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Full Length Article

Effects of Potassium Fertilizer on Maize Growth and Heavy Metal Content in Heavy Metal Contaminated Soil

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Abstract

Pot test method is adopted in this study, and the corn is used as test material. In the soil contaminated by heavy metal As-Cd-Pb-Cu, six different amounts of potassium fertilizer were used to treat the soil, which are No potassium, application of KCI 100 mg/kg, application of KCI 200 mg/kg, application of KCI 300 mg/kg, application of KCI 400 mg/kg, and application of KCI 500 mg/kg. It aims to study the effects of different potassium concentrations on the growth, absorption and accumulation of heavy metals (As, Cd, Pb and Cu) in corn seedlings. The results showed that different potassium concentrations promoted plant height, leaf width and root length of corn seedlings, but there was no significant difference compared with CK. Potassium fertilizer could significantly increase the absorption of heavy metals (As, Cd, Pb and Cu) by 2.4 times, 2.8 times, 2.3 times and 2.3 times, respectively. Among them, 200 mg/kg As, 300 mg/kg Cd, 200 mg/kg Pb and 200 mg/kg Cu were the best. The application of potassium fertilizer can reduce the absorption of As and Pb in the underground part of the maize, in which the content of As and Pb in the corn is the least with the concentration of 400 mg/ kg. Potassium fertilizer could significantly increase the content of Cd and Cu, and the concentration of 20 and 100 mg/kg was respectively the best. Potassium fertilizer could reduce the contents of available heavy metals As, Cd and Cu in soil by 28.8, 14.4 and 7.9%, respectively, and at a maximum of 300, 500 and 500 mg/kg, respectively. Potassium fertilizer is beneficial to the increase of effective Pb content in soil, and the maximum increase is 200 mg/kg. Potassium fertilizer could promote the transfer ability and enrichment of heavy metals As, Cd, Pb and Cu in corn. The maximum transfer coefficients increased by 4.00 times, 47.6%, 3.11 times and 31.1%, respectively, and the treatment of 200, 300, 300 and 200 mg/kg was the highest respectively. The maximum enrichment coefficients were increased by 38.2%, 2.37 times, 74.5% and 2.23 times respectively, and 200, 300, 200 and 100 mg/kg was the highest respectively. There was a positive correlation between potassium application rate and heavy metal transfer coefficient and enrichment coefficient, and a very significant positive correlation between As transfer coefficient and Pb, Cu enrichment coefficient. © 2020 Friends Science Publishers

Keywords: Potassium fertilizer; Heavy metal; Soil; Corn

Introduction

In 2014, the Ministry of Environmental Protection and the Ministry of Land and Resources issued *The National Soil Pollution Survey Public Notice*, which pointed out that the environmental quality of cultivated land is worrying, the rate of exceeding the standard of cultivated land is 19.4%, and the main pollutants are cadmium, nickel, copper, arsenic, mercury, lead, DDT and polycyclic aromatic hydroxyl. Therefore, the remediation of heavy metals in soil has always been one of the key issues of concern. At present, the remediation of heavy metal pollution at home and abroad is mainly from physical repair, chemical remediation, phytoremediation, leaching and electric remediation, *etc*. (Ding *et al*. 2012). Phytoremediation, as a kind of low economic cost, low labor cost, high processing efficiency, no secondary pollution, can recover heavy metal. Thus, it becomes a promising soil restoration method for heavy metal pollution. However, the super-enriched plants often used in phytoremediation are often small biomass, slow growth, and the repair effect is not ideal (Wei *et al.* 2004; Huang *et al.* 2006). In recent years, some scholars have used high biomass crops as remediation plants (Kimenyu *et al.* 2009). The enrichment effect of maize on Cd and Pb reached the standard of super-enriched plants. maize, as an enriched plant, is rich in seed resources, widely published and large in biomass. At the same time, potassium is one of the three elements of fertilizer (Yuan *et al.* 2016). Application of potassium fertilizer can improve the tolerance of Chinese cabbage to high cadmium stress, and potassium fertilizer has application potential in the production of Chinese cabbage in cadmium contaminated soil (Wang *et al*. 2012). The application of K_2SO_4 could reduce the absorption of Cd by oil and wheat vegetables in

