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NUTRIENTS DECREASE AL TOXICITY TO DROUGHT RESISTANT VARIETY OF GRAM (*CICER ARIETINUM* VARIETY RSG – 973)

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ABSTRACT

Aluminum third most abundant element of earth's crust usually found in bounded form due to its highly reactive nature. Different environmental factors and pollutants decrease yield of food crops.During this study toxicity of aluminum on drought variety of gram (*Cicer arietinum* variety RSG – 973) was recorded on different parameters. Aluminum decreases its root- shoot length, biomass, dry weight, and R/S ratio at different concentrations; but nutrient supply (Hoagland's medium) decreases the toxic effects.

KEYWORDS:Aluminum, Toxicity, Drought resistant variety, Plant parameters, Hoagland

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INTRODUCTION

Aluminum is third most prevalent metal in earth crust; found natural in soil, water, air[1]. Al^{+3}ionscontribute to soil acidity through their tendency to hydrolyze. The hydrogen ions released give a very low pH value in the soil solution and are a major source of hydrogen in most acid soils[2]. Aluminum (Al) is toxic to plants at low pH and can begin to inhibit root growth within 3 h in solution experiments and finally decrease in yield. Herbaceous species have been mainly used to elucidate the effects of aluminum[3]. Al interferes with uptake or transport and utilization of essential nutrients like Ca, Mn, P, Mg, B, Fe, Cu, K, and Zn[4].

MATERIALS AND METHODS

Plant Materials

Gram (*Cicer arietinum* variety RSG – 973) seeds were obtained from Durgapura Agriculture Research Station, Jaipur, were surface sterilized with 0.1% mercuric chloride ($HgCl_2$). Equal sized seeds were sown at equal distance in Petri dishes lined with filter paper and germinated in dark at 25±5° for 24 h.

Preparation of stock solution of Aluminum and Hoagland's' medium composition

1000 ppm stock solution was prepared with Analar grade aluminum sulphate (**$Al_2(SO_4)_3.16H_2O$**). Various dilutions (100, 250, 500, 750, 1000ppm) were prepared using both distilled water and Hoagland's Solution. To prepare Hoagland's medium KH_2PO_4, KNO_3, $MgSO_4.7H_2O$, Boric acid, $MnCl_2.H_2O$, $ZnSO_4.7H_2O$, $CuSO_4.5H_2O$, Molybdic acid, Fe-EDTA mixed in appropriate composition and make up to one liter of solution.

Treatments for Gram

Group A- Al solutions (100, 250, 500, 750, 1000ppm) made in distilled water; Group B- Al solutions (100, 250, 500, 750, 1000ppm) made in Hoagland's nutrient medium; were shown in petri plates over filter paper. Control of GroupA was set in distilled water whereas of Group B in Hoagland's nutrient solution.

Growth conditions

The plants were grown under 500 watt fluorescent light bulb. This light stayed on for 10 hours a day for 10 days. Harvesting was after 10 days. Root numbers were counted while root-shoot lengths were measured with the help of scale. Fresh weight of root-shoot was measured immediately after harvesting. Roots and shoots were separated and oven dried at 60°C for two days. Dry weight was taken after two days on electronic balance.

RESULTS AND DISCUSSION

Toxicity of different Al concentrations (Diluent = distilled water) on gram

Al does not have any toxicity to seed germination. Others also reported that aluminum does not affect the seed germination[5].Al had no adverse effect on root-shoot number of gram seedlings but their length, more particularly of root, was adversely affected. Root growth inhibition was detected 2-4 days after the initiation of seed germination[6]. Al inhibits root growth and elongation by different mechanisms, including its interactions within symplast, plasma membrane and cell wall[7]. Inhibition of root growth is considered to be primarily the result of inhibition of cell elongation, at least in early stages of toxicity, while reduced cell division can obviously affect growth in older stage[8, 9]. Under Al stress; role of plant growth regulators (ethylene and auxin) which have been implicated in inhibition of root elongation, as shown in lotus and *Arabidopsis*[10].Dry weights of shoot decreased at various concentrations of Al, except at 750 ppm. 100 and 250 ppm caused stronger inhibition of dry matter production in shoot than other concentrations (Table1). Dry weight of roots increased in Al treatments (Table 1). The roots were thick, pale and smaller than control. At 750 ppm, roots were smallest but they had

maximum dry weight (47.9% significant at P<0.5) (Table 1). The least increment in root dry weight was at 500ppm (Table 1). Compared with controls, seedling biomass in Al treatments were also higher. R/S ratios were also higher in Al treatments. Aluminum exposure affected plant growth adversely. In the present investigation, Al stress decreased plant height, root length and plant biomass. These findings are in agreement with other workers[11, 12].It is evident from the ongoing account that Al was toxic to seedlings only at its lower concentrations. This may be due to that drought resistant variety gram seeds need very less water and at higher concentration Al precipitated and remained over the filter paper not available for absorption.

Table 1
Toxicity of different concentrations of Al (diluted with distilled water) on gram (C. arietinum) seedlings.

	Shoot Number	Root Number	Shoot length (cm)	Root Length (cm)	Dry weight of shoot (mg)	Dry weight of root (mg)	Total dry weight (mg)	Root/Shoot dry wt. ratio
Control	1.0±0.0	1.0±0.0	1.3±0.2	5.5±1.2	8.4±0.8	9.4±1.4	17.8±2.2	1.1
100 ppm	1.0±0.0 (Nil)	1.0±0.0 (Nil)	1.0±0.3 (-23.1%)	5.2±0.3 (-5.5%)	4.5±1.4* (-46.4%)	12.2±0.7 (+29.8%)	16.7±1.9 (-6.2%)	2.7 (+144.1%)
250 ppm	1.0±0.0 (Nil)	1.0±0.0 (Nil)	1.1±0.1 (-15.4%)	4.7±0.3 (-14.7%)	4.5±0.5* (-46.4%)	11.5±1.6 (+22.3%)	16.1±1.9 (-9.6%)	2.6 (+130.6%)
500 ppm	1.0±0.0 (Nil)	1.0±0.0 (Nil)	1.4±0.4 (+7.7%)	3.4±0.3 (-38.2%)	6.6±2.3 (-21.4%)	11.1±1.4 (+18.1%)	17.8±3.4 (Nil)	1.7 (+51.4%)
750 ppm	1.0±0.0 (Nil)	1.0±0.0 (Nil)	2.0±0.1* (+53.8%)	2.6±0.2* (-52.7%)	9.6±0.9 (+14.3%)	13.9±1.2* (+47.9%)	23.6±1.6 (+32.6%)	1.5 (+30.6%)
1000 ppm	1.0±0.0. (Nil)	1.0±0.0 (Nil)	1.6±0.1 (+23.1%)	3.3±0.3 (-40.0%)	6.8±0.8 (-19.0%)	12.9±1.3 (+37.2%)	19.7±0.9 (+10.7%)	1.89 (+70.3%)

Significance at 5% ** 1% and *** 0.1% probability, data in parenthesis indicate percent change in values in comparison to control

Toxicity of different Al concentrations of Al (diluted with Hoagland's solution) on gram seedlings

There was dose dependent reduction in length, dry weight of shoot, root and seedlings in Al treatments (except 100 ppm) when compared with control. The maximum phytotoxicity of Al on gram seedlings was recorded at 500ppm and 750ppm (Table. 2). Compare to group-I; there is protection to root- shoot length, mass, dry mass and to their root-shoot ratio when nutrient medium provided. R/S ratio is comparatively less in group-II represented good absorption by plant. Al toxicity at similar concentrations was relatively less when dilutions (100 and 250 ppm) of stock solution were made in Hoagland's nutrient (Table. 1 & 2). This may be either on account of chelation of Al with EDTA or competition of Al with divalent cations for absorption. Others also reported that maize seedlings with roots exposed to solutions of Al complexed by citrate, EDTA, or soil organic matter extract, were not significantly different in appearance, yields, or chemical analyses of their tops from plants not receiving Al[13].

Table 2
Toxicity of different concentrations of Al (diluted with Hoagland's solution) on gram (C. arietinum) seedlings.

	Shoot Number	Root Number	Shoot length (cm)	Root Length (cm)	Dry weight of shoot (mg)	Dry weight of root (mg)	Total dry weight (mg)	Root/Shoot dry wt. ratio
Control	1.0±0.0	1.0±0.0	2.0±0.3	5.9±0.9	11.4±1.1	15.1±2.5	26.5±3.0	1.3
100 ppm	1.0±0.0 (Nil)	1.0±0.0 (Nil)	2.0±0.3 (Nil)	7.5±.05 (+27.1%)	8.8±0.6 (-22.8%)	17.3±0.6 (+14.5%)	26.1±0.8 (-15.1%)	1.9 (+48.5%)
250 ppm	1.0±0.0 (Nil)	1.0±0.0 (Nil)	1.2±0.3 (-40.0%)	5.8±0.5 (-1.7%)	6.5±1.6* (-42.9%)	14.4±0.7 (-4.6%)	20.9±1.8 (-21.1%)	2.2 (+66.7%)
500 ppm	1.0±0.0 (Nil)	1.0±0.0 (Nil)	1.1±0.4 (-45.0%)	3.6±0.3* (-38.9%)	3.9±1.4* (-65.8%)	10.9±1.9 (-27.8%)	14.7±2.9* (-44.5%)	2.8 (+111.4%)
750 ppm	1.0±0.0 (Nil)	1.0±0.0 (Nil)	0.7±0.2* (-65.0%)	3.3±0.3* (-44.1%)	3.8±1.5* (-66.7%)	8.4±1.1 (-44.4%)	12.2±1.5* (-53.9%)	2.2 (+67.4%)
1000 ppm	1.0±0.0. (Nil)	1.0±0.0. (Nil)	1.3±0.2 (-35.0%)	3.0±0.3* (-49.2%)	5.7±0.5** (-50.0%)	12.2±0.7 (-19.2%)	17.8±0.6 (-32.8%)	2.1 (+62.1%)

Significance at 5% ** 1% and *** 0.1% probability, data in parenthesis indicate percent change in values in comparison to control

CONCLUSION

The lower concentrations were toxic to RSG – 973 drought resistant variety of gram and Hoagland's nutrient medium provides supports to seedling growth and decreased Al toxicity.

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