
Effect of Cadmium Salts on Some Growth and Metabolic Activities of Selected Fungi from the Rhizosphere of *Glycine max* and *Zea mays*

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ABSTRACT. Six fungi, isolated from the rhizosphere of *Glycine max* and *Zea mays*, were selected for their variable resistance to soil application of cadmium nitrate and cadmium sulphate, at the range of 100-1000 ppm concentration. These were (a) *Aspergillus terreus* and *Rhizopus oryzae*; (b) *Paecilomyces divaricata*, *Curvularia tetramera*; (c) *Fusarium oxysporum* and (d) *Cladosporium herbarum*.

Fifty ppm cadmium salts exerted no effect on spore germination of *R. oryzae*, *F. oxysporum* or *C. tetramera*, stimulated *A. terreus* and *P. divaricata* and suppressed *C. herbarum*. 100 ppm dose exerted variable effects dependent on the organism and/or accompanying anion. 1000 ppm cadmium arrested spore germination of all the tested fungi except *F. oxysporum* where marked suppression were observed.

Cadmium arrested growth of *C. herbarum* and *P. divaricata* at 50 ppm, initiated that of *A. terreus*, *C. tetramera* and *F. oxysporum* but seemed without effect on *R. oryzae*. Larger doses seemed to be inhibitory to all organisms, *R. oryzae* being least affected.

Seven-day old mycelial felts of the last mentioned four fungi were produced from 5 mm diameter mycelial discs grown on media containing 0, 50, 100, or 500 ppm cadmium nitrate or cadmium sulphate. These, as well as the media, were analysed for their nitrogen and phosphorus components. The results show that nitrogen secretion was not a function of tolerance of the fungi to cadmium applied to the soil but was largely controlled by the effect of cadmium on the permeability of the cells of each individual fungus. Cadmium seemed to stimulate nitrogen metabolism of *Aspergillus* and *Fusarium*, had little or no effect on that of *Rhizopus* but suppressed that of *Curvularia*. Most accumulated nitrogen was in the form of amino and other soluble nitrogen.

Cadmium inhibited the incorporation of absorbed phosphorus into energy-rich compounds. This was concomitant with the failure of amino acid incorporation into proteins.

Cadmium is an important environmental pollutant and its increasing presence in soils and surface waters leads to its accumulation in microorganisms, higher plants and animals.

Several studies have considered the role of heavy metals as inhibitors of spore germination, but relatively less attention has been directed to effects on metabolism. Babich and Stotzky (1977a) noted wide extremes among fungi in sensitivity to cadmium. There was no correlation between the class of fungus and tolerance to cadmium. Tatsuyama *et al.* (1975b) found that *Penicillium lilacinum* was strongly resistant to zinc, copper, tin and cadmium whereas *P. purpurogenum* showed resistance to cadmium and copper only. They observed that ED₅₀ of the heavy metals, tested on conidial germination of *P. lilacinum*, were different from those on mycelial growth.

Fungi can adapt to heavy metals (Ashida 1965 and Turner 1969) and in recent years resistance to heavy metals has been demonstrated under field conditions. Tatsuyama *et al.* (1975a) isolated cadmium resistant microorganisms on media containing 1000 ppm of the metal. Tatsuyama *et al.* (1975b) observed that fungi isolated from soil containing a high percentage of cadmium, showed a high tolerance to cadmium. A cadmium resistant yeast strain which might be used to remove cadmium from industrial wastes was isolated by Tohoyama and Murayama (1977). Houba and Remacle (1980) showed that some bacteria developed in very high concentrations of cadmium but their physiological characteristics were not the same as those of the sensitive strains.

In a previous publication, Sharaf (1984) studied the effect of cadmium sulphate and cadmium nitrate, within the range of 100-2000 ppm, on the ability of fungi to survive in the rhizosphere of soybean and corn plants, during the growth season. She found that even 100 ppm of either salts significantly decreased the count of rhizosphere fungi, sulphate being more effective than nitrate salt. In this investigation we selected six members of these rhizosphere fungi to represent those of high, moderate, weak as well as rare frequency, in the presence of cadmium. These fungi were tested for some growth and metabolism under laboratory supplementation using several levels of cadmium sulphate and cadmium nitrate to attempt to understand their variable response to cadmium.

