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Impact of Cobalt on Germination and Seedling Growth of *Eleusine coracana* L. And *Oryza sativa* L. Under Hydroponic Culture

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Abstract: Germination studies were conducted in ragi (*Eleusine coracana* L.) and paddy (*Oryza sativa* L.) inorder to find out the impact of soil cobalt level on germination and seedling vigour. The seeds of ragi and paddy were germinated with six concentrations of cobalt chloride solution ranging from 5-100 mg/l in hydroponic condition upto 8 days. The germination was found increased significantly under low level of cobalt with decreased in germination and reduction in the length of radical and plumule were observed in seeds of ragi and paddy. Vigour index, tolerance index and dry weight of root and shoot of the seedlings increased at low level of cobalt treatments and decreased with increase in cobalt concentrations. However, the germination percentage of ragi and paddy seeds showed a significant difference with cobalt treatment.

Key words: Cobalt, Ragi, Paddy, Germination, Seedling, Vigour, Hydroponics

INTRODUCTION

The presence of heavy metals in the environment is of major concern because of their toxicity and threat to plant and animal life. Moreover, recovery of heavy metals from industrial waste streams is becoming increasingly important as society realises the necessity for recycling and conservation of essential metal waste streams from metal plating, mining operations and semi conductor manufacturing operations [1].

Cobalt as a heavy metal pollutant has been studied by Jayakumar and Vijayarengan [2], Terry [3] and Wallace *et al*. [4]. As cobalt is an important heavy metal pollutant, it is of interest to study its effect on the germination and seedling growth of ragi (*Elusine coracana* L.) and paddy (*Oryza sativa* L.).

MATERIALS AND METHODS

Seeds of ragi (*Elucsine coracana* L.) cv CO1 were obtained from Tamil Nadu Agricultural University, Coimbatore and seeds of paddy (*Oryza sativa* L.) cv ADT-43 were obtained from Tamilnadu Rice Research Institute, Aduthurai. The present study was taken up with cobalt ($CoCl_2$) at 5, 10, 25, 50, 75 and 100 mg Co/L along with control (untreated). Ten seeds of each of ragi and paddy were surface sterilized with 0.1% of mercuric chloride and washed thoroughly with tap water and then with distilled water.

Ten uniform sized seeds were placed in petridish of 10 cm with different concentrations of cobalt chloride solution (5, 10, 25, 50, 75 and 100 mg Co/L) in a seed germinator at a constant temperature 28°C. The seeds were irrigated with 10 ml of test solutions and distilled water twice a day. Each treatment was replicated five times. The number of seeds germinated in each treatment was counted on 5 days after sowing (DAS) and the total germination percentage was calculated. The root and shoot length of seedlings in various cobalt levels were measured on 8 DAS. Vigour index of the seedlings was calculated by using the formula proposed by Abdul-Baki and Anderson [5]. Tolerance index of the seedlings was

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calculated by using the formula of Turner and Marshal [6]. The plant samples were kept in an oven at 60°C for 24 hours and the dry weights were taken by using electronic balance.

RESULTS AND DISCUSSION

The result of the study was given in Table 1 and 2. Germination percentage, decreased at higher concentration of cobalt. Reduction in germination percentage of ragi and paddy at higher concentrations may be attributed to the interference of cobalt ions. Similar inhibition of germination at higher concentrations was observed by Jayakumar and Vijayarengan [7] with cobalt treatment in *Vigna mungo* (L.) Hepper and Mahalakshmi and Vijayarengan [6] with zinc (Three plant species).

Seedling vigour, dry weight, vigour index and tolerance index were increased at lower concentration (5 mg Co/L) and decreased at higher concentration (10-100 mg Co/L). The significant increase in radicle and plumule length and dry weight of ragi seedlings at 5 mg Co/L concentration suggested that low concentration of cobalt was beneficial for seedling growth. Cobalt at higher concentrations suppressed the seedling growth and dry weight of the ragi and paddy seedlings.