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contaminated soil. Obviously, fertilizer can improve the soil Rhizosphere environment, thus affecting the chemical behavior of heavy metals in soil, resulting in the difference of the availability of heavy metals, and then affecting the absorption of heavy metals by plants (Jiao *et al.* 2011; Li *et al*. 2014). However, most of the studies are mainly aimed at single heavy metal pollution, but the research on farmland compound pollution is less. Therefore, this paper adopts pot experiment to study the effect of different potassium application concentrations on the absorption and enrichment of heavy metal Pb, Cd, As and Cu on heavy metal soil by using maize as the test material. Besides, the feasibility of the application of potassium fertilizer to the improvement of the heavy metal-contaminated soil in maize was discussed. The aim of this paper is to provide a reference for the good combination of the fertilizer and the plant to repair the heavy metal pollution.

Materials and Methods

Experimental details and treatments

Experimental material: The tested soil, yellow brown soil, was collected from the soil contaminated by heavy metals around a mining area in Gejiu City, Yunnan Province. Five-point sampling method was used to collect 0–20 cm soil samples from cultivated layer. After air drying, grinding and 5 mm screening, the samples were used for pot experiment of maize culture. The physical and chemical properties of the soil were pH 6.5, total nitrogen 8 g/kg, total phosphorus 5.018 g/kg, total potassium 3.7 g/kg, As was 31.8 mg/kg, Cd was 11.3 mg/kg, Pb was 8.58 mg/kg, and Cu was 74.9 mg/kg. The developed self-intersection breed Hongdan 3 was selected for several generations by Institute of Agricultural Sciences in Honghe State. Test reagent: KCl is potassium fertilizer, urea is nitrogen fertilizer, Na2HPO4 is phosphorus fertilizer, all reagents are analytical pure.

Treatments: The plastic flowerpot (inner diameter 20 cm, high 18 cm) was used in a simulated pot experiment, and the soil content in each pot was 2 kg. As base fertilize, the amount of urea was 200 mg/kg, and the amount of Na_2HPO_4 was 100 mg/kg. KCI was added with the preset dosage. Six treatments were designed as follows: Treatment 1: No potassium (short for CK); Treatment 2: application of KCI 100 mg/kg (K1); treatment 3: application of KCI 200 mg/kg (K2); treatment 4: application of KCI 300 mg/kg (K3); treatment 5: application of KCI 400 mg/kg (K4); treatment 6: application of KCI 500 mg/kg (K5). There were 3 repeats for each treatment. 10 seeds were sown in each pot, and after 2 weeks, 5 plants with uniform growth were retained and cultured in a unified way. The growth indexes of maize (plant height, leaf number, leaf length, leaf width, *etc*.) were observed every 3 days. After 2 months, the above ground part, underground part and soil samples were collected respectively.

Determination of plant and soil samples: The corn samples were cleared and then removed at 105°C for 15 min and dried at 70°C. The corn samples were smashed with smashing machine powder and put into sealed bags. The soil was collected, air-dried, grounded, over 100 mesh screen, into a sealed bag to match. The contents of As, Cd, Pb and Cu in soil and plant samples were determined by microwave digestion-ICP, effective As was extracted by NaH_2PO_4 method (Bao 2000), and effective Cd, Pb and Cu were extracted by diethyltriamine pentaacetic acid-triethanolamine method (Sparrow 1996).

Data analysis

Microsoft Excel was used for data processing and mapping, and SPSS 13.0 for variance analysis and correlation analysis.

Results

Effect of potassium fertilizer on maize growth

As can be seen from Table 1, after the application of potassium fertilize to the maize seedlings, the height, the width and the root length were higher than CK, but the leaf length was lower than CK, and the effect of each treatment was different. In terms of the effect on plant height of maize, the highest potassium application rate was 33. 3 cm for 500 mg/kg, followed by 200 and 300 mg/kg. Through the analysis of variance, there was no significant difference among the potassium treatments. In terms of leaf length, all treatments were lower than CK, among them, 500 mg/kg treatment was best at 19.7 cm. However, there was no significant difference between potassium application treatment and CK. In terms of leaf width, the potassium application treatment of 100, 200 and 300 mg/kg were the best, followed by 500 mg/kg, and there was no significant difference between each fertilizer treatment and CK. In terms of root length, the highest amount of potassium application was 25.9 cm in 200 mg/kg, followed by 300 mg/kg. However, there was no significant difference between potassium application treatment and CK. Overall, the potassium application amount of 200 mg/kg is better for maize seedling growth.