Material and Methods

Six organisms viz. *Rhizopus oryzae*, *Aspergillus terreus* (80 and 70% occurrence respectively); *Paecilomyces divaricata*, *Curvularia tetramera* (40-50%); *Fusarium oxysporum* (32%) and *Cladosporium herbarum* (12%) were selected from the rhizosphere of both soybean and corn plants, grown in soils containing 100, 500 or 1000 ppm cadmium nitrate or cadmium sulphate.

Spores of these six fungi were subjected to germination experiments where a dilute spore suspension was spread on solid Czapek medium containing 50, 100, 1000 ppm cadmium nitrate or cadmium sulphate. These plates were incubated at

25°C ± 0.1°C and examined when germination in cadmium - free plates had reached 50%.

Five mm diameter agar discs from the periphery of 7-day old cultures of each of the six fungi were inoculated into 50 ml liquid Czapek Dox medium amended with 50, 100, 500 or 1000 ppm cadmium nitrate or cadmium sulphate. Flasks were inoculated at 25°C ± 0.1°C for 7 days after which the resultant mycelia were thoroughly washed with distilled water and dried in a continuous hot air oven at 120°C for 30 min. and then at 80°C until constant weight.

The mycelia were extracted with borate buffer, at pH 8, and after centrifugation, the soluble components were determined in the supernatant fraction and the insoluble components estimated in the residue. Total soluble and insoluble nitrogen and phosphorus were determined in the digest of the buffer extract and residue using the Berthelot reaction (Chaney and Marbach 1962) and sulphite-metol method (Burton and Riley 1956) respectively.

Peptide nitrogen in the media, buffer extract or the sodium hydroxide extract of the residue were determined by the Folin-phenol method (Lowry *et al.* 1951) while nucleoprotein nitrogen was obtained as the difference between the peptide and total nitrogen of the sodium hydroxide extract. Ammonia and amino nitrogen were assayed by the Berthelot reaction and Russel method (1944) respectively. Five replicates were used for each determination.

Results

Spore Germination

Table 1 shows that germination of *R. oryzae* spores seemed almost unaffected by either salts of cadmium at 50, or 100 ppm whereas 1000 ppm arrested spore germination. *F. oxysporum* and *C. tetramera* spores were similarly unaffected by 50 or 1000 ppm of either salts, but 1000 ppm cadmium nitrate reduced spore germination, for these two organisms, to almost 50% of the control. Cadmium sulphate, at 1000 ppm, arrested spore germination completely. Both cadmium salts suppressed germination of *C. harbarum*, cadmium nitrate being less effective. Both salts caused complete inhibition at 1000 ppm.

Spore germination was stimulated in *A. terreus* at 50 ppm cadmium sulphate and in *P. divaricata* at both 50 and 100 ppm; at 1000 ppm germination was inhibited in both organisms. On the other hand, cadmium nitrate, at all levels, including 1000 ppm, enhanced spore germination of *Paecilomyces*, spore germination of *Aspergillus* was hardly affected by 50 ppm, stimulated at 100 ppm and partly inhibited at 1000 ppm of the nitrate.

Table 1. Influence of cadmium compounds on spore germination of several soil fungi.

Examination		Percentage of spore germination at						
Fungal species	Time	Control	Cadmium sulphate ppm			Cadmium nitrate ppm		
	(hours)		50	100	500	50	100	500
<i>Rhizopus oryzae</i>	5.50	53.0	45.0	47.7	00.0	47.7	43.0	00.0
<i>Aspergillus terreus</i>	18.00	60.0	79.0	56.0	00.0	58.0	75.5	20.0
<i>Paecilomyces divaricata</i>	30.00	52.0	80.0	87.0	00.0	84.0	89.7	70.0
<i>Curvularia tetramera</i>	1.25	59.2	50.5	45.1	00.0	51.8	55.0	33.0
<i>Fusarium oxysporum</i>	3.50	52.0	41.0	43.5	00.0	48.0	41.0	25.8
<i>Cladosporium herbarum</i>	12.00	53.3	22.0	17.0	00.0	34.0	18.5	00.0

Mycelial Dry Weight

Preliminary investigations revealed that *P. oryzae*, *C. herbarum* and *P. divaricata* grew feebly on Czapek Dox medium and cadmium salts, at 1000 ppm. When shifted to potato-dextrose medium, *C. herbarum* and *P. divaricata* were unable to grow in the presence of 50 ppm cadmium salts.

