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EFFECT OF MICRONUTRIENTS ON SEED GERMINATION OF *AMARANTHUS HYBRIDUS* SUBSP. *CRUENTUS*(L) VAR. *PANICULATUS* (L.) THEL L.

PRAVEEN MOHIL and USHA JAIN*
Department of Botany, Govt. Lohia P.G. College, Churu, Rajasthan, India.
*Department of Botany, University of Rajasthan, Jaipur ,Rajasthan, India.
praveenmohil@gmail.com

The effect of micronutrients, *viz.* $CuSO_4$, H_3BO_3, $MnSO_4$ and $ZnSO_4$ on seed germination and seedling growth of *Amaranthus hybridus* subsp. *Cruentus* (L) var. *paniculatus* (L.) Thell. L. has been studied. Treatment with various micronutrients improved percentage seed germination and seedling growth (at certain concentrations) as compared to control.

Keywords: Amaranthus hybridus subsp. *cruentus* (L.) var. *paniculatus* (L.) Thell; $CuSO_4$; H_3BO_3; $MnSO_4$; $ZnSO_4$.

Introduction

Amaranthus hybridus subsp. *cruentus* (L) var. *paniculatus* (L.) Thell. belongs to family Amranthaceae, commonly used as vegetables and its grains known as *Ramdana* or *Salgira.* It is an important pseudo cereal. Plant is used as a pot herb, to treat intestinal haemorage, ulcer,diarrhea,dysentery piles, and excessive menstrual flow. Plant has a cleansing effect and helps to reduce tissue swelling with blood purifiering properties. The essential requirements are availability of water, proper temperature, oxygen and light. Besides the environmental factors, nutrients and growth regulators are also required for seed germination. Thus, the present study deals with the effect of micronutrients on seed germination and seedling growth of *Amaranthus hybridus* subsp. *cruentus* (L.) var. *paniculatus* (L.) Thell.

Material and Methods

Seeds of *Amaranthus hybridus* subsp. *cruentus* (L) var. *paniculatus* (L.) Thell were collected from different sites located in Jaipur and stored in glass stoppered 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[1]. 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 for every chemicals.The experiments were conducted at laboratory conditions.After pretreatments of seeds,they were allowed to germinate for 10 days. On the completion of this (11^{th} 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

Manganese is known to cause hormonal imbalance in plant metabolism. Decrease in IAA oxidase activity was observed in cotton[2]. Participation of manganese in Hill reaction has also been established[3]. The role of manganese either as an activator or a constituent of enzyme is well documented[4]. It is reported that Mn is essential for the growth of five species of Lemnaceae and it was observed that when plants were deprived of Mn, growth ceased after a time and typical symptoms of deficiency appeared and again supplied with the element, recovery was observed readily within 3 days[5].

Accelerated rate of germination of mung bean, maize and cabbage was found in a wide range of concentrations of manganese sulphate[6]. The lower concentrations of manganese favoured germination but higher concentrations were toxic in black gram. On the contrary, it is also observed that no specific symptoms of toxicity were shown in pigeon pea at higher levels of manganese[7]. Spraying with $MnSO_4$ and $ZnSO_4$ on onion plants has improved seed germination and 0.1% solution of Zn and Mn gave the highest percentage of seed germination. Application of IAA with either Zn or Mn

Table 1. Effect of micronutrients on seed germination (%) of *A. hybridus* subsp. *cruentus* var. *paniculatus.*

S.No.	Micronutrients	Concentration (ppm)					
		Control	50	100	200	500	1000
1	$CuSO_4$	60.00	63.33	63.33	66.66	80.00	63.33
2.	H_3BO_3	60.00	56.66	83.33	73.33	66.67	53.33
3.	$MnSO_4$	60.00	80.00	70.00	66.66	56.67	53.33
4.	$ZnSO_4$	60.00	53.33	46.66	73.33	80.00	66.67

Analysis of variance

Source of variation	DF	SS	MSS	F-ratio
Conc. within $CuSO_4$	5	328.4444	65.6888	0.69 NS
Conc. within H_3BO_3	5	1083.4435	216.6887	2.29NS
Conc. within $MnSO_4$	5	625.7832	125.1566	1.32NS
Conc. within $ZnSO_4$	5	1235.3247	247.0649	2.61*
Between micronutrients	3	18.8579	6.2859	0.06 NS
Error	48	4536.9013	94.5187	-

NS Non significant ; * Significant;

Table 2. Effect of micronutrients on radicle length (cm) of *A. hybridus* subsp. *cruentus* var. *paniculatus.*

S.No.	Micronutrients	Concentration (ppm)					
		Control	50	100	200	500	1000
1	$CuSO_4$	3.43	1.65	2.90	0.95	0.54	1.16
2.	H_3BO_3	3.43	3.17	2.49	2.03	3.98	2.47
3.	$MnSO_4$	3.43	2.49	2.34	2.87	2.78	2.16
4.	$ZnSO_4$	3.43	3.38	2.04	1.94	1.57	1.50

Analysis of variance

Source of variation	DF	SS	MSS	F-ratio
Conc. within $CuSO_4$	5	19.5537	3.9107	8.08**
Conc. within H_3BO_3	5	7.8496	1.5699	3.24*
Conc. within $MnSO_4$	5	3.0937	0.6187	1.27NS
Conc. within $ZnSO_4$	5	9.8655	1.9731	4.07**
Between micronutrients	3	13.2499	4.4166	9.13**
Error	48	23.2156664	0.4836	-

NS Non significant; * Significant; ** Highly significant

Table 3. Effect of micronutrients on hypocotyl length (cm) of *A. hybridus* subsp. *cruentus* var. *paniculatus.*

S.No.	Micronutrients	Concentration (ppm)					
		Control	50	100	200	500	1000
1	$CuSO_4$	2.46	2.63	2.52	1.35	0.68	1.11
2.	H_3BO_3	2.46	2.39	2.42	2.52	2.74	2.38
3.	$MnSO_4$	2.46	1.81	1.95	2.33	2.70	2.69
4.	$ZnSO_4$	2.46	2.37	2.55	2.89	2.74	2.32

Analysis of variance

Source of variation	DF	SS	MSS	F-ratio
Conc. within $CuSO_4$	5	10.7117	2.1423	11.1147**
Conc. within H_3BO_3	5	0.2709	0.0541	0.2811NS
Conc. within $MnSO_4$	5	2.1086	0.4217	2.1879 NS
Conc. within $ZnSO_4$	5	0.7234	0.1446	0.7506NS
Between micronutrients	3	6.4153	2.1384	11.0945**
Error	48	9.2518	0.1927	-

NS Non significant; ** Highly significant

also gave significant increase in the percentage of seed germination[8]. In the present study seed germination was found to be maximum at 100 ppm concentrations of H_3BO_3, and $MnSO_4$, and thereafter with increasing concentration decrease in the germination was observed. In $ZnSO_4$, and a $CuSO_4$ highest germination *i.e.* 80.00 % was recorded at 500 ppm(Table1).Among all treatments Boron gave most superior result at lower concentrations.

The effect of Cu and Ni on *Acer rubrum, Cornus stolonifera, Lonicera tatarica* and *Pinus resinosa* was studied and found 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 Cu alone[9]. 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[10]. The higher concentration of Zn promoted seedling growth in groundnut. Higher concentrations suppressed the growth in all other crop plants[11]. Similar results were also observed with four cultivars of *Raphanus sativus* where higher concentrations of Zn and Cu decreased seedling length[12]. The 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[13]. Similar stimulation of radicle and hypocotyl growth was observed at higher concentration of $ZnSO_4$ in *Ephedra foliata*[14]. Mercury inhibited seed germination and seedling growth in *Phaseolus aureus*[15]. In *Sorghum,* finger millet and green gram similar findings were also observed[16,17]. Whereas Zn and Cu at 100, 200 and 500 ppm concentrations showed decrease in seed germination in four cultivars of *Raphanus sativus*[12].

In the present investigation $CuSO_4$ showed increase in germination up to 500 ppm of concentration. 500 ppm of $ZnSO_4$ was found to be more effective where 83% increase in germination was recorded. Regarding effect on radical length $ZnSO_4$ and $CuSO_4$ enhanced growth slightly at 50 and 200 ppm, respectively. Increasing concentration of $CuSO_4$ and $MnSO_4$ showed inhibition on radical growh (Table 2). 50 ppm of $CuSO_4$ and 200 ppm of $ZnSO_4$ showed maximum increase in growth of hypocotyls *i.e.* 2.63 and 2.89 cm, respectively, whereas higher concentrations of $CuSO_4$ gave least growth as compared to control. 500 ppm of H_3BO_3 and $MnSO_4$ were found to be most favourable (2.74 and 2.70 cm, respectively) for growth (Table 3).

Boron is known to have involvement in protein

metabolism. The deficiency of boron caused increased accumulation of phenolic compounds[18]. It is also reported that the increase in RNAase activity is associated with boron deficiency in sunflower[19]. Similar findings were also reported for beans[20]. Lower concentrations of boron favoured seed germination in *Tecoma stans, Tecomella undulata* and *Haphlophragma adenophyllum* but radicle and hypocotyl length was found better at 500 ppm concentration[13]. In the present work increasing concentrations up to 100 ppm gave the best percentage of seed germination as well as radicle and hypocotyle growth at 50 and 200 ppm, respectively of H_3BO_3.

Different micronutrient concentrations have promotory effect, seems to have relative effectiveness on percentage seed germinationan and radicle length in H_3BO_3 > $MnSO_4$ > $ZnSO_4$,$CuSO_4$ treatments. For hypocotyl length, the relative effectiveness is H_3BO_3 > $ZnSO_4$ > $MnSO_4$ > $CuSO_4$.

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