Effects of potassium fertilizer on absorption of heavy metals As, Cd, Pb and Cu in ground and underground parts of maize

The effect on As: As can be seen from Fig. 1, as the concentration of potassium is increased, the content of As in the upper part of the maize is increased first, then decreased, then increased. Each fertilizer treatment was significantly higher than CK ($P < 0.05$). Overall, it is 1.7–2.4 times higher than CK. However, the performance of each treatment was different, and the content of As in the ground part of maize was the highest in the treatment of 200 mg/kg application, followed by 300 and 100 mg/kg, the lowest

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Table 1: Effects of different potassium application on maize growth

Treatment	Plant height (cm)	Leaf length (cm)	Leaf width (cm)	Root length (cm)
CK	31.7 ± 1.5a	26.3 ± 1.9a	1.5 ± 0.1a	23.5 ± 1.3a
K1	31.5 ± 2.0a	19.5 ± 1.0a	1.8 ± 0.1a	22.0 ± 0.3a
K2	33.2 ± 0.6a	18.7 ± 1.5a	1.8 ± 0.1a	25.9 ± 0.9a
K3	33.2 ± 2.4a	19.6 ± 2.8a	1.8 ± 0.2a	25.0 ± 1.5a
K4	31.7 ± 0.9a	18.5 ± 0.3a	1.6 ± 0.2a	23.3 ± 1.1a
K5	33.3 ± 0.6a	19.7 ± 2.9a	1.7 ± 0.3a	24.7 ± 0.9a

Mean ± standard deviation. Values sharing same letters differ non-significantly ($P > 0.05$)

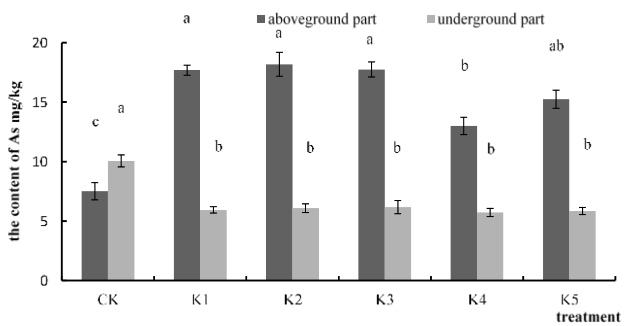

Fig. 1: Effects of potassium fertilizer on absorption of heavy metal as on above-ground and underground parts of maize

were 500 and 400 mg/kg. The results showed that potassium application could significantly promote the absorption of As by maize under the treatment of low concentration and medium concentration. For the underground part, the As content of each potassium treatment was lower than that of CK, the decreased rate was 38.6–42.9%, which was significantly different from that of CK. However, there was no significant difference among the fertilizer treatments. The content of As in underground part of maize treated with 300 mg/kg was the highest. On the whole, the content of As in maize was higher in the above ground part than in the underground part.

The effect on Cd

It can be seen from Fig. 2 that different potassium concentration treatments can improve the absorption of Cd by the ground and underground parts of maize. All treatments were significantly higher than CK ($P < 0.05$). The ground part and underground parts increased 1.6–2.8 times and 1.8–1.9 times, respectively. With the increase of potassium concentration, the content of Cd in ground part and underground part of maize increased at first and then decreased. But the performance of each treatment is different. The ground part shows that the highest content of Cd in maize treated with 300 mg/kg was 3.2 mg/kg, which was significantly different from other potassium treatments ($P < 0.05$). The content of Cd in underground part of maize treated with potassium was between 2.113–2.233 mg/kg. Among them, 200 mg/kg treatment is the highest. The

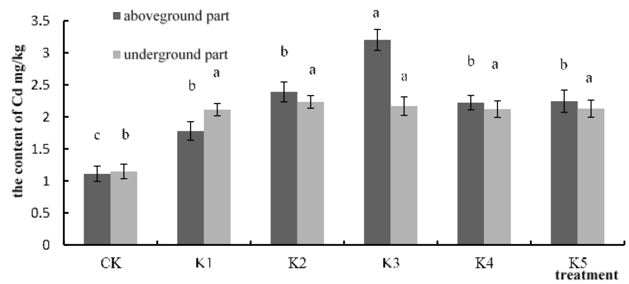

Fig. 2: Effects of potassium fertilizer on absorption of heavy metal Cd on above-ground and underground parts of maize

variance analysis showed that there was no significant difference among the potassium treatments. On the whole, except for 100 mg/kg treatment, the content of Cd in the ground part was higher than that in the underground part, and the medium concentration potassium application rate was beneficial to the absorption of heavy metal Cd by maize.