Table 2 shows that the dry weight gain by *R. oryzae* was hardly affected by either cadmium salts at 50 or 100 ppm but at 500 ppm a noticeable drop was observed particularly in the presence of cadmium sulphate. Dry weight gain by *A. terreus* was drastically inhibited by the cadmium ions; sulphate again being more effective than nitrate especially at the larger doses. *C. tetramera* and *F. oxysporum* behaved similarly though mycelial growth was better than in *Aspergillus*.

Nitrogen Secretion

Figure 1 shows that 50 and 100 ppm cadmium salts had little effect on total nitrogen secretion by *R. oryzae* whereas 500 ppm slightly enhanced secretion. Both cadmium salts had a stimulatory effect on nitrogen secretion by *C. tetramera*, the effect increasing with concentration. A similar effect occurred with *F. oxysporum* though cadmium sulphate was more effective than cadmium nitrate.

In the presence of cadmium sulphate, *A. terreus* secreted the largest amount of nitrogen up to 100 ppm, whereas 500 ppm inhibited growth of the fungus. Cadmium nitrate was less effective causing a slight increase in nitrogen secretion (at 100 ppm) and marked stimulation at 500 ppm.

Under all conditions, peptide and/or other soluble nitrogen largely participated in these respects whereas the fluctuations in amino nitrogen were only apparent in *Aspergillus* media particularly when supplemented with cadmium nitrate.

Nitrogen Components of Biomass

Figure 2 shows that cadmium nitrate had little effect on the total nitrogen content of *R. oryzae*, but that large concentrations of cadmium sulphate were suppressive. Cadmium sulphate had little effect on the nitrogen content of *A. terreus* while 500 ppm inhibited growth of the fungus. Cadmium nitrate was most stimulatory at 100 ppm but 500 ppm dose attenuated this process.

Both cadmium salts suppressed nitrogen accumulation by *C. tetramera* particularly at the higher concentrations. Furthermore, the stimulatory effects of both salts on nitrogen gain by *F. oxysporum* continued in the presence of the larger concentrations of cadmium nitrate but were slightly inhibited at higher concentrations of cadmium sulphate.

Table 2. The influence of cadmium compounds on growth of several soil fungi cultured, for 7 days, on Czapek Dox or potato dextrose (*Rhizopus oryzae* only) media.

(mg per cultural growth)

Organism	Control	Cadmium sulphate ppm			Cadmium nitrate ppm		
		50	100	500	50	100	500
<i>Rhizopus oryzae</i>	244 ± 8.3	236 ± 8.0	224 ± 7.6	107 ± 3.6	218 ± 7.1	210 ± 7.1	146 ± 4.9
<i>Aspergillus terreus</i>	505 ± 18.2	149 ± 5.1	116 ± 3.9	—	263 ± 8.9	161 ± 3.6	107 ± 3.6
<i>Curvularia tetramera</i>	496 ± 17.9	282 ± 6.1	181 ± 6.1	132 ± 4.5	349 ± 12.6	246 ± 8.3	158 ± 5.3
<i>Fusarium oxysporum</i>	398 ± 11.1	330 ± 11.9	145 ± 4.8	99 ± 3.3	235 ± 7.9	142 ± 3.9	124 ± 4.2

