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EVALUATION OF ARSENIC ACCUMULATION BY *Colocasia esculenta* (Kochu) FROM SOIL

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ABSTRACT

Manirul MI, Mayda U, Mehraj H, Shiam IH, Jamal Uddin AFM (2015) Evaluation of arsenic accumulation by *Colocasia esculenta* (Kochu) from soil. *J. Soil Nature* 8(2), 1-4.

An experiment was conducted for the evaluation of arsenic accumulation by kochu (*Colocasia esculenta*) from different concentration of arsenic contaminated soil during July 2012 to October 2012. Plants were grown on soil treated with different arsenic concentrations *viz.* A_0; 0 mg/kg, A_1; 500 mg/kg, A_2; 1000 mg/kg and A_3; 2000 mg/kg. From the experiment it was found that leaf number, plant height, leaf area, number of runner, number of sucker, plant leaf biomass and runner biomass were decreased significantly while the arsenic contamination level in soil increased. Kochu leaves accumulated 422.3, 751.7 and 973.5 mg/kg arsenic and kochu runner accumulated 178.8, 202.3 and 210.4 mg/kg arsenic when soil treated with 2000 mg/kg, 1000 mg/kg and 500 mg/kg arsenic respectively.

Key words: *Colocasia esculenta, soil arsenic and arsenic accumulation*

INTRODUCTION

Arsenic contamination in soils and irrigation water cause arsenic contamination of the plants grown therein. Available forms of arsenic in soil and groundwater is taken by plant roots with other nutrients and enters the plant body and eventually deposited in leaves and other edible parts of plants. Consumption of these arsenic contaminated plant parts is a threat for human and animal health. Kochu (*Colocasia esculenta*) is a leafy vegetable used as vegetable almost everywhere in Bangladesh, is a very rich source of vitamin A and C. Concentration of arsenic as high as 80 mg/kg in soil was found in some areas of Bangladesh receiving irrigation with arsenic-contaminated water (Huq *et al.* 2006). Kochu is a common plant in those areas. Kochu has been found to accumulate more arsenic. Under this consideration, present experiment was conducted to evaluate the arsenic accumulation pattern by kochu grown in highly arsenic contaminated soils.

MATERIALS AND METHOD

The experiment was conducted at the Horticulture farm, Sher-e-Bangla Agricultural University, Bangladesh during July 2012 to October 2012. Three weeks kochu seedlings were used in the experiment. The experiment was carried out in a Completely Randomized Design where soil treated with four levels of arsenic *viz.* A_0: Control (0 mg/kg); A_1: 500 mg/kg; A_2: 1000 mg/kg; A_3: 2000 mg/kg with three replications. Arsenic was applied in the form of Arsenic trioxide (As_2O_3). A ratio of 1:1 well rotten cow dung and soil were mixed and pots were filled 15 days before transplanting. Three weeks old kochu seedlings were transplanted in the pot. The pots were hand-weeded and watered as needed. No additional fertilizers or soil amendments were used during the growing season. Data were collected on leaf number, plant height, leaf area, number of runner, number of sucker, leaf biomass, runner biomass and arsenic accumulationin leaf and runner. Leaf area was measured by non-destructive method using CL-202 Leaf Area Meter, (USA) and plant biomass was measured by using precision balance after drying (oven dry). The chemical analysis was performedby using "Atomic Absorption Spectrometer" in Bangladesh Council of Scientific Research Institute (BCSRI). Collected data were statistically analyzed using MSTAT-C computer package programmed. Mean for every treatments were calculated and the analysis of variance for each one of the characters was performed by F–test (Variance Ratio). Difference between treatments was evaluated by Least Significance Difference (LSD) test at 5% level of significance (Gomez and Gomez, 1984).

RESULT AND DISCUSSION

Leaf number: Leaf number of kochu showed statistically significant differences among control (0 mg/kg), 500 mg/kg, 1000 mg/kg and 2000 mg/kg at 15, 30, 45 and 60 DAT (Fig. 1a). Maximum leaf number was recorded in control (A_0; 14.0) whereas minimum in the plants grown in 2000 mg/kg arsenic treated soil (A_3; 5.7) at 60 DAT (Fig. 1a) and revealed that plant leaf number was reduced with the increase of arsenic concentration.

Runner number: Runner number showed statistically significant differences among control (0 mg/kg), 500 mg/kg, 1000 mg/kg and 2000 mg/kg at 60 DAT (Fig. 1b). Maximum runner number was recorded in A_0 (8.9) whereas minimum in A_3 (1.4) at 60 DAT (Fig. 1b).

Plant height: Plant height of kochu varied significantly among the control (0 mg/kg), 500 mg/kg, 1000 mg/kg and 2000 mg/kg at 15, 30, 45 and 60 DAT (Fig. 1c). Tallest plant was observed in A_0 (62.0 cm) whereas shortest plant in A_3 (31.0 cm) at 60 DAT (Fig. 1c). From the current study it was found that kochu showed a trend to survive on the arsenic contaminated soil but it reduce their height when the level of arsenic in soil increased.

