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RESEARCH ARTICLE

IN-VITRO EVALUATION OF TOLERANCE TO CADMIUM AND NICKEL BY RHIZOCTONIA SOLANI

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ABSTRACT

Heavy metals are constantly being released into the ecosystem resulting in soil pollution which in turn enters in to the food chain through crops and also affect the microbial health in soil. Some heavy metals are essential for plants and microbes in trace amount but become toxic at high concentration whereas, others are toxic even in trace amount. Since microbial growth is affected by the presence of heavy metals in soil, in the study attempt was made to determine the effect of two metals viz., cadmium and nickel on mycelial and carpogenic growth of *R. solani*. The results revealed that as nonessential heavy metal cadmium is highly toxic to *R. solani* at 2-3ppm and nickel although be an essential metal element, however becomes toxic above 60 ppm concentration.

INTRODUCTION

Soil pollution with heavy metals resulting from mining and smelting of metalliferous substances, electroplating, gas exhaust, energy and fuel production, indiscriminate fertilizer and pesticide application, industrial effluents is a global concern being everywhere, though to different degrees and is specific to certain parts of the biogeosphere. Environmental stresses brought about by the contamination could be a reason for the reduction in microbial species but increasing the population of few surviving species (Griffioen, 1994). Living organisms are not able to prepare and adapt rapidly to a sudden and huge load of different toxic substances. Metals play an integral role in the life processes of microorganisms. Some metals, such as calcium, cobalt, chromium, copper, iron, potassium, magnesium, manganese, sodium, nickel and zinc, are essential, serve as micronutrients and are used for redox-processes; to stabilize molecules through electrostatic interactions; as components of various enzymes; and for regulation of osmotic pressure. Many other metals have no biological role (e.g. silver, aluminium, cadmium, gold, lead and mercury), and are nonessential and potentially toxic to microorganisms (Bruins *et al.*, 2000). Accumulation of certain elements, especially of heavy metals with toxic effect, can cause undesirable changes in the biosphere bearing unforeseeable consequences (Djukic and Mandic 2000). In view of this an attempt was made to study the effect of cadmium and nickel on mycelial and carpogenic growth of *Rhizoctonia solani*.

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MATERIAL AND METHODS

R. solani was isolated from sheath blight infected rice plant and the PDA based culture had been utilized in the present investigation. Cadmium sulphate ($CdSO_4$) and nickel chloride ($NiCl_2$) were selected as heavy metal source to observe the level of tolerance by the pathogen. To measure the mycelial growth of the pathogen at different concentrations of cadmium (1, 2, 3 and 5 ppm) and nickel (10, 25, 40, 60, 100 and 150 ppm), mycelia disc was inoculated at the centre of 90mm Petriplate poured with fortified heavy metals at their respective concentrations. The inoculated plates were incubated at 27 ± 1^0C for the 3 days and then the radial growth was recorded. The biomass produced at different concentrations of heavy metals was recorded after inoculating the pathogen in 100ml potato dextrose broth supplemented with different concentrations of the heavy metals and incubating at the same condition for 7 days. Mycelial mat was harvested, oven dried and the weight was measured. The percent inhibition of growth both in terms of radial growth and biomass over non-treated heavy metals was also taken into consideration. A similar set was kept for 15 days and the sclerotia were harvested with the enumeration of number and weight of sclerotia produced in each treatment.

RESULTS AND DISCUSSION

R. solani showed significant reduction in radial growth, biomass production and sclerotial development at very low concentration of cadmium, whereas, in case of nickel the pathogen can resist substantially high level of metal contamination (Table 1). The pathogen could tolerate cadmium

Table 1. Effect of cadmium and nickel on mycelial and sclerotial growth of *R. solani*

Treatment	Radial growth (mm)	% inhibition in radial growth	Biomass production (g)	% inhibition in biomass	No. of sclerotia produced	Sclerotia wt. (g)
Non treated	90.00	-	0.677	-	94.40	0.325
Cadmium						
1ppm	87.00	3.33	0.474	29.98	59.40	0.217
2ppm	71.90	20.01	0.281	58.49	32.80	0.121
3ppm	59.12	34.31	0.138	79.62	24.80	0.091
5ppm	11.20	87.56	0.020	97.05	19.80	0.076
SEm±	1.12		0.016		1.14	0.0045
CD(P=0.05)	3.36		0.048		3.42	0.013
Nickel						
10 ppm						
25 ppm						
40 ppm	72.58	19.36	0.513	24.22	53.20	0.204
60 ppm	71.08	21.02	0.413	39.00	36.20	0.155
100 ppm	32.24	64.18	0.220	67.50	26.40	0.127
150 ppm	14.40	84.00	0.045	93.35	18.00	0.092
SEm±	2.71		0.127		1.41	0.005
CD(P=0.05)	8.12		0.381		4.23	0.014

contamination upto 2 ppm, however, above 3 ppm more than 35% reduction in radial growth and biomass production was recorded and it increased rapidly to nearly 90% at 5 ppm concentration of the contaminant indicating high toxicity of cadmium to *R. solani*. Sclerotial development also reduced drastically even at 1 ppm concentration and more than 50% inhibition in sclerotial number and weight was enumerated at 2 ppm cadmium contamination. Nickel in different concentration on the other hand showed that it was less inhibitory to *R. solani*. Both radial growth and biomass production were inhibited by 50% at nearly 90-95 ppm concentration. Sclerotial development also reduced significantly with increasing concentration of nickel and more than 50% reduction in sclerotial number was enumerated at 60 ppm concentration.

Several researchers have reported the use of *Aspergillus niger, Aspergillus* sp, *Penicillium* sp and *Fusarium* sp to remove heavy metals Cr, Zn, Ni, Pd and Cd and observed their tolerance towards $CdSO_4$, $ZnSO_4$, $PdSO_4$ and $NiSO_4$ in the Soil (Gadd 1990, Fourest *et al.*, 1994, Bai and Abraham 2001, Teskova and Petrov 2002). Tolerance of toxic metals is based on ionic species associating with the cell surface or extra cellular polysacharides, proteins and chitins (Volesky 1990). Toxicity of nonessential metals occurs through the displacement of essential metals from their native binding sites or through ligand interactions (Nies 1999, Bruins *et al.*, 2000). For example, Hg2+, Cd2+ and Ag2+ tend to bind to SH groups, and thus inhibit the activity of sensitive enzymes (Nies 1999). In addition, at high levels, both essential and nonessential metals can damage cell membranes; alter enzyme specificity; disrupt cellular functions; and damage the structure of DNA (Bruins *et al.*, 2000). The present investigation revealed that as nonessential heavy metal cadmium is highly toxic to *R. solani* at 2-3ppm and nickel although be an essential metal element, however becomes toxic above 60 ppm concentration.

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