The effect on Pb

The application of potassium fertilizer had a certain effect on the absorption of Pb by maize plants. It can be seen from Fig. 3 that the content of Pb in ground part of maize is significantly higher than that of CK ($P < 0.05$) which increased 1.7–2.3 times than CK. With the increase of potassium concentration, the content of Pb in maize increased at first, then decreased and then increased. Among them, 200 mg/kg treatment is the highest. The variance analysis showed that there was no significant difference between each potassium fertilizer treatment. As for the ground part, the content of Pb is lower than that of CK except for 500 mg/kg treatment. With the increase of potassium application concentration, it decreased at first and then increased; 500 mg/kg treatment was the highest up to 2.247 mg/kg. After variance analysis, there was no significant difference between 500 mg/kg treatment and CK, 100 and 200 mg/kg treatment, which holds significant difference with 300 and 400 mg/kg. On the whole, the content of Pb in the ground part of maize was higher than that in the underground part, and the amount of potassium applied in the middle concentration was beneficial to the absorption of heavy metal Pb by maize.

The effect on Cu

As can be seen from Fig. 4, the application of potassium fertilizer can promote the absorption of Cu by the ground and underground parts of maize. But the performance of each treatment is different. With the increase of potassium application concentration, the content of Cu in the ground part increased at first and then decreased and then increased. The content of Cu in maize with different potassium treatment was 1.7–2.3 times higher than that of CK. Among

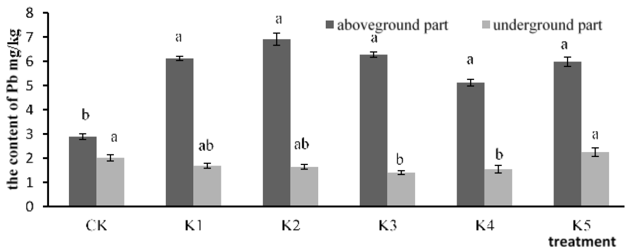

Fig. 3: Effects of potassium fertilizer on absorption of heavy metal pb in above-ground and underground parts of maize

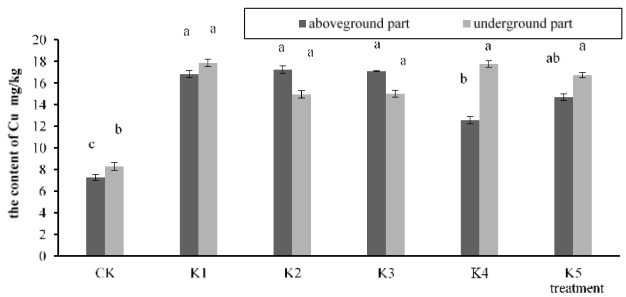

Fig. 4: Effects of potassium fertilizer on absorption of heavy metal Cu on above-ground and underground parts of maize

them, 200 mg/kg treatment is the highest, 300 mg/kg treatment is the second, 100 mg/kg is the third. Through variance analysis, there was no significant difference among the three treatments. With the increase of potassium application, the content of Cu in underground part decreased at first and then increased and then decreased, and the highest treatment was 100 mg/kg up to 17.84 mg/kg. The results show that the absorption of Cu in polluted soil can be promoted in the underground part of maize. On the whole, except for 200 and 300 mg/kg treatment, the Cu content in the ground part of the other treatments was lower than that in the underground part. Low and medium concentration potassium Application is beneficial to the absorption of heavy metal Cu in maize. This may be due to the high concentration of potassium fertilizer and the increase of chloride ion, which leads to the increase of charge in soil to increase the binding power of Cu ion.

Effects of potassium fertilizer on available As, Cd, Pb and Cu in soil

Table 2 shows that potassium fertilizer, compared with CK, can reduce the content of available As, Cd and Cu in soil. However, the effects of different potassium application rates are different. The content of effective As was decreased 12.2–28.8% than that of CK. The lowest amount of potassium application was 300 mg/kg, which was significant different with CK, while there is no significant difference with other potassium treatments. The content of effective Cd decreased by 5.6–14.4%, and the potassium treatment with 500 mg/kg decreased the most. Through variance analysis, there was no significant difference between it and other treatments. Compared with CK, the content of available Pb increased except potassium 500 mg/kg treatment. Among them, the amount of potassium applied is up to twice as much as that of 100 mg/kg treatment. By variance analysis, there was significant difference. The content of available Cu decreased by 5.7–7.9%, and the potassium application with 500 mg/kg was the least, but there was no significant difference between the treatments.