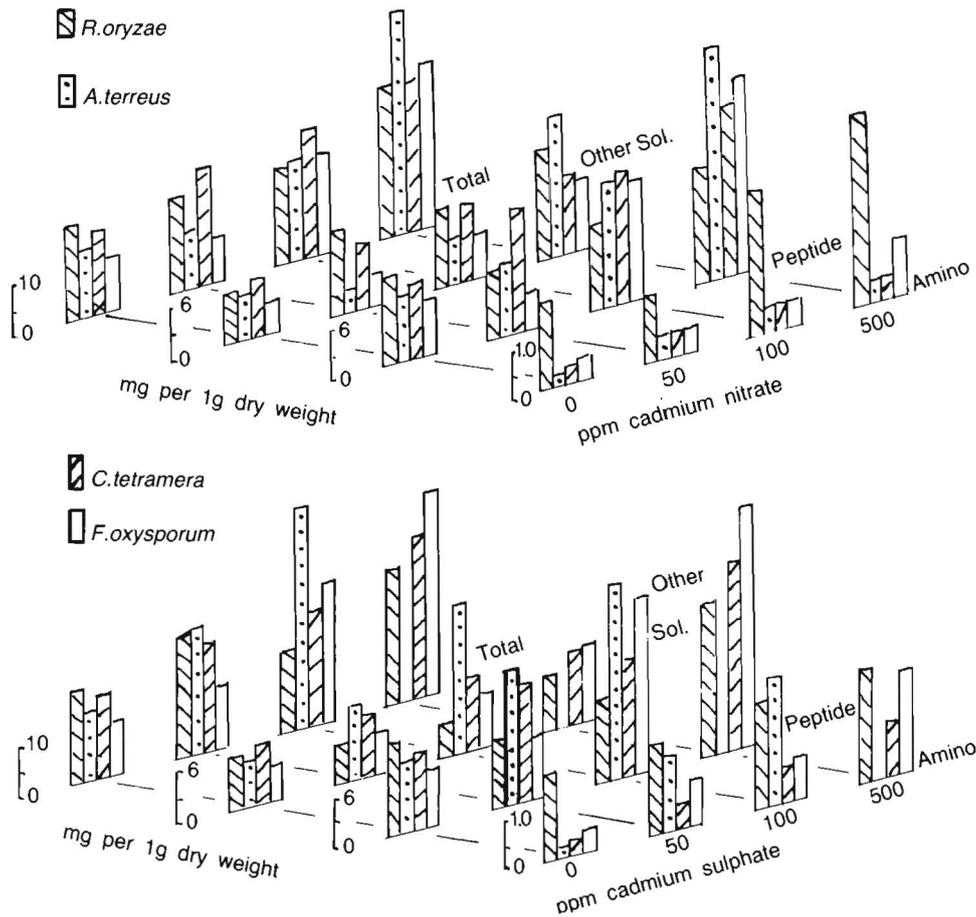


Fig. 1. The influence of cadmium ions on the nitrogen secretion by selected soil fungi cultured for 7 days on Czapek Dox or potato dextrose (*Rhizopus oryzae* only).

Apart from these fluctuations, cadmium slightly increased ammonia content of the biomass with a concomitant drop in amino and other soluble and/or nucleoprotein nitrogen whereas protein and other insoluble nitrogen were almost unaffected. Larger doses of cadmium nitrate increased the amino nitrogen content of the tested fungi except for *Rhizopus*. Such increases were accompanied by a comparatively lower level of other insoluble nitrogen components.

