THE DIFFERENCE OF CADMIUM TOLERANCE IN TWO VARIETIES OF NICOTIANA TABACUM L. AND EFFECT OF EXOGENOUS ABSCISIC ACID ON CADMIUM ACCUMULATION IN NICOTIANA TABACUM L.

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Abstract

Hydroponic cultures were conducted to investigate the difference of cadmium (Cd) on tolerance and accumulation of Cd between two varieties of N. tabacum L., 'MS yunyan87' and 'MS K326' . The effect of Cd and abscisic acid (ABA) on growth and Cd accumulation of tobacco seedlings was also investigated. A significant decrease in the dry weight, net photosynthetic rate, stomatal conductance, intercellular CO_2 concentration and transpiration rate was found in two varieties of N. tabacum L.. The dry weight of 'MS K326' was higher than that of 'MS yunyan87' when exposed to 50 μmol·L^{-1} Cd. With the same treatment, net photosynthetic rate, stomatal conductance, intercellular CO_2 concentration and Cd accumulation in shoots of 'MS K326' were higher than those of 'MS yunyan87' . The Cd concentration in shoots and roots of two varieties of N. tabacum L. increased with the increasing Cd treatment concentration. In all treatments, Cd concentrations were higher in the roots than that in the shoots. In the presence of 50 μmol·L^{-1} $CdCl_2$, exogenous ABA treatment increased the concentration of in roots, reduced Cd concentration in shoots and the transport of Cd to the shoots from root.

Objectives

This paper studies the effects of excessive Cd on the accumulation and the differences and exogenous ABA treatment on growth and Cd accumulation in tobacco plants in different tobacco varieties, which to understand the toxic effects of Cd on tobacco.

Materials and Methods

Material: Tobacco (Nicotiana tabacum L.) cultivar 'MS Yunyan 87' and 'MS K326'.

Cadmium concentrations: The tobacco seedlings were cultured of 1/2Hoagland in nutrient solution, nutrient solution pH to 5.5 or so. Cd concentration is set to 0 (control), 20, 50, 100 μmolL^{-1}.

Determination of project: Including tobacco root length, chlorophyll content, determination of the third leaf treatment after 7 days of photosynthesis parameters. Harvest the plant samples, separate, shoot and root dry biomass and Cd content, determination. Another 50 μmol L^{-1} combined treatment Cd and ABA, ABA concentration of 0, 1, 10μmol·L^{-1} levels, leaf net photosynthetic rate measured 7 d after treatment (Pn), stomatal conductance (Gs), intercellular CO_2 concentration (Ci) and transpiration rate (Tr), biomass and Cd content.

Results and Discussion

Effects of cadmium stress on the growth of tobacco plants: Cd stress has obvious inhibitory effect on plant growth of 2 tobacco varieties (Table 1). In the same concentrations of Cd, tobacco variety 'MS K326' of the biomass, photosynthesis related parameters are slightly higher than the 'MS Yunyan 87', but the net photosynthetic rate, stomatal conductance and transpiration rate were not significantly different.

Cadmium accumulation in tobacco: Cd content increased with the increase of the concentration of Cd increased (figure1). The same concentrations of Cd, 'MS K326' shoot Cd content is significantly higher than that of 'MS Yunyan 87' (Fig. 1a), and the varieties and Cd treatment has a significant interaction. Furthermore, there was no significant difference in 2 tobacco varieties root Cd content (Fig. 1b).

ABA on the growth and Cd accumulation in tobacco: In 50 μmol L^{-1} Cd treatment with the concentration of ABA, Cd content increased, and to shoot Cd content decreased (Table 2). There were no significant difference in Cd content of two kinds of biomass, shoot and root of tobacco.

Effect of ABA on photosynthetic parameter of tobacco: 50 μmol L^{-1} Cd treatment severely inhibited two tobacco net photosynthetic rate, stomatal conductance, intercellular CO_2 concentration, transpiration rate, and 'MS K326' higher than 'MS Yunyan 87' in parameter above(Table 3). In the presence of 50 μmol L^{-1} Cd, two tobacco photosynthetic parameters with the concentration of ABA increased significantly decreased, and the intercellular CO_2 concentration was significant differences between varieties.

Table 1 Effect of Cd on dry weight and photosynthetic parameters in two varieties of *N. tabacum*.

Cd Treatment (μmol·L^{-1})	Dry weight per plant(g·plant^{-1})		Content of chlorophyll (mg/g · FW)		Net photosynthetic rate (μmolCO_2 m^{-2}·s^{-1})		Stomatal conductance (mmolH_2O m^{-2}·s^{-1})		Intercellular CO_2 concentration (μmolCO_2 m^{-2}·s^{-1})		Transpiration rate (mmolH_2O·m^{-2}·s^{-1})	
	MS Yunyan87	MS K326	MS Yunyan87	MS K326	MS Yunyan87	MS K326	MS Yunyan87	MS K326	MS Yunyan87	MS K326	MS Yunyan87	MS K326
0	0.48	0.52	0.76	0.72	29.8	30.7	70.5	74.0	317	336	20.0	18.7
20	0.36	0.40	0.64	0.70	24.5	27.8	39.4	57.1	238	266	15.1	16.5
50	0.13	0.28	0.59	0.70	23.2	25.4	25.1	42.5	212	255	13.2	12.6
100	0.09	0.11	0.56	0.61	18.2	21.7	15.8	23.4	143	182	6.50	9.30
ANOVA F ratio												
Variety	0.008^{NS}		2.558^{NS}		2.703^{NS}		0.042^{NS}		8.687**		1.790^{NS}	
Cd	23.924***		6.443**		105.210***		7.846**		38.201***		123.837***	
Variety*Cd	0.399^{NS}		1.604^{NS}		12.903***		2.335^{NS}		0.243^{NS}		4.668*	