Effect of potassium fertilizer on transfer coefficient and enrichment coefficient of heavy metals

In order to further understand the effect of potassium fertilizer on the transfer ability of As, Cd, Pb and Cu absorbed by maize, the transfer coefficient (BTC) and enrichment coefficient (BAC) of maize were calculated. As can be seen from Table 3, compared with CK, the transfer coefficient of As in each potassium application treatment increased by 3.03–4.00 times. 200 mg/kg treatment was the highest, 100 mg/kg was the second, and 300 mg/kg was the third. Except for 100 mg/kg treatment, the other treatments showed an increasing trend. The increased rate was 8.30–47.6%, with 300 mg/kg treatment increased most. The transfer coefficient of Pb increased by 1.85–3.11 times, with 300 mg/kg treatment up to the most. The transfer coefficient of Cu in high concentration potassium application is lower than that of CK. Medium and low concentration potassium application is higher than CK. 200 mg/kg treatment was the highest, which increased by 31.1% than CK. On the whole, the medium concentration of potassium application was beneficial to the transfer of heavy metals As, Cd, Pb and Cu in maize. From the point of view of the transfer ability of heavy metals, Pb > As > Cd > Cu.

As seen from the enrichment factor, the enrichment ratio of maize to As increased by 6.70–38.2%, up to 300 mg/ kg. Compared with CK, the increase value of Cd enrichment coefficient in maize was 1.72–2.37 times, and the highest in 300 mg/kg treatment. The enrichment factor of Pb increased by 35.9–74.5% than CK, and it was treated with the highest concentration of 200 mg/kg. Compared with CK, the increase of the enrichment coefficient of Cu was 1.95–2.23 times, and the highest was treated with 100 mg/kg. Therefore, the medium concentration of potassium application is beneficial to the enrichment of As, Cd and Pb in maize and the low concentration is beneficial to the enrichment of Cu, from the point of view of the enrichment ability of heavy metals in maize, As > Pb > Cu > Cd.

Correlation between the amount of potassium and the absorption of As, Cd, Pb and Cu in maize

As can be seen in Table 4, there is a certain correlation between the potassium application amount, the heavy metal transfer coefficient and the enrichment factor. Among them,

Table 2: Effects of potassium fertilizer on available As, Cd, Pb and Cu in soil (mg/soil kg)

	As	Cd	Pb	Cu
CK	4.128 ± 0.351a	1.234 ± 0.118a	1.035 ± 0.015b	7.976 ± 0.728a
K1	3.266 ± 0.910b	1.139 ± 0.074a	2.070 ± 0.792a	7.440 ± 0.108a
K2	3.625 ± 0.083ab	1.165 ± 0.121a	1.860 ± 0.667a	7.516 ± 0.109a
K3	2.940 ± 0.071b	1.073 ± 0.021a	1.506 ± 0.754ab	7.351 ± 0.026a
K4	3.135 ± 0.269b	1.145 ± 0.033a	1.253 ± 0.424b	7.389 ± 0.184a
K5	3.333 ± 0.205ab	1.056 ± 0.062a	0.862 ± 0.125bc	7.339 ± 0.047a

Table 3: Effect of potassium fertilizer on transfer coefficient and enrichment coefficient of heavy metals

Treatment	BTC				BAC			
	As	Cd	Pb	Cu	As	Cd	Pb	Cu
CK	0.7456	0.9686	1.434	0.8784	0.5521	0.1998	0.5708	0.2076
K1	2.977	0.8414	3.628	0.9423	0.7431	0.3444	0.9089	0.4628
K2	2.986	1.069	4.212	1.152	0.7631	0.4090	0.9963	0.4295
K3	2.874	1.476	4.467	1.139	0.7523	0.4749	0.8947	0.4284
K4	2.266	1.047	3.310	0.7066	0.5891	0.3843	0.7761	0.4045
K5	2.605	1.054	2.659	0.8781	0.6636	0.3869	0.9585	0.4192

