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EFFECT OF VARIOUS MICRONUTRIENTS ON SEED GERMINATION OF *AMARANTHUS SPINOSUS* L.

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The effect of micronutrients, *viz.* $CuSO_4$, H_3BO_3, $MnSO_4$ and $ZnSO_4$ on seed germination and seedling growth of *Amaranthus spinosus* L. has been studied. Treatment with various micronutrients improved seed germination and seedling growth (at certain concentration) as compared to control.

Keywords: *Amaranthus spinosus;* $CuSO_4$; H_3BO_3; $MnSO_4$; $ZnSO_4$.

Introduction

Amaranthus spinosus (Prickly amaranths) belongs to family Amaranthaceae commonly used as vegetables and grains[1]. Plant is also used as a pot herb, poultice to abscess, boils, burns, snake bite etc. and regarding medicinal properties. It is also used in colic pain, leucorrhoea and as diuretics[2].Seeds of many plants are unable to germinate while they are enclosed within the fruit attached to the parent plant or for a period of time after fruit ripening and seed dispersal. The essential requirements for seed germination are availability of water, proper temperature, oxygen and light. Besides the environmental factors, nutrients and growth regulators are also required for germination. Thus, present paper deals with the effect of micronutrients on seed germination and seedling growth of *Amaranthus spinosus.*

Material and Method

Seeds of *Amaranthus spinosus* were collected from different sites located in Jaipur and stored in glass stopper bottles. After a preliminary selection for uniformity (criteria being the size and colour of the seed), the seeds were surface sterilized with 0.1% $HgCl_2$ for two minutes and repeatedly washed with distilled water[3].Then the seeds were soaked for 24 hours in aqueous solution of different concentrations, *viz.*50, 100, 200, 500, and 1000 ppm of $CuSO_4$, H_3BO_3, $MnSO_4$ and $ZnSO_4$. Soaked seeds were washed thoroughly with distilled water. Seeds soaked in distilled water for 24 hours were taken as control in all the cases. Treated seeds were then kept for germination in petri dishes over filter paper, kept moist by distilled water. Three replicates of 10 seeds were used for each concentration of every chemical. The experiments were conducted at laboratory conditions. After pretreatments of seeds, they were allowed to germinate for 10 days. On the completion of this (11th day) number of seeds germinated and seedling growth parameters *viz.*, hypocotyls and radical length were recorded and tabulated. All the data were statistically analysed.

Results and Discussion

It is reported that accelerated rate of germination of mung bean, maize and cabbage in a wide range of concentrations of manganese sulphate[4]. Lower concentrations of manganese favoured germination but higher concentrations were toxic in black gram[5]. On the contrary, it is also observed that no specific symptoms of toxicity in pigeon pea at higher levels of manganese[6]. The effect of spraying onion plants with $MnSO_4$ and $ZnSO_4$ which improved seed germination. Spraying onion plant with 0.1% solution of Zn and Mn gave the highest percentage of seed germination. Application of IAA with either Zn or Mn also gave significant increase in the percentage of seed germination[7]. Treatments at 200 and 500 ppm concentration of all micronutrients showed promontory effects on seed germination in comparison to the control. Lower concentrations (200 ppm) of H_3BO_3, $CuSO_4$ and $MnSO_4$ were found most favourable whereas $ZnSO_4$ enhance seed germination (73.33 %) up to 500 ppm. Most inhibitory effect was observed at 1000 ppm of $ZnSO_4$. All the results were highly significant (Table1).

Boron is known to have involvement in protein metabolism. The deficiency of boron caused increased accumulation of phenolic compounds[8] .The increase in RNAase activity in boron deficient sunflower is observed[9].Similar observations were also recorded for beans[10]. It was observed that lower concentrations of boron favoured seed germination in *Tecoma stans, Tecomella undulata* and *Haphlophragma adenophyllum* but radicle and hypocotyl length was better at 500 ppm

Table 1. Effect of micronutrients on seed germination (%) of A. spinosus.

S.No.	Micro nutrients	Control	Concentration (ppm) 50	100	200	500	1000
1	$CuSO_4$	13.33	20.00	50.00	50.00	30.00	20.00
2	H_3BO_3	13.33	43.33	73.33	80.00	60.00	30.00
3	$MnSO_4$	13.33	40.00	50.00	70.00	60.00	36.66
4	$ZnSO_4$	13.33	40.00	53.33	60.00	73.33	23.33

Analysis of variance

Source of variation	DF	SS	MSS	F-ratio
Conc. within $CuSO_4$	5	1534.0772	306.8154	10.26**
Conc. within H_3BO_3	5	3951.1652	790.2330	26.44**
Conc. within $MnSO_4$	5	2333.2747	466.6549	15.61**
Conc. within $ZnSO_4$	5	3010.2302	602.0460	20.14**
Between micronutrients	3	1403.8822	467.9607	15.66**
Error	48	1434.2147	29.8794	-

** Highly significant

Table 2. Effect of micronutrients on radicle length (cm) of *A. spinosus.*

S. No.	Micro nutrients	Control	Concentration (ppm) 50	100	200	500	1000
1	$CuSO_4$	1.51	1.58	1.73	1.58	1.67	1.26
2	H_3BO_3	1.51	1.96	2.50	2.90	2.00	1.63
3	$MnSO_4$	1.51	2.36	2.56	2.20	1.80	1.46
4	$ZnSO_4$	1.51	1.63	1.90	2.16	1.90	1.60

Analysis of variance

Source of variation	DF	SS	MSS	F-ratio
Conc. within $CuSO_4$	5	0.3969	0.0793	1.08NS
Conc. within H_3BO_3	5	4.1540	0.8308	11.37**
Conc. within $MnSO_4$	5	3.1573	0.6314	8.64**
Conc. within $ZnSO_4$	5	0.9040	0.1808	2.47*
Between micronutrients	3	2.9286	0.9762	13.37**
Error	48	3.5046	0.0730	-

NS: Non Significant; *Significant; ** Highly significant

concentration[11]. In the present work increasing concentration up to 200 ppm gave the best percentage of seed germination as well as radicle and hypocotyle growth also at 200ppm of H_3BO_3.

Manganese is known to cause hormonal imbalance in plant metabolism. Decrease in IAA oxidase activity was observed in cotton[12]. Participation of manganese in Hill reaction has also been established. The role of manganese either as an activator or a constituent of enzyme is well documented[13]. It is reported that manganese is essential for the growth of five species of Lemnaceae and he observed when plants are deprived of Mn, growth ceases after a time and typical symptoms of deficiency appears and again supplied with the element recovery may be observed readily within 3 days[14]. Application of $CuSO_4$ showed that radicle length increased as the concentration increases and was maximum (1.73 cm) at 100 ppm concentration and lowest (1.26 cm) at 1000 ppm which was lesser than the control. The treatment of H_3BO_3 and $ZnSO_4$ showed that length of radicle was maximum at 200 ppm *i.e.* 2.90 and 2.16 cm, respectively. $MnSO_4$ gave the best results at 100 ppm for radicle length

Table 3. Effect of micronutrients on hypocotyl length (cm) of *A. spinosus.*

S. No.	Micro	Control	Concentration (ppm)				
			50	100	200	500	1000
1	$CuSO_4$	1.30	1.48	1.59	1.31	1.46	1.20
2	H_3BO_3	1.30	1.53	2.00	2.00	1.63	1.30
3	$MnSO_4$	1.30	1.96	1.83	1.83	1.60	1.30
4	$ZnSO_4$	1.30	1.43	1.96	1.96	1.93	1.63

Analysis of variance

Source of variation	DF	SS	MSS	F-ratio
Conc. within $CuSO_4$	5	0.3139	0.0627	0.71NS
Conc. within H_3BO_3	5	1.5027	0.3005	3.40*
Conc. within $MnSO_4$	5	1.2427	0.2485	2.81*
Conc. within $ZnSO_4$	5	1.2961	0.2592	2.93*
Between Micronutrients	3	1.0130	0.3376	3.82*
Error	48	4.2322	0.0881	-

NS: Non significant; *Significant.

(2.56 cm) but minimum, *i.e.* 1.46 cm at 1000 ppm lower than the control. Data regarding statistical analysis, the only concentration within $CuSO_4$ was not significant while rest of all were significant (Table 2).

The effect of Cu and Ni studied on *Acer rubrum, Cornus stolonifera, Lonicera tatarica* and *Pinus resinosa.* It was observed that *Lonicera* was most sensitive to all concentrations of Ni and Cu in terms of growth retardation while *Acer* and *Cornus* were highly sensitive to higher concentrations of copper alone[15]. It is found that heavy metals inhibited seedling growth in *Hordeum vulgare* var. BH-75 and BG-25, the order of toxicity was Cd > Ni > Zn[16]. Higher concentration of Zn promoted seedling growth in groundnut. Higher concentrations suppressed the growth in all other crop plants[17]. Similar results were also observed with four cultivars of *Raphanus sativus* where higher concentrations of Zn and Cu decreased seedling length[18]. Higher concentrations of Zn inhibited both radicle and hypocotyl length in *Tecomella undulata* and *Tecoma stans.* However, in *Haplophragma adenophyllum* higher concentrations of Cu and Zn favoured seedling growth[11]. Similarly stimulation of radicle and hypocotyl growth at higher concentration of $ZnSO_4$ in *Ephedra foliata*[19]. It has been reported that mercury inhibited seed germination and seedling growth in *Phaseolus aureus*[20], *Sorghum,* finger millet and green gram[21], and also in eleven species including crop and vegetable plants[22]. Zn and Cu at 100, 200 and 500 ppm concentrations decreased seed germination in four cultivars of *Raphanus sativus*[18]. The seed germination decreased at higher concentration of Cu in *A. spinosus,* where it is favoured in the present study of $ZnSO_4$. $CuSO_4$ (100 ppm) promote the hypocotyle growth *i.e.*, 1.59 cm, where the 1000 ppm showed inhibitory effect on growth (*i.e.* 1.20 cm) which was lesser than the control (1.30 cm). With increase in concentration of, $ZnSO_4$ promote hypocotyl length (1.63cm) up to 100 or 200 ppm. A definite pattern is found with response to H_3BO_3 and $MnSO_4$ and the highest was same at 100 and 200 ppm concentrations having length 2.00 and 1.83 cm, respectively. In both H_3BO_3 and $MnSO_4$ at 1000 ppm results were equal to control *viz.* 1.30 cm. Statistically all results were significant except concentration within $CuSO_4$ (Table 3).

In 500 ppm of $ZnSO_4$ was found to be more effective where 73.33% increase in seed germination was recorded. It is observed that concentration of 200 ppm of Mn gave 70% germination. For seedling growth 100 ppm concentration of $CuSO_4$ were favourable for both radicle and hypocotyl growth, while 200 ppm of $ZnSO_4$ concentration were also found most suitable. Regarding seedling growth enhancement was found up to 200 ppm only. Our findings are similar to existing data. Relative effectiveness on percentage seed germination and hypocotyl length is $H_3BO_3 > ZnSO_4 > MnSO_4 > CuSO_4$. For radicle length is $H_3BO_3 > MnSO_4 > ZnSO_4 > CuSO_4$.

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