Leaf area: Leaf area showed statistically significant differences among control (0 mg/kg), 500 mg/kg, 1000 mg/kg and 2000 mg/kg at 15, 30, 45 and 60 DAT (Fig. 1d). Highest leaf area was recorded in control (A_0; 85.6 cm^2) whereas lowest in A_3 (34.1 cm^2) at 60 DAT (Fig. 1d).

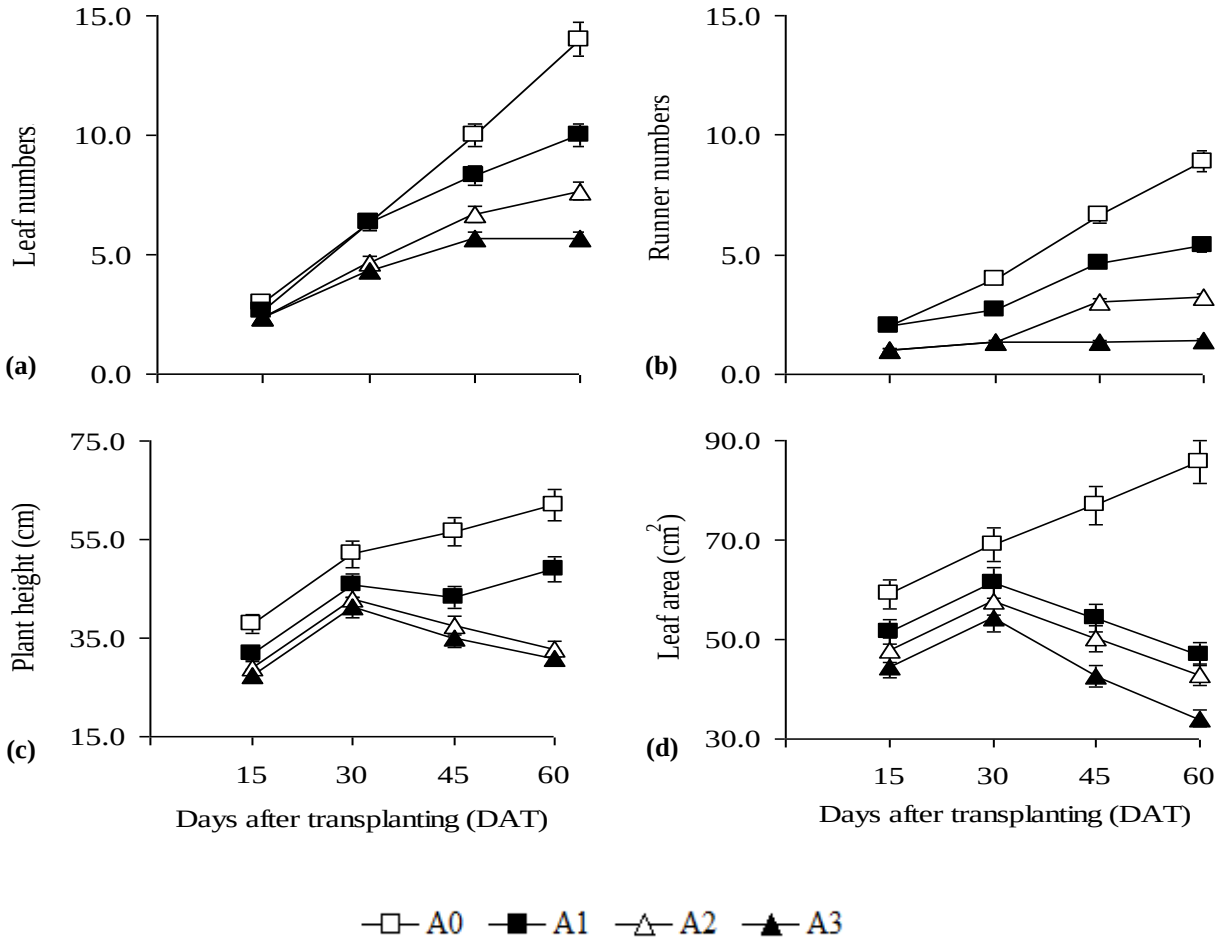

Fig. 1. Response of kochu plant grown in different concentrated arsenic treated soil on (a) leaf numbers, (b) runner numbers, (c) plant height and (d) leaf area

A_0; Control | A_1: 500 mg/kg arsenic treated soil | A_2; 1000 mg/kg arsenic treated soil | A_3; 2000 mg/kg arsenic treated soil

Plate 1. Plant growth variation grown at different concentrated arsenic treated soil

Number of newly emerged leaves at 30 DAT: Number of newly emerged leaves at 30 DAT showed statistically significant differences among control (0 mg/kg), 500 mg/kg, 1000 mg/kg and 2000 mg/kg. Highest number of newly emerged leaves was observed at the plant grown in 500 mg/kg arsenic treated soil (A_1; 3.7) which was statistically similar to control (A_0; 3.3) while lowest from A_3 (2.0) which was statistically similar to A_2 (2.3) (Table 1).