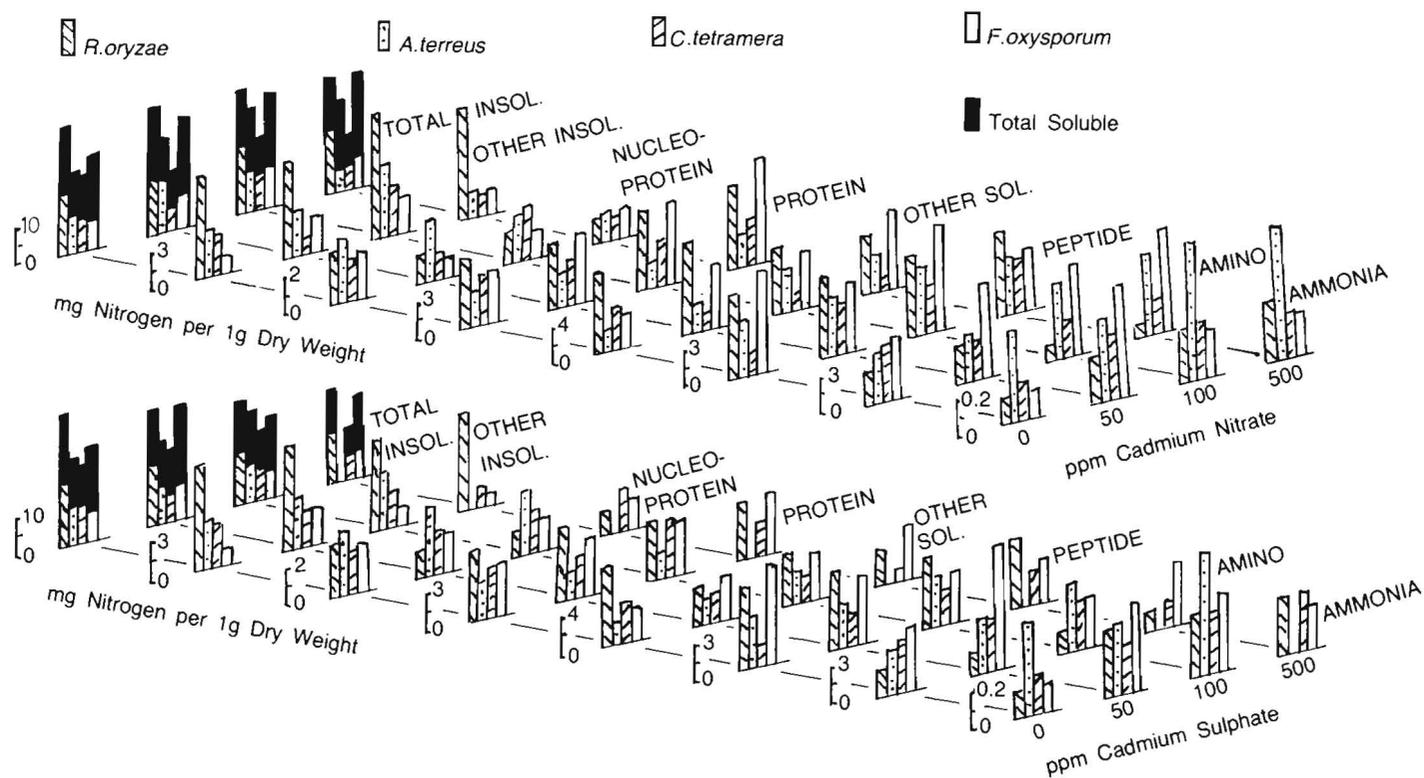


Fig. 2. The influence of cadmium ions on the nitrogen components of selected soil fungi cultured for 7 days on Czapek Dox or potato dextrose (*Rhizopus oryzae* only).

Phosphorus Components of the Biomass

Table 3 shows that cadmium only slightly affected the total phosphorus content of *F. oxysporum* mycelia. *R. oryzae* mycelia responded similarly though the higher concentrations of cadmium sulphate were slightly stimulatory. Cadmium salts enhanced phosphorus gain by *C. tetramera* mycelia, more prominently at the larger doses. Similar effects were observed with cadmium nitrate and *A. terreus* mycelia while cadmium sulphate was less effective or even stopped growth at 500 ppm.

In spite of these fluctuations, cadmium sulphate stimulated soluble organic phosphorus accumulation whereas cadmium nitrate exerted no effect. Both salts had little effect on the insoluble phosphorus content of *Rhizopus* but increased that of *Curvularia* or *Aspergillus*, whereas the severe drop in this component of *Fusarium* mycelia, caused by the smaller doses, was alleviated by the rise of concentration.

Discussion

The results of this investigation show that the response of spore germination to cadmium salts is not a simple function of the organism to this metal. This is obvious from the fact that 1000 ppm arrested spore germination of the most resistant (*Rhizopus*) and most sensitive (*Cladosporium*) fungi but caused only 50% inhibition of the moderately and weakly tolerant organisms (*Curvularia* and *Fusarium*). Smaller cadmium doses seemed without effect except on the highly tolerant (*Aspergillus*) and moderately tolerant (*Paecilomyces*) where they were stimulatory particularly with nitrate as the accompanying anion.

In this connection, it may be mentioned that Brown and Smith (1980) claimed that the generation time of the yeast *Cryptococcus albidus* was increased 3-fold when cultures were supplemented with 10 mg CD^{2+}/l and cell division of the yeast was arrested at 50 mg/l or above. Imagawa *et al.* (1981) reported that 5 μ M cadmium chloride suppressed the growth of *Bacillus megaterium*, but the organism ceased growth at 50 μ M concentration. Ross (1982) observed that 7.5-10.0 μ M cadmium almost completely suppressed germination of *Candida albicans* spores while no mycelial development occurred.