Table 4: Correlation between the amount of potassium and the absorption of As, Cd, Pb and Cu in Maize

		BTC				BAC			
		As	Cd	Pb	Cu	As	Cd	Pb	Cu
	Amount of applied K	0.438	0.364	0.261	-0.225	0.050	0.649	0.492	0.510
BTC	As	-	0.248	0.884*	0.462	0.873*	0.860*	0.945**	0.980**
	Cd	-	-	0.504	0.506	0.314	0.663	0.198	0.169
	Pb	-	-	-	0.610	0.852*	0.889*	0.754	0.830*
	Cu	-	-	-	-	0.807	0.449	0.507	0.280
BAC	As	-	-	-	-	-	0.703	0.845*	0.771
	Cd	-	-	-	-	-	-	0.793	0.833*
	Pb	-	-	-	-	-	-	-	0.898*

except for the negative correlation between potassium application and Cu transfer coefficient (r = -0.226), there was a positive correlation among the other treatments. The transfer coefficient of As and the transfer coefficient of Pb (r = 0.884*), the transfer coefficient of As and the enrichment factor of As (r = 0.873*), the transfer coefficient of As and the enrichment factor of Cd (r = 0.860*), the transfer coefficient of Pb and the enrichment factor of As (r = 0.852*), the transfer coefficient of Pb and the enrichment factor of Cd (r = 0.889*), the transfer coefficient of Pb and the enrichment factor of Cu (r = 0.830*), the transfer coefficient of As and the enrichment factor of Pb (r = 0.845*), the enrichment factor of Cd and the enrichment factor of Cu (r = 0.833*), the enrichment factor of Pb and the enrichment factor of Cu (r = 0.898*), all of them showed significant correlation ($P < 0.05$). The transfer coefficient of As and the enrichment factor of Pb (r = 0.975**), the transfer coefficient of As and the enrichment factor of Cu (r = 0.975**), achieved a very significant correlation ($P < 0.01$).

Discussion

Potassium, as one of the necessary nutritional elements for maize growth, plays an important role in maize growth and nutrient absorption and accumulation. The potassium element can maintain the high yield of the crop by promoting the synthesis of the protein and increasing the stress resistance of the plant (Wang *et al*. 2012; Li *et al*. 2014). This study shows that, potassium fertilizer can promote maize production, and the effect of medium concentration (200 mg/kg) is better. This is consistent on the effect of N, P, K fertilizer on the absorption and accumulation of heavy metals in maize seedlings (Jiao *et al.* 2011). However, there was no significant difference with the treatment without potassium fertilizer. This may be due to the fact that potassium fertilizer mainly improves the quality of crops, and the effect of potassium fertilizer on plant yield is generally not as obvious as that of nitrogen fertilizer.

Considering that potassium can maintain the osmotic pressure inside and outside plants (Sparrow 1996; Chen *et al.* 2010). It may reduce the effect of heavy metal stress on plant growth. The results showed that different potassium application rates could not significantly promote the growth of maize. However, it could significantly ($P < 0.05$) increase the content of As, Cd, Pb and Cu in the ground part of maize, thus increasing the absorption of heavy metals in the ground part of the soil polluted by heavy metals. Among them, low and medium concentration treatment (100–300 mg/kg) was beneficial to maize. With the increase of potassium application rate, the absorption capacity of As, Cd, Pb and Cu in the ground part of maize increased at first and then decreased. This is consistent with the reesult that low concentration potassium application is beneficial to maize absorption of Pb. The trend of water-soluble heavy metals

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through plants also showed that with the increase of potassium concentration, the absorption capacity of Pb in each part of maize increased at first and then decreased. The main organ of plants absorbing heavy metals in soil is root (Li *et al*. 2009; Jiao *et al.* 2011; Huo *et al*. 2018). The order of heavy metal absorption in different parts of maize was root > stem > leaf, which was not consistent with the result of this study-stem and leaf > root, but it was consistent (Shi *et al*. 2017; Guo *et al*. 2018). On sulfur chrysanthemum, Persian chrysanthemum and wheat this may be due to the different crops and varieties tested the type and amount of fertilizer applied the type of soil, the environmental conditions and the selected growth period. Therefore, the application of potassium fertilizer for the release and transfer of heavy metals in maize needs to be further verified.