Number of died leaves at 30 DAT: Number of died leaves at 30 DAT showed statistically significant differences among control (0 mg/kg), 500 mg/kg, 1000 mg/kg and 2000 mg/kg. Highest died number of leaves was observed on the plants grown in 2000 mg/kg arsenic treated soil (A_3; 3.7) which was statistically similar to A_2 (3.0) whereas lowest in control (A_0; 0.5) (Table 1). From the present study it was observed that death of the plant leaves caused by the increased arsenic level on soil.

Number of sucker: Number of sucker showed statistically significant differences among different level of arsenic in soil. Maximum number of sucker was recorded from control (A_0; 5.3) whereas minimum from plants grown in 2000 mg/kg arsenic treated soil (A_3; 1.3) which is statistically similar to A_2 (2.0) (Table 1). The present study identified that number of sucker was reduced with the increase of arsenic concentration.

Plant leaf biomass: Plant leaf biomass showed statistically significant differences among different level of arsenic treated soils. Maximum plant leaf biomass was recorded in control (A_0; 1624.1 mg) whereas minimum from A_3 (715.2 mg) (Table 1). Plant biomass varied due to the variation of the concentration of arsenic (Wei *et al.* 2006).

Total arsenic accumulation on plant leaves: Plants from 2000 mg/kg arsenic treated soil accumulate maximum arsenic in their leaves (A_3; 973.5 mg/kg) whereas minimum from A_0 (0.3 mg/kg) (Table 2). Tani *et al.* (2012) analyzed different market basket vegetables at Jessore district in Bangladesh and found that kochu leaves had1 mg/kg (dry weigh). On the other hand, it was found that kochu (kochu) vegetable accumulate more than 150 mg/kg of arsenic from contaminated soil (Huq *et al.* 2006). But current study reports that kochu leaves had 973.5 mg/kg arsenic which was much more than the previous reports. It may be due to the high level of arsenic in soil. So, it is reported here that Kochu had high arsenic uptake ability and hence could be used for phytoremediation of arsenic contaminated soils.

Runner biomass: Maximum plant runner biomass (361.6 mg) was recorded from control (A_0) whereas the minimum plant leaf biomass (90.4 mg) was found from 2000 mg/kg (A_3) arsenic which is statistically similar to 1000 mg/kg (A_2) arsenic (Table 4). The present study identified that plant runner biomass was reduced with the increase of arsenic concentration. Plant biomass varied due to the variation of the concentration of arsenic (Wei *et al.* 2006).

Total arsenic accumulation in runner: Plants from 2000 mg/kg arsenic treated soil accumulated maximum arsenic in their runners (A_3; 210.3 mg/kg) which was statistically similar with A_2 (202.3 mg/kg) and A_1 (178.8 mg/kg) whereas the lowest arsenic accumulation was observed in A_0 (0.04 mg/kg) (Table 2). Huq *et al.* (2006) reported that kochu (kochu) vegetable accumulate more than 150 mg/kg of arsenic when grown in arsenic contaminated soil. Many countries including Bangladesh have no legislation on arsenic Maximum Permissible Limit (MPL) but MPL of total arsenic in vegetables in Bangladesh is considered as 1.0 mg/kg (fresh weight) (Ahmed 2000).

Table 1. Response of rice plant grown in different concentrated arsenic treated soil on different attributes

Arsenic concentrations	Number of leaves at 30 DAT		Number of sucker	Plant leaf biomass (mg)
	Newly emerged	Died		
A_0	3.3 a	0.5 b	5.3 a	1621.1 a
A_1	3.7 a	2.3 ab	3.3 b	1136.7 b
A_2	2.3 b	3.0 a	2.0 c	1045.2 b
A_3	2.0 b	3.7 a	1.3 c	715.2 c
LSD	0.7	1.3	1.0	197.2
CV%	13.2	26.0	16.7	8.7

[x] In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

Table 2. Response of kochu plant grown in different concentrated arsenic treated soil on arsenic accumulation attributes

Arsenic concentrations	Total arsenic accumulation in plant leaves (mg/kg)	Runner biomass (mg)	Total arsenic accumulation in runner (mg/kg)
A_0	0.3 d	361.6 a	0.04 b
A_1	422.3 c	226 b	178.8 a
A_2	751.7 b	135.6 c	202.3 a
A_3	973.5 a	90.4 c	210.4 a
LSD	160.3	67.7	97.8
CV%	12.6	16.7	30.2

[x] In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of significance

CONCLUSION

Arsenic contamination in soil affected the growth of kochu plant. Kochu had a tendency to accumulate arsenic from soil at higher level. When the soil contamination level was 2000 mg/kg then kochu plant accumulated 973.5 mg/kg arsenic in leaves and 210.3 mg/kg arsenic in runner. Kachu had a higher arsenic accumulating capability and hence could be recommended for phytoremediation of arsenic contaminated soils.

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