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Toxicity Effect on Eleusine Coracana (Ragi) Under Hydroponic Condition

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Abstract: ***Elevated levels of heavy metals in contaminated soils are extensively increased and concerns have been raised over the potential risks to humans, animals and agricultural crops. This study was conducted to evaluate the impact of different soil levels of cadmium & nickel on germination and seedling vigour in ragi (Eleusine coracana L.). The seeds of ragi were germinated with six concentrations of cadmium chloride and nickel chloride solutions ranging from 5-100 mg/l in hydroponic condition upto 8 days. The germination was found increased significantly under low level of cadmium and nickel but decrease in germination and reduction in the length of radical and plumule were observed in seeds of ragi as the concentrations of cadmium and nickel were raised. Vigour index, tolerance index and dry weight of root and shoot of the seedlings increased at low level of cadmium and nickel treatments and decreased with increase in cadmium & nickel concentrations. However, observations indicate that at high concentrations, cadmium has more toxic effect than nickel.***

Key words: Cadmium, Nickel, Ragi, Germination, Seedling, Vigour, Hydroponics

Introduction

The existence of heavy metals in the environment is of major concern because of their toxicity and threat to plant and animal life. Moreover, since society realizes the necessity for recycling and conservation of essential metal waste streams from metal plating, mining operations and semiconductor manufacturing operations, the recovery of heavy metals from industrial waste streams is becoming gradually more significant.

Some heavy metals, such as zinc (Zn), manganese (Mn), copper (Cu) and nickel (Ni) are essential in trace amounts by higher plants to complete their life cycle (Marschner, 1995; Yang et al., 1996a, 1996b, 1997), while others [i.e., cadmium (Cd), lead (Pb), and mercury (Hg)] are non-essential. In extended concentrations, however, all heavy metals are toxic. Redistribution of heavy metals in the environment is caused by the escalating applications of sludge to agricultural soils and continuing discharge of industrial wastes (Cataldo et al., 1978). The expansion of industrial production and modern city development enhanced the seriousness of heavy-metal pollution (Zhang et al., 1999). Therefore, it is highly relevant to conduct researches concerning the uptake, transport, and redistribution of heavy metals in cultivated plants in order to prevent or decrease the inflow of these elements in the food chain.

As nickel and Cadmium are two famous heavy metals which are largely used in electronic industries thus the waste water of factories could pollute agricultural lands. Thus it is of interest to study the effects of different concentrations of nickel and Cadmium on the germination and seedling growth of ragi.

MATERIALS AND METHODS

Seeds of ragi (*Elucsine coracana* L.) were obtained from Durgapura Agricultural University, Jaipur, Rajasthan. The present study was taken up with cadmium ($CdCl_2$) & nickel ($NiCl_2$) at 5, 10, 25, 50, 75 and 100 mg/l along with control (untreated). Ten seeds of ragi 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 cadmium chloride solution (5, 10, 25, 50, 75 and 100 mg/l) and nickel chloride solution (5, 10, 25, 50, 75 and 100 mg/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 5th day after sowing and the total germination percentage was calculated. The root and shoot length of seedlings in various cadmium and nickel levels were measured on 8th day. Vigour index of the seedlings were calculated by using the formula proposed by Abdul-Baki and Anderson. Tolerance index of the seedlings was calculated by using the formula of Turner and Marshal. 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 cadmium and nickel. Reduction in germination percentage of ragi at higher concentrations may be attributed to the interference of cadmium & nickel ions. Seedling vigour, dry weight, vigour index and tolerance index were increased at lower concentration (5 mg/l) and decreased at higher concentration (10-100 mg/l) Figure 1 and 2. The significant increase in radicle and plumule length and dry weight of ragi seedlings at 5 mg/l concentration suggested that low concentration of cadmium & nickel was favorable for seedling growth. Cadmium & nickel at higher concentrations suppressed the seedling growth and dry weight of ragi seedlings.

At higher levels, Cadmium & nickel 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 metal deficiency. The dry phytomass yield decreased at higher levels of cadmium & nickel might be due to poor growth of seedlings. At higher concentrations Cd & Ni act as toxic metals. Related results were reported on the effect of cobalt [Jayakumar and Vijayarengan (*Vigna mungo* (L.) Hepper)], cadmium [Kalita *et al.* (*Triticum aestivum)*], chromium

[Corradi *et al*. (*Salvia sclarea*)], cobalt (Terry 1981; Wallace *et al*.) and cobalt and zinc [Burhan (*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 cadmium & nickel level in the medium. The values of growth parameters indicated that cadmium & nickel had a significant stimulating, beneficiary and nutritional effect at 5 mg/l concentration for ragi. The growth process beyond this concentration indicated that a little excess of cadmium & nickel above these levels had an adverse effect.

Conclusion

From the results of this investigation, it can be concluded that cadmium & nickel at lower concentrations has a stimulating effect on the germination process and seedling growth and will inhibit the same at higher concentrations. It has also been revealed that cadmium is more toxic than nickel, when observations from cadmium and nickel treatments were compared.

