enhanced due to lower concentration of Al. Al toxicity causes short, stubby, thickened, brittle and dark brown roots in germinating pigeonpea (Narayanan and Saymala, 1989). Bhamburdekar (2002) investigated inhibition in root growth with browning of root tips due to Al in pigeon pea.

During 24 hr and 120 hr of seed germination the decrease in moisture percentage was recorded in cv. W-55 (Fig. 2). The increase in moisture percentage was evident by 10 and 100 ppm Al-levels during major period of germination in cv. SB-11. During germination of seeds the number of functions played by water. Water deficit causes dehydration of

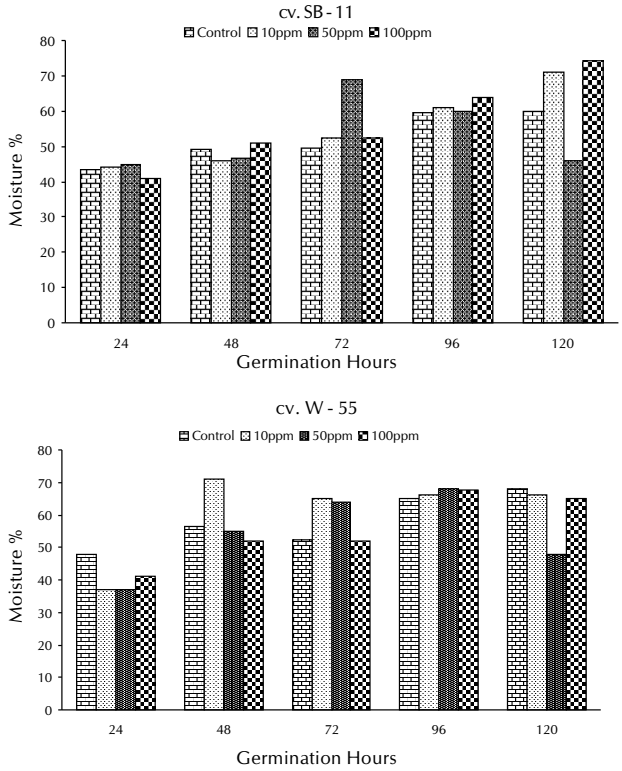

Figure 1: Effect of A1 toxicity on Moisture percentage during groundnut (*Arachis hypogaea* L.) seed germination

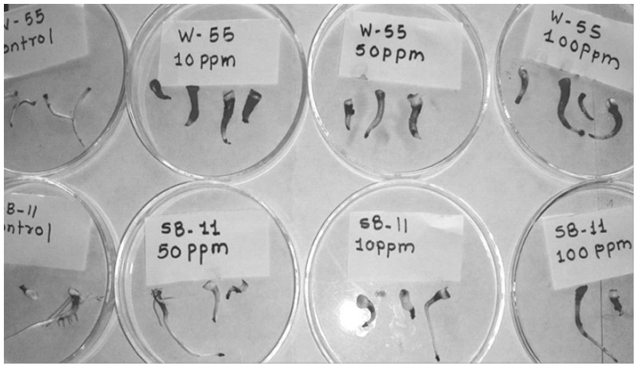

Figure 2: Qualitative determination of Al tolerance in groundnut

Table 1a: Effect of Al on Germination percentage of W-55

Tteatment(ppm)	Germination Percentage				
	24 h	48h	72h	96h	120h
Control	90	100	100	100	100
10	80	100	100	100	100
50	60	100	100	100	90
100	50	80	80	80	80

Table 1b: Effect of Al on Germination percentage of SB-11

Tteatment(ppm)	Germination Percentage				
	24 h	48h	72h	96h	120h
Control	50	100	100	100	100
10	40	100	100	100	100
50	40	80	80	90	90
100	40	80	80	90	90

Table 2: Effect of Al on growth parameters

Parameters	Treatments	Germination hours									
		SB-11					W-55				
		24h	48h	72h	96h	120h	24h	48h	72h	96h	120h
Root length(cm)	Control	-	0.41	0.5	0.6	0.7	-	1.08	2.2	3.1	3.5
	10	-	0.33	o.8	1.0	1. 05	-	0.7	1.2	1.3	1.7
	50	-	0.5	o.4	0.6	1.0	-	0.5	1.3	1.4	2.0
	100	-	0.9	1.0	1.3	1.30	-	0.2	0.9	1.2	1.6
Shoot Length(cm)	Control	-	0.5	0.6	0.8	1.0	-	0.8	1.2	1.5	2.1
	10	-	0.46	0.70	1.02	1.07	-	0.66	0.8	0.9	1.1
	50	-	0.55	1.0	1.2	1.4	-	0.72	1.0	1.2	1.4
	100	-	0.6	1.0	1.3	1.4	-	0.27	0.7	1.1	1.3

Each value is a mean of three replications containing 20 seeds per plate; Due to poor performance data are left unexpressed where the mark (-) is given.

protoplasm (Levitt, 1956) which results in loss of turgor. Thus a reduction in moisture percentage is an obvious effect of water stress in almost all plant species.

Hematoxylene stain forms complexes with Al on roots and exhibit extensive dark purple staining (Photoplate-1). The development of purple color with hematoxylene was noticed with all Al concentrations in cv. W-55 and it was more distinct with 10 and 100 ppm Al treatments where the entire portion of root is stained dark purple. In cv. SB-11 the formation of hematoxylene complex was evident only of higher dose of Al *i.e.* 100 ppm. The pattern of hematoxylene staining depends upon differential Al binding to hematoxylene and reacting Al might be fixed in roots tissue as $AlPO_4$. Polle *et al*., (1978) described the difference in hematoxylene staining with Al stressed roots in Al- sensitive and Al-tolerant ones (Rincon and Gonzales, 1992). If the presence of extracellular phosphate in Al-sensitive cultivars and not in Al- tolerant cultivars which may be due to differential staining of roots by hematoxylene.

