Effect of Potassium on Arsenic Accumulation in Two Basil Cultivars

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Abstract: In order to evaluate the effects of potassium fertilizers on arsenic toxicity in two varieties of basil, a factorial experiment was conducted using Completely Randomized Block Design. Studied factors included two varieties of keshkeniluvelouand local of Zabol seed as the first factor and triple super phosphate fertilizer at three levels of 50, 150 and 250 mg.kg soil-1 as the second factor. Fixed amount of 15 mg.kg soli -1 arsenic sulphate was added to all pots. Analysis of variance showed no significant effect of variety on aerial parts potassium percentage, while potassium fertilizer levels effect with arsenic and their interactive effect were significant. Interaction between arsenic and potassium showed that highest arsenic content at the aerial parts achieved from lowest applied potassium level.

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1. Introduction:

Basil (Ocimumbasilicum L.), a member of the Lamiaceae family, is used both as a culinary and ornamental herb. The genus Ocimum contains between 50 and 150 species of herbs and shrubs found in the tropical regions of Asia, Africa, and Central and South America. Traditionally basil has been used as a medicinal plant in the treatment of headaches, coughs, diarrhea, constipation, warts, worms, and kidney malfunctions. Externally, basil can be used as an ointment for insect bites, and its oil is applied directly to the skin to treat acne (Javanmardi et al, 2002).Arsenic is a heavy metal that is considered toxic when present in very low concentrations, on the order of parts per billion (ppb). Arsenic has been used in embalming fluids, herbicides, insecticides, defoliants, and is typically found in the vicinity of metal smelters. Arsenic is released into the environment from anthropogenic sources such as mining activities and the application of arsenic-based pesticides and wood preservatives, in both inorganic and organic forms. Arsenite [As(III)] and arsenate [As(V)] are the inorganic phytoavailable forms of arsenic in soil and water. Plants vary in their sensitivity and resistance to arsenic (Mokgalaka-Matlala et al, 2009). In developing countries heavy metal pollution is very serious due to mining, smelting and tannery industries (Wang et al., 2001). Heavy metal pollution does not only affect the production and quality of crops, but also influences the quality of the atmosphere and water bodies, and threatens the health and life of animals and human beings (Kumar et al, 2008). The use of herbal medicines has been on the rise in recent years due to their low prices and the lack of awareness of people about their adverse side effects. There is a common concept among people that herbal medicines have no side effects and that being natural in origin, herbs are safe. The assimilation of heavy metals in plants is obvious because of widespread heavy metals in the soil due to geo-climatic conditions (Ali khan et al, 2007). Arsenic in plants by attacking cell membranes and preventing their regular actions will cause their death (Ozturk et al., 2010). Potassium can cause stabilization of arsenic in the soil and prevent its accumulation in the plant (Sisr et al., 2007). Kumar (1999) reported a positive correlation between potassium and arsenic accumulation. Carbonell et al., (1995) during assessment of arsenic adsorption in tomato plants found that with increased uptake of this element, the incidence of injuries due to high accumulation of arsenic in the plant's reduced the ability to absorb the element. This decrease was due to roots damage which reduced its uptake and transfer from roots to shoots. In report arsenic was found to reduce potassium absorption in tomato plants (Carbonell-Barrachina et al., 1998).

2. Materials and Methods:

In order to evaluate the effect of potassium fertilizer on the uptake and accumulation of arsenic in two varieties of basil herb, a factorial experiment was conducted in the research greenhouse of Zabol University in an isolated environment with controlled temperature, light, humidity and other environmental factors where experimental design was completely randomized block design. The experiment was conducted in 2011 at the Zabol University greenhouse in Zabol (61° 29 N, 31° 23E, 450 m above sea level), south Iran. Studied factors included two varieties of basil inbred seeds (keshkeniluvelouand local of Zabol) as the first factor and three fertilizers levels of 50, 150 and 250 mg (K).kg Soil -1 for each variety as the second factor. Fixed amount of 15 mg.kg soil -1Arsenic Sulphate was added to all pot soils. Seeds were sown in 20 cm height and 15 cm diameters pots and after that pots were placed randomly in the greenhouse, and when seedling were grown to 3 cm height plants in the pots were thinned up to five plant in each pot. During the experiment pots were irrigated once every three days. Potassium measurement was done using flame photometer and digestion method using dry burning and combination with HCl was used for extract preparation for atomic absorption (Pu9100x-Philips).