The toxicity of heavy metals is related not only to the total amount, but also to the chemical form (Wahid and Ghani 2008). Therefore, it is significant to understand the changes of different forms of heavy metals in soil after fertilizer application. It was found that the application of potassium fertilizer could promote the reduction of the content of available heavy metals in soil to a certain extent. Among them, the contents of available As, Cd and Cu in soil treated with medium and high concentration potassium application were the least. This may be due to the fact that fertilizers promote crop growth and increase the absorption of available heavy metals by crops, thus reducing the content of heavy metals in the soil (Wang and Li 2014). This study showed that potassium fertilizer could significantly increase the transfer ability and enrichment coefficient of heavy metals As, Cd, Pb and Cu to the above ground part of maize. Among them, the medium concentration potassium application level was beneficial to the transfer of heavy metals As, Cd, Pb and Cu to maize, and the low and middle concentration potassium application level was beneficial to the enrichment of heavy metals As, Cd, Pb and Cu in maize. This is consistent with the reesult that Nitrogen fertilizer can significantly enhance the enrichment coefficient of heavy metal Cd, Pb in maize and its transport capacity to shoot (Li *et al*. 2014). In order to further understand the relationship between potassium fertilizer and heavy metal absorption in maize, Pearson correlation analysis was also carried out from the amount of potassium application, transfer coefficient and enrichment coefficient. The results show that the transfer ability and enrichment ability of potassium fertilizer to heavy metals As, Cd and Pb are positively correlated. Therefore, potassium application amount is also one of the factors affecting heavy metal absorption in maize. In addition, the transfer coefficient and enrichment coefficient of some heavy metals reached significant and extremely significant positive correlation, which may promote the absorption of heavy metals by maize.

Conclusion

In this study, pot test method is adopted, and the corn is used as test material. In the soil contaminated by heavy metal As-Cd-Pb-Cu, six different amounts of potassium fertilizer were used to treat the soil, which are No potassium, application of KCI 100 mg/kg, application of KCI 200 mg/kg, application of KCI 300 mg/kg, application of KCI 400 mg/kg, and application of KCI 500 mg/kg. It aims to study the effects of different potassium concentrations on the growth, absorption and accumulation of heavy metals (As, Cd, Pb and Cu) in corn seedlings. The results can be concluded as follows:

(1) In the compound polluted soil of the heavy metal As-Cd-Pb-Cu, the medium concentration of potassium (200 and 300 mg/kg) can promote the growth of corn, but there is no significant difference with CK.

(2) Potassium fertilizer can significantly increase the absorption of heavy metals As, Cd, Pb and Cu in the aerial part of corn. The treatment of low and medium concentration (100–300 mg/kg) is beneficial to the absorption of heavy metals As, Cd, Pb and Cu. in the aerial part of corn. The effects of potassium fertilizer on the absorption of heavy metals As, Cd, Pb and Cu in underground part of corn are different. Potassium fertilizer can reduce the absorption of As and Pb in the underground part of corn, which can significantly increase the content of Cd and Cu in the underground part, and the middle and low concentration treatment is the best. Overall, the content of heavy metals in the ground part is higher than that of the underground part.

(3) Potassium fertilizer could reduce the content of available As, Cd and Cu in soil up to 28.8, 14.4 and 7.9%, respectively. Medium and high concentration treatment is beneficial to reduce the content of available As, Cd and Cu in soil. Potassium fertilizer was beneficial to the increase of available Pb content in soil, and 200 mg/kg increased the most.

(4) There was a positive correlation between potassium application amount and some heavy metal transfer coefficients and enrichment coefficients, but there was no significant correlation.

(5) Fertilizer is one of the important agricultural measures to ensure the increase of agricultural yield and income. Besides, it holds great effects on the adsorption and desorption of heavy metals in the soil, the absorption of the heavy metals by the physical and chemical properties and corps in the rhizosphere soil. The situation of heavy metal compound pollution is more complex than that of single heavy metal element. The mechanism of action is also very complex, but it turns out to be more realistic. The determination of heavy metal content in plants can illustrate the absorption ability of plants to heavy metals. This study finds that the application of low and medium concentration potassium fertilizer is beneficial to the absorption of heavy metals by maize However, it is necessary to carry out further research on the influence of different potassium fertilizer on the absorption of heavy metals on the corn on the composite contaminated soil and its interaction with the nitrogen, the phosphate fertilizer and its ions.

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