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Mitigation of Arsenic Stress by Vermicompost and Inorganic Fertilizers in Brri Dhan47

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Abstract: *This experiment was done to evaluate the influence of vermicompost and inorganic fertilizers for the mitigation of arsenic stress in BRRI dhan47. Five different doses of vermicompost and inorganic fertilizers i.e.* $\boldsymbol{T_o}$*= Recommended doses of vermicompost without inorganic fertilizers,* $\boldsymbol{T_1}$*= Recommended doses of inorganic fertilizers without vermicompost,* $\boldsymbol{T_2}$*= Recommended doses of vermicompost + inorganic fertilizers,* $\boldsymbol{T_3}$ *= Reduction of 40% of recommended doses of inorganic fertilizers + Addition of vermicompost to supplement the reduction of inorganic fertilizers,* $\boldsymbol{T_4}$*= Reduction of 60% of recommended doses of inorganic fertilizers + Addition of vermicompost to supplement the reduction of inorganic fertilizers were applied under four levels of arsenic [*$\boldsymbol{As_0}$*=No arsenic applied,* $\boldsymbol{As_1}$*= 10 ppm arsenic,* $\boldsymbol{As_2}$*= 20 ppm arsenic,* $\boldsymbol{As_3}$*= 30 ppm arsenic] to observe the mitigation of arsenic.* As_0T_2 *gave maximum result in almost all the yield contributing parameters and grain yield of rice whereas* As_3T_1 *gave minimum results. The maximum N, P and K content in grain, straw and root were found in* As_0T_2 *and the minimum were observed from* As_3T_1 *treatment; whereas, highest As by* As_3T_1 *and lowest by* $As_0T_{0.}$

Key Word: *Mitigation; Vermicompost; Inorganic Fertilizer; Arsenic; Yield.*

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I. Introduction

Arsenic (As), a naturally occurring metalloid, is very mobile in the environment. It enters into farming systems through a variety of means which include natural geochemical processes[1], use of arsenic-based pesticides, mining operations, irrigation with arsenic contaminated groundwater, and also fertilization with municipal solid wastes[2]. For Bangladesh perspective, groundwater contamination of arsenic is a pressing issue for various districts. Up to various levels, most of the districts of Bangladesh have arsenic contaminated groundwater and 17 of them have exceeded the safety level of WHO recommendation for safety including Chandpur, Comilla, Noakhali, Feni, Munshiganj, Brahmanbaria, Faridpur, Madaripur, Laxmipur, Gopalganj, Shariatpur, Narayanganj, Narail, Satkhira and Chapainawabganj[3]. Now-a-days, twenty countries including Bangladesh have been suffering from groundwater contamination by arsenic, which is the most severe problem occurring in Asia[4]. According to WHO recommendation the permissible limit of arsenic in rice is 1mg/kg. The As contaminated areas in Bangladesh have shown as more