The present results further show that 500 ppm cadmium strongly inhibited growth. At this concentration, growth of *A. terreus* (highly tolerant) was inhibited while growth in the other organisms was suppressed by at least 50%. In general, cadmium sulphate was more inhibitory than cadmium nitrate.

This difference might be attributed to better utilization of nitrate than sulphate. This would render the media with sulphate more acidic than those with

Table 3. The influence of cadmium compounds on phosphorus components of several soil fungi after 7 days growth on Czapek Dox or potato dextrose (*Rhizopus oryzae* only) media.

(mg per 1 g D. Wt. of Biomass)

Organism	P component	Control	Cadmium sulphate ppm			Cadmium nitrate ppm		
			50	100	500	50	100	500
<i>R. oryzae</i>	Inorganic P	3.98 ± 0.17	3.88 ± 0.17	3.42 ± 0.14	2.61 ± 0.11	4.83 ± 0.19	4.66 ± 0.18	4.73 ± 0.19
<i>A. terreus</i>		3.48 ± 0.16	3.16 ± 0.15	5.08 ± 0.20	—	4.00 ± 0.16	4.51 ± 0.19	4.53 ± 0.18
<i>C. tetramera</i>		3.31 ± 0.15	3.81 ± 0.16	3.01 ± 0.13	1.14 ± 0.06	3.36 ± 0.14	2.89 ± 0.12	2.41 ± 0.11
<i>F. oxysporum</i>		6.46 ± 0.25	5.73 ± 0.23	3.97 ± 0.16	2.87 ± 0.11	4.97 ± 0.21	6.57 ± 0.25	4.29 ± 0.17
<i>R. oryzae</i>	Soluble Organic P	1.59 ± 0.08	3.91 ± 0.17	8.06 ± 0.30	9.11 ± 0.32	1.06 ± 0.07	1.29 ± 0.08	1.04 ± 0.07
<i>A. terreus</i>		4.44 ± 0.15	10.22 ± 0.38	6.35 ± 0.24	—	10.46 ± 0.37	4.88 ± 0.19	4.05 ± 0.16
<i>C. tetramera</i>		3.10 ± 0.13	3.42 ± 0.15	6.77 ± 0.25	7.31 ± 0.27	6.19 ± 0.24	5.33 ± 0.21	4.51 ± 0.17
<i>F. oxysporum</i>		15.44 ± 0.25	13.26 ± 0.48	19.47 ± 0.63	12.86 ± 0.46	14.56 ± 0.52	16.36 ± 0.58	14.57 ± 0.50
<i>R. oryzae</i>	Total Soluble P	5.57 ± 0.23	7.79 ± 0.28	11.48 ± 0.41	11.72 ± 0.41	5.89 ± 0.24	5.95 ± 0.24	5.77 ± 0.22
<i>A. terreus</i>		7.92 ± 0.30	13.38 ± 0.46	11.43 ± 0.40	—	14.46 ± 3.50	9.39 ± 0.35	8.58 ± 0.32
<i>C. tetramera</i>		6.41 ± 0.24	7.23 ± 0.28	9.78 ± 0.35	8.45 ± 0.30	9.55 ± 0.35	8.22 ± 0.32	6.92 ± 0.26
<i>F. oxysporum</i>		21.50 ± 0.77	18.99 ± 0.67	23.44 ± 0.87	15.73 ± 0.55	19.53 ± 0.68	22.93 ± 0.80	18.86 ± 0.63
<i>R. oryzae</i>	Insoluble P	8.95 ± 0.34	7.04 ± 0.26	8.88 ± 0.33	8.84 ± 0.32	9.90 ± 0.32	8.11 ± 0.29	9.37 ± 0.33
<i>A. terreus</i>		3.30 ± 0.14	3.86 ± 0.16	2.68 ± 0.12	—	6.09 ± 0.23	4.93 ± 0.20	7.45 ± 0.27
<i>C. tetramera</i>		1.42 ± 0.08	2.33 ± 0.11	3.49 ± 0.14	6.51 ± 0.26	2.65 ± 0.12	2.51 ± 0.11	6.30 ± 0.24
<i>F. oxysporum</i>		6.27 ± 0.25	4.41 ± 0.17	2.24 ± 0.10	6.16 ± 0.25	1.70 ± 0.09	1.46 ± 0.08	6.33 ± 0.25
<i>R. oryzae</i>	Total P	14.52 ± 0.51	14.83 ± 0.52	20.36 ± 0.70	20.56 ± 0.71	25.79 ± 0.86	14.06 ± 0.48	15.14 ± 0.54
<i>A. terreus</i>		11.22 ± 0.41	17.24 ± 0.61	14.11 ± 0.48	—	20.55 ± 0.72	14.32 ± 0.50	16.03 ± 0.55
<i>C. tetramera</i>		7.83 ± 0.30	9.56 ± 0.37	13.27 ± 0.46	14.96 ± 0.55	12.12 ± 0.45	10.73 ± 0.40	13.92 ± 0.50
<i>F. oxysporum</i>		28.17 ± 0.96	23.40 ± 0.81	15.68 ± 0.56	21.89 ± 0.75	21.23 ± 0.75	24.39 ± 0.85	25.19 ± 0.85

nitrate and could lead to better cadmium uptake by the cells and appearance of symptoms of toxicity at lower concentrations than cadmium nitrate.

The observed tolerance or sensitivity of these fungi does not appear to be inherent to the organisms but may also be due to other factors prevailing in the soil medium. It is interesting to note that Moshe *et al.* (1982) noticed that 1 mg/l cadmium was toxic to algae, under laboratory conditions, whereas 6 mg/l was ineffective in the oxidation ponds. Babich and Stotzky (1977b) concluded that clay minerals protected fungi against cadmium toxicity.

The results of these experiments further show that nitrogen secretion by *A. terreus*, *C. tetramera* and *F. oxysporum* increased with increasing concentration of cadmium. On the other hand, only 500 ppm effected high nitrogen secretion by *R. oryzae*. This indicates that nitrogen secretion, by these fungi, was not a function of their tolerance to cadmium but was largely controlled by the effect of cadmium on the permeability of the mycelial cells of each individual fungus. Regardless of the largest dose which was toxic to the four fungi, the smaller doses seemed without effect on the permeability of *Rhizopus oryzae* cells, but increased cell permeability in the other three fungi.

In this connection it may be mentioned that Hutchinson and Czyska (1975) suggested that cadmium affected the feed back control of permease systems that transport phosphate (or silicate) into cells of *Asterionella formose*. Li (1978) reported that cadmium interreacted with phospholipid monolayers, implying that it may have a toxic effect on biological membranes.

Results of mycelial analysis further confirm the significant role played by the anion accompanying cadmium. Cadmium nitrate-treated mycelia showed higher levels of total nitrogen than cadmium sulphate-treated mycelia. This would reduce the acidity of the outer medium thus suppressing the solubility and availability of cadmium to the cells.

Cadmium seemed to stimulate nitrogen metabolism of *Fusarium oxysporum* but most of the accumulated nitrogen was in the amino and other soluble forms indicating a lagging rate of transformation of amino acids to peptides. In the meantime, accumulation of these two components in *Fusarium* and *Aspergillus* coupled with slight increase in the insoluble nitrogen in *A. terreus*, might explain the low toxicity of the absorbed cadmium by both fungi, most probably through complexing with these components. However, the insensitivity of nitrogen metabolism of *Rhizopus* to cadmium treatment might be attributed to larger amounts of other insoluble nitrogen (cell wall nitrogen) which might oppose or hinder permeation to cadmium. The shortage of this nitrogen component in *Curvularia* might allow for accumulation of enough inorganic cadmium to exert apparent metabolic disorders.

It is worth mentioning that Hampp *et al.* (1976) observed a strong affinity of cadmium for side ligands of proteins; an indication that the element could interfere with enzymatic activities. Payer and Runkel (1978) reported that mercury and cadmium are present in inorganic forms as well as chemically bound to organic metabolites within algal cells. Metallothione-like proteins were reported by Hart and Bertram (1980) as a mechanism of tolerance of *Chlorella pyrenoidosa* against large doses of cadmium. Imagawa *et al.* (1981) showed that the greater part of cadmium, absorbed by *Bacillus megaterium* was bound to a protein with a molecular weight higher than 200,000.