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Table 1: Effect of $CdCl_2$ on Seed Germination, Dry Weight, Vigour Index, Tolerance Index of the Ragi (8th Day)

$CdCl_2$ level mg/L	Germination Percentage	Length (cm)		Dry weight (10pts)		Vigour index	Tolerance index
		Root	Shoot	Root	Shoot		
Control	98 ± 3.76	2.98 ± 0.101	15.86 ± 0.524	0.08 ± 0.003	0.19 ± 0.006	1971± 60.354	-
5	98 ± 3.76	3.66 ± 0.120	16.83 ± 0.611	0.09 ± 0.003	0.21 ± 0.009	2167± 72.000	1.27 ± 0.022
10	94 ± 3.68	2.13 ± 0.110	13.46 ± 0.314	0.06 ± 0.002	0.17 ± 0.005	1415 ± 57.500	0.97 ± 0.042
25	89 ± 3.57	2.02 ± 0.068	11.89 ± 0.203	0.06 ± 0.002	0.16 ± 0.006	1371 ± 45.323	0.73 ± 0.040
50	83 ± 3.53	1.87 ± 0.041	9.06 ± 0.198	0.05 ± 0.002	0.14 ± 0.005	1015 ± 34.301	0.66 ± 0.039
75	81 ± 3.47	1.65 ± 0.039	8.79 ± 0.193	0.03 ± 0.001	0.13 ± 0.006	983 ± 32.101	0.51 ± 0.029
100	78 ± 3.41	1.12 ± 0.031	7.12 ± 0.186	0.02 ± 0.001	0.11 ± 0.004	791 ± 26.102	0.32 ± 0.010

The values are mean ± SD of 5 replicates

Table 2: Effect of $NiCl_2$ on Seed Germination, Dry Weight, Vigour Index, Tolerance Index of the Ragi (8th Day)

$NiCl_2$ level mg/L	Germination Percentage	Length (cm)		Dry weight (10pts)		Vigour index	Tolerance index
		Root	Shoot	Root	Shoot		
Control	98± 3.76	2.98 ± 0.101	15.86 ± 0.524	0.08 ± 0.003	0.19 ± 0.006	1971± 60.354	-
5	98± 3.76	3.81 ± 0.130	17.71 ± 0.520	0.09 ± 0.003	0.22 ± 0.009	2276± 77.000	1.33 ± 0.035
10	96 ± 3.33	2.33 ± 0.100	15.41 ± 0.415	0.08 ±0.002	0.18 ± 0.005	1935 ± 69.400	1.26 ± 0.048
25	93 ± 3.26	2.14 ± 0.098	13.96 ± 0.311	0.07 ± 0.002	0.18 ± 0.006	1877 ± 55.343	0.93 ± 0.046
50	88 ± 3.53	2.07 ± 0.032	12.11 ± 0.243	0.06 ± 0.002	0.16 ± 0.005	1346 ± 46.321	0.87 ± 0.040
75	87 ± 3.42	1.86 ± 0.026	9.83 ± 0.200	0.05 ± 0.001	0.14 ± 0.006	1036 ± 38.133	0.67 ± 0.037
100	83 ± 3.37	1.47 ± 0.021	8.87 ± 0.181	0.04 ± 0.001	0.13 ± 0.004	973 ± 31.120	0.48 ± 0.021

The values are mean ± SD of 5 replicates

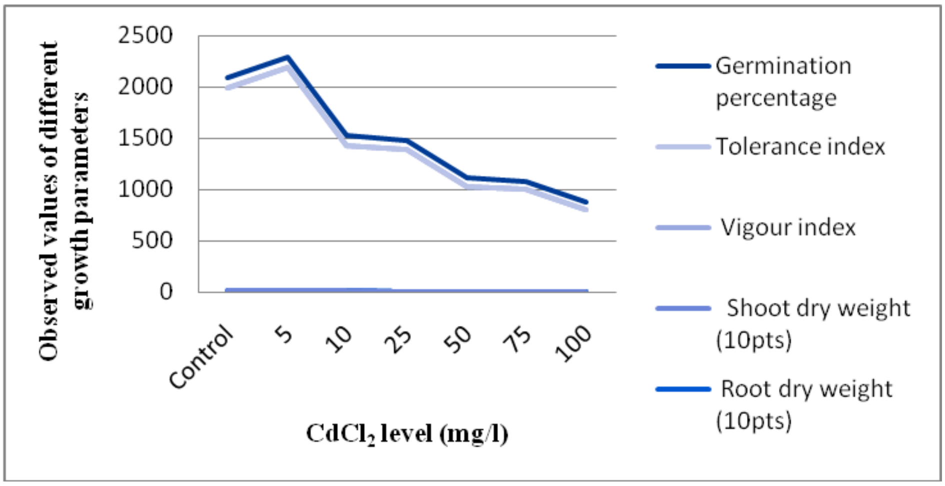

Fig 1. Effect of $CdCl_2$ on Seed Germination, Dry Weight, Vigour Index, Tolerance Index of the Ragi

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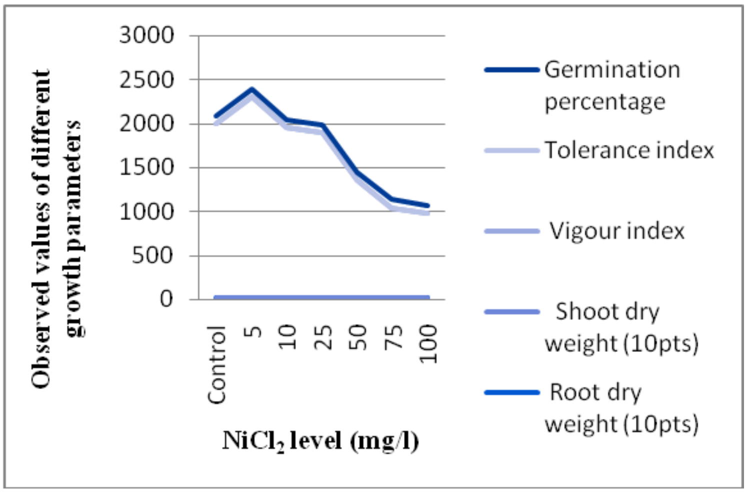

Fig 2. Effect of $NiCl_2$ on Seed Germination, Dry Weight, Vigour Index, Tolerance Index of the Ragi