3. Results and discussion:

Analysis of variance showed that effect of variety and potassium fertilizers were significant on arsenic concentration in vegetative parts at 1% of probability, while there interactive effect was not significant (Table 1). Means comparison of main effect of varieties showed that arsenic accumulation content in the aerial parts of keshkeniluvelouwas significantly different from with local of Zabol, which can be also the reason for better growth of local of Zabolvariety,besides, this variety compared to bred variety is better adapted to environmental conditions of this region (Table 2). Comparison of means of potassium fertilizer with arsenic showed that the highest and lowest arsenic concentrations in vegetative parts are for 50 and 150 mg.kg soli-1, respectively (Table 3).

Table 1. Analysis of variance of elements on basil affected by K fertilizers with As

SOV	DF	Shoots K	Roots K	As
		Means Square		
Replication	2	11.11	0.17	192.77
Variety	1	0.09^{ns}	0.48^{**}	11857.4^{**}
Fertilizer	6	5.99^{*}	0.71^{**}	1152.6^{**}
Varity×Fertilizer	6	8.81^{**}	0.47^{**}	213.7^{ns}
Error	26	0.33	0.09	202.9
C.V. (%)		14.38	5.62	9.62

ns, * and ** not significant, significant at 5 and 1%, respectively.

Table 2. Basil varieties means comparison of elements

Variety	Shoots K (%)	Roots K (%)	Arseinc (ppb)
'Kashkani LOLO'	4.08 a	1.81 a	164.844 a
'Local'	3.98 a	1.60 a	131.238 b

Means with similar letter are not significant at the 5% probability level

Table 3. Means comparison of elements affected by K fertilizer with As

Treatment	Shoots K (%)	Roots K (%)	Arseinc (ppb)
K50	3.37 cd	1.52 d	153.85 bc
K 150	2.84 d	1.81 b	137.9 bc
K 250	3.40 cd	1.73 bc	138.6 bc
Control	5.89 a	2.40 a	138.75 bc

Means with similar letter are not significant at the 5% probability level

Also regarding to arsenic and potassium, highest arsenic content was observed at 50 mg.Kg-1 of potassium fertilizers with arsenic. According to the results it can be said that both varieties have high arsenic stabilization ability. In the bred variety, lowest arsenic content was observed at 150 mg.kg soil-1 while this content for other variety was just at 50 mg.kg soil-1. Comparing control treatment of both varieties showed that local varieties are more able to prevent entry of arsenic in to the aerial parts. In general, local variety of Zabol due to its compatibility to the region had better growth than the European cultivar, but in the control treatment of both varieties that As content of 15b mg/kg soil solely added to the soil, reduced local variety growth compared to other treatments, which may be due to lack of heavy metals contamination in this region. Studies on As showed that this element can cause plant stress and thus prevent their growth. It can be said that potassium interaction in other treatments prevent negative effect of As on local cultivars (Gunes et al., 2009), while in control treatment of European variety a type of growth stimulation was observed. This stimulating effect of As low levels on growth was similar to those achieved by Chen and Liu (1993) and Jian et al (1992) on rice in which low As levels resulted in growth stimulation but contradicts with results obtained from wheat, maize, cucumber and cabbage (Sisr et al., 2007) and helianthus (Gulz et al., 2005) in which this stimulating effect did not happen. In a pot study that was conducted on pigweed, As levels of more than 15 mg/kg soil showed negative effect on seeds germination and leaves number (Choudhury et al., 2008). Miteva et al (2005) reported the negative effect of As on tomato through limiting the growth through limiting roots and shoots growth. Their results showed that increased As concentrations reduce plants height and the highest reduction was in 100 mg/kg soil, but no significant difference was not found between 25 and 50 mg/kg soil. High As levels had a negative effect on JatrophaCurcas (Euphorbiaceae) growth, but this reduction was lower in treatments containing As, N, P and K (Kumar et al., 2008). Fresh and dry weight reduction of shoots and roots with increased fertilizers levels can be due to lower growth of these plants at higher P and K levels that are consistent with those achieved from Artemisia (Peyvandi et al., 2009). Although quantitative traits of local Zabol variety was significantly different from European cultivar of keshkeniluvelou, but in compare with studies conducted in different regions of Iran on basil, presented results of three cultivars of basil, all results in terms of morphologic characters are very different, which represents the greater effectiveness of this variety from As toxicity (Javanmardi et al., 2002).

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