It is worth noting that the increased nitrogen accumulation, following cadmium administration to *F. oxysporum*, was accompanied by a concomitant lowering of total phosphorus; more prominent in the inorganic and insoluble fractions. This confirms the possible impairment of protein synthesis as a result of lower nucleoprotein nitrogen as confirmed by low insoluble phosphorus. The increased inorganic phosphorus and/or soluble organic phosphorus in *A. terreus* coupled with low protein and high amino acid nitrogen indicate the inability of the fungus, under cadmium stress, to incorporate the absorbed phosphorus into energy-rich compounds to participate in protein synthesis from the accumulated amino acids.

Cadmium-treated *C. tetramera* accumulated the largest amounts of phosphorus, mostly in the insoluble forms whereas most of the increased phosphorus uptake by *R. oryzae* was in the soluble organic form. This might explain the low metabolic activity in the former fungus as well as the increased metabolic activity of the latter fungus.

From the above discussion, it seems that tolerance or sensitivity of the fungus to cadmium is the cumulative result of the effect of this ion on various metabolic activities of each individual fungus.

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تأثير أملاح الكادميوم على بعض ظواهر النمو والأيض لبعض الفطريات حول جذور نباتات فول الصويا والذرة

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قسم النبات - كلية العلوم - جامعة القاهرة
القاهرة - مصر

الملخص

اختبرت ست فطريات معزولة من حول جذور نباتات فول الصويا والذرة لتمثل المقاومة المتباينة لسميه كبريتات الكادميوم المضافة للتربة بتركيزات تتراوح بين ١٠٠، ١٠٠٠ جزء في المليون. هذه الفطريات هي اسبرجيليس تيروس، ريزوبس أوريزي (عالية المقاومة)، باسيلوميس ديقاريكاتا، كورفولاريا تتراميرا (متوسطة المقاومة)، فيوزاريوم اكسيسبورم (ضعيف المقاومة)، كلادوسبوريوم هرباروم (شديد الحساسية).

وقد تبين أن انبات جراثيم كل من الريزوبس والفيوزاريوم والكوفورلاريا لا تتأثر بوجود ٥٠ جزء في المليون من الكادميوم ولكن يزداد انبات جراثيم الاسبرجيليس والباسيلوميسس في حين يقل انبات جراثيم الكلادوسبوريوم. أما تركيز ١٠٠ جزء في المليون فإنه يؤثر تأثيراً متبايناً على نسبة انبات جراثيم هذه الفطريات معتمداً على نوع الفطرة والأيون المصاحب للكادميوم.

أما تركيز ١٠٠٠ جزء في المليون فقد أوقف انبات جراثيم هذه الفطريات فيما عدا جراثيم الفيوزاريوم التي أنبتت بنسبة ضعيفة واضحة .

كما لوحظ أن ٥٠ جزء في المليون من الكادميوم توقف نمو فطره الكلاوسوريوم والباسيلوميس في المنابت السائلة ولكنها تحفز زيادة الوزن الجاف لفطرة الاسبرجيليس والكورفولاريا في حين لا تؤثر على نمو الريزوبس أما التركيزات الأعلى من الكادميوم فإنها تثبط نمو جميع الفطريات بدرجات متفاوتة أقلها فطرة الريزوبس .

زرعت الأربع فطريات الأخيرة على منابت غذائية تحتوي على صفر، ٥٠، ١٠٠، ٥٠٠ جزء في المليون من كبريتات الكادميوم أو نترات الكادميوم ولمدة ٧ أيام تم بعدها تحليل الغزل الفطري ومحاليل التغذية لمكوناتها النتروجينية والفوسفورية .

وقد أظهرت النتائج أن إخراج المركبات النتروجينية لا يعتمد على مدى مقاومة الفطرة لأملاح الكادميوم بقدر ما يتوأكب مع تأثير هذه الأملاح على نفاذية خلايا كل فطرة على حدة . كذلك يبدو أن أملاح الكادميوم تحفز الأيض النتروجيني لكل من الاسبرجيليس والفيوزاريوم دون تأثير ملحوظ على أبيض الريزوبس ولكن تثبطه في الكورفولاريا . وقد تبين أن معظم التراكم في صورة أحماض أمينية أو النتروجين الذائب الآخر .

كذلك يثبط الكادميوم إدماج الفوسفور الممتص في المركبات ذات الطاقة العالية ويتمشى ذلك مع فشل الأحماض الأمينية في التحول إلى بروتينات .