In the present investigation the initial decrease in germination percentage in both the cultivars was recovered as germination hours increased especially with the higher concentration of Al concentrations. This data indicates the ability of both the cultivars of groundnut to germination and growth under toxic effects of aluminium. Al caused significant decrease in root growth in cv. W-55. The noticeable reduction in moisture percentage at 120 hr in both the cultivars has no effect on germination performance. However, increase in moisture content with all treatments after 48 hr stimulated seed germination in both the cultivars, especially cv. SB-11 shows better performance to Al toxicity. The qualitative determination of Al- tolerance might be observed with groundnut cv. SB-11 than in cv. W-55.

Thus the present work cleared the Al tolerant nature of groundnut cultivar SB-11.

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REFERENCES

Asp, H., Bengtsson, B. and Jensen, P. 1988. Growth and cation uptake in spruce (*Picea abies* Karst) grown in sand culture at various aluminum supply. *Plant Soil.* **111:**127-133.

Bhamburdekar, S. B. 2002. Germination studies in pigeonpea (*Cajanus cajan* L.). Ph. D. Thesis, Shivaji University, Kolhapur, India. pp.104

Carver, B. F. and J. D. Ownby, 1995. Acid Soil Tolerance in wheat. *Advances in Agronomy*. **54:**117-173.

Elison, B., Blancaflor 2, David, L., Jones 2 and Simon, Gilroy. 1998. Alteration in cytoskeleton accompany aluminum induced growth inhibition and morphological changes in 'primary root of maize 1.' *Plant Physiol.* **118:**159- 172.

Foy, C. D. 1984. Physiological effects of hydrogen, aluminium and manganese toxicities in acid soil In: Soil Acidity and liming. Adams F. (Ed). *American Society of Agronomy,* Inc. Madison WI. pp. 57-97

Foy, C. D. and Fleming, A. L. 1978. The physiology of plant tolerance of excess available Al and Mn in acid soils. In: Jung, G. A. (Ed.), Crop tolerance to *Suboptimal Land Conditions, ASA* spec. pub. No. 32. *AM. Soc. Of Agron.,* Madison, Wisconsin. pp. 301-328

Jamal, S. N., Iqbal, M. Z. and Athar, M. 2006. Effect of aluminum and chromium on the growth and germination of mesquite (*Prosopis juliflora* (Swartz) Dc). *Int. J. Environ. Sci. Techn*. Accepted for publication.

Jayasundara, H. P. S., Thomson, B. D. and Tang, C. 1998. *Advances in Agronomy*. **63:** 77-151.

Kochiana, L. V. 1995. Cellular mechanism of aluminium toxicity and resistance in plants. *Annu. Rev. Plant Physiol. Plant Mol. Biol*. **46:** 237-260.

Levitt, J. 1956. The Hardiness of plants. pp. 278. Academic press, New York.

Ma, J. F., Zheng, S. J., Matsumoto, H. and Hiradate, S. 1997. Detoxifying aluminium with buckwheat. *Nature*. **390:** 569-570.

Magnovaea, R. 1998. Adaptation of plants to soil constraints and better nutrient utilization to improve crop productivity. Eds. V. R. Chopra, R. B. Sing and A. Verma. Oxford and IBH publishing Co. Pvt. Ltd., New Delhi. pp- 335 -341.

Narayanan, A. and Saymala, R. 1989. Response of pigeonpea *Cajanus Cajan,* L.) genotypes to aluminium toxicity. *Indian J. plants physiol.* **1:**17-24.

Neogy, M., Dutta, J., Roy, A. K. and Mukherji, S. 2000. Studies on phototoxic effect of aluminum on growth and some morphological parameters of *Vigna radiata* L. wilcz. *J. environ. Biol*. **23:** 411-416.

Nosko, P. Brassard, P., Kramer, J. R. and Kershaw, K. A. 1988. The effect of aluminum on seed germination, early seeding estblishment, growth and respiration of white spruce (*Picea glauca*). *Can. J. Bot.* **66**: 2305-2310.

Ownby, J. D. 1993. Mechanism of reaction of hematoxylin with aluminium treated wheat roots**.** *Physiol. Plant***. 87:** 371-380.

Polle, E., Konzak, C. F. and Kittrick, J. A. 1978. Visual detection of aluminium tolerance level in wheat by hematoxylin staining of seedling roots. *Crop. sci***. 18:** 823-827.

Rincon, M. and Gonzales, R. A. 1992. Aluminium partitioning in intact roots of aluminium–tolerant and aluminium–sensitive wheat (*Triticum aestivum*) cultivars. *Plant Physiol*. **99**:1021-1028.

Rout, G. R., Samantara, S. and Dasp, P. 2001. Aluminium toxicity in plants. *Agronomie.* **21:** 3-21.

Sarkunan, V., Biddapa, C. C. and Nayak, S. K. 1984. Physiology of Al toxicity in rice. *Curr. Sci*. **53:** 822-824.

Thornton, F. C. Schaedle, M. and Raynal, D. L. 1986. Effect of aluminium on the growth of sugar maple in solution culture. *Can. J. For. Res*. **16**: 892-896.

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