Note: NS:no significant difference; *:P<0.05; **:P<0.01; ***:P<0.001

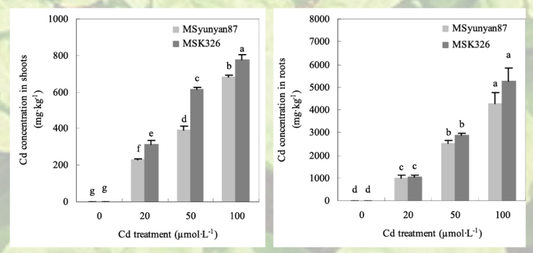

Fig. 1 Effect of Cd treated with 7 days on Cd content in shoots (a) and roots (b) of *N. tabacum*.

Table 2 Effect of exogenous abscisic acid on dry weight and Cd concentration of shoots and roots in *N. tabacum* with 50 μmol·L^{-1} Cd treatment.

Treatment	Dry weight per plant (g.plant^{-1})		Cd concentration (mg.kg^{-1}DW)			
			shoot		root	
	MSYunyan87	MSK326	MSYunyan87	MSK326	MSYunyan87	MSK326
0	0.35	0.35	0.00	0.00	0.00	0.00
Cd	0.21	0.25	571	595	939	946
Cd + 0.1 μmol·L^{-1} ABA	0.20	0.21	546	547	888	842
Cd + 1.0 μmol·L^{-1} ABA	0.19	0.20	514	531	900	825
Cd + 10 μmol·L^{-1} ABA	0.14	0.14	454	411	1539	1575
ANOVA F ratio						
Variety	1.195^{NS}		0.327^{NS}		1.834^{NS}	
ABA	6.740**		41.173***		544.389***	
Variety*ABA	0.623^{NS}		5.533**		3.045^{NS}	

Table 3 Effect of exogenous abscisic acid on growth and photosynthetic parameters of *N. tabacum* with 50 μmol·L^{-1} Cd treatment

Treatment	Net photosynthetic rate(μmolCO_2 m^{-2}·s^{-1})		Stomatal conductance (mmolH_2O m^{-2}·s^{-1})		Intercellular CO_2 concentration (μmolCO_2 m^{-2}·s^{-1})		Transpiration rate (mmolH_2O·m^{-2}·s^{-1})	
	MSYunyan 87	MSK326	MSYunyan87	MSK326	MSYunyan87	MSK326	MSYunyan87	MSK326
0	29.6	30.6	70.0	72.4	323	343	21.8	20.1
Cd	24.2	26.6	43.9	49.4	224	255	13.1	12.7
Cd + 0.1 μmol·L^{-1} ABA	23.4	23.3	37.2	48.4	215	243	12.7	12.1
Cd + 1.0 μmol·L^{-1} ABA	21.9	21.5	30.0	39.1	194	213	11.8	13.1
Cd + 10μmol·L^{-1} ABA	17.1	17.6	23.4	20.4	154	167	9.80	8.90
ANOVA F ratio								
Variety	0.791^{NS}		4.338^{NS}		11.345**		0.092^{NS}	
ABA	69.291***		16.165***		31.067***		11.962***	
Variety*ABA	1.118^{NS}		1.337^{NS}		1.420^{NS}		1.013^{NS}	

Conclusions

a) Cd treatment significantly inhibited the biomass of 2 tobacco varieties. With 50 μmol L^{-1} Cd treatment, 'MSK326' biomass was significantly higher than that of 'MS Yunyan 87'.

b) The shoot and root Cd contents of two tobacco varieties were increased with the concentration of Cd increases significantly increased, Cd content was significantly higher than that in shoots and roots. In the same concentrations of Cd, 'MS K326' shoot Cd content is significantly higher than that of 'MS Yunyan 87'.

c) Cd treatment reduced net photosynthetic rate, stomatal conductance, intercellular CO_2 concentration and transpiration rate of 2 tobacco varieties. In the same concentrations of Cd, the net photosynthetic rate, stomatal conductance, intercellular CO_2 concentrations of 'MS K326' were higher than 'MS Yunyan 87'.

d) Under the stress of Cd, the application of the exogenous ABA can reduce tobacco root Cd to shoot translocation, reduced shoot Cd content. Two kinds of tobacco, net photosynthetic rate, stomatal conductance, intercellular CO_2 concentration, transpiration rate decreased with the increasing concentration of ABA significantly decreased.

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