Cobalt at higher levels may inhibit the root growth directly by inhibition of cell division or cell elongation or combination of both, resulting in the limited uptake and translocation of nutrition and water and induced mineral deficiency. The dry phytomass yield decreased at higher levels of cobalt might be due to poor growth of seedlings. At higher concentrations it acts as a toxic metal. Similar results were reported on the effect of cobalt [Jayakumar and Vijayarengan [2] (*Vigna mungo* (L.) Hepper)], cadmium [Kalita *et al*. [8] (*Triticum aestivum)*], chromium [Corradi *et al*. [9] (*Salvia sclarea*)], cobalt (Terry 1981; Wallace *et al*. [3]) and cobalt and zinc [Burhan [4] (*Pennisetum americanum* (L.) and *Parkinsonia aculeata* L.)]. Results obtained from the germination studies indicated that the ragi showed higher germination percentage, seedling growth and dry weight at 5 mg l^{-1} cobalt level in the medium. The values of growth parameters indicated that cobalt had a significant stimulating, beneficiary and nutritional effect at 5 mg l^{-1} concentration for both ragi and paddy. The growth process beyond this concentration indicated that a little excess of cobalt above these levels had an adverse effect. From the results of this investigation, it can be concluded that cobalt at lower concentrations has a stimulating effect on the germination process and seedling growth and will inhibit the same at higher concentrations.

Table 1: Effect of Cobalt on Seed Germination, Dry Weight, Vigour Index Tolerance Index of the Ragi (8th Day)

Cobalt level mg/L	Germination percentage	Length (cm) Root	Length (cm) Shoot	Dry weight (10 pts) Root	Dry weight (10 pts) Shoot	Vigour index	Tolerance index
Control	100 ± 3.84	2.98 ± 0.101	15.73 ± 0.524	0.08 ± 0.003	0.18 ± 0.006	1871 ± 60.354	-
5	100 ± 3.84	3.81 ± 0.130	17.86 ± 0.612	0.09 ± 0.003	0.21 ± 0.009	2167 ± 72.000	1.27 ± 0.022
10	99 ± 3.80	2.93 ± 0.100	13.39 ± 0.312	0.07 ±0.002	0.17 ± 0.005	1615 ± 57.500	0.98 ± 0.042
25	96 ± 36.9	2.34 ± 0.078	11.92 ± 0.201	0.06 ± 0.002	0.16 ± 0.006	1368 ± 45.323	0.78 ± 0.040
50	94 ± 3.61	1.87 ± 0.040	9.16 ± 0.196	0.05 ± 0.002	0.14 ± 0.005	1036 ± 34.301	0.62 ± 0.039
75	93 ± 3.57	1.65 ± 0.039	8.81 ± 0.192	0.03 ± 0.001	0.13 ± 0.006	972 ± 32.101	0.55 ± 0.029
100	91 ± 3.50	1.12 ± 0.021	7.63 ± 0.190	0.02 0.001	0.11 ± 0.004	796 ± 26.102	0.37 ± 0.010

The values are mean ± SD of 7 replicates

Table 2: Effect of Cobalt on Seed Germination, Dry Weight, Vigour Index Tolerance Index Tolerance Index of the Paddy (8th Day)

Cobalt level mg/L	Germination percentage	Length (cm) Root	Length (cm) Shoot	Dry weight (10 pts) Root	Dry weight (10 pts) Shoot	Vigour index	Tolerance index
Control	100 ± 3.84	3.11 ± 0.115	16.18 ± 0.599	0.09 ± 0.003	0.19 ± 0.001	1929 ± 68.892	-
5	100 ± 3.84	3.98 ± 0.153	17.89 ± 0.640	0.10 ±0.001	0.22 ± 0.012	2187 ± 78.167	1.27 ± 0.042
10	100 ± 3.84	2.94 ± 0.113	15.43 ± 0.431	0.08 ± 0.002	0.18 ± 0.011	1837 ± 65.607	0.94 ± 0.031
25	98 ± 3.76	2.46 ± 0.112	15.13 ± 0.422	0.07 ± 0.002	0.16 ± 0.010	1721 ± 59.344	0.79 ± 0.026
50	95 ± 3.65	1.93 ± 0.110	12.69 ± 0.212	0.05 ± 0.001	0.13 ± 0.010	1388 ± 47.862	0.62 ± 0.020
75	93 ± 3.57	1.57 ± 0.010	10.73 ± 0.199	0.03 ± 0.001	0.11 ± 0.099	1143 ± 39.413	0.55 ± 0.029
100	91 ± 3.25	1.18± 0.099	8.98 ± 0.182	0.02 ± 0.001	0.9 ± 0.098	1016 ± 31.623	0.37 ± 0.010

The values are mean ± SD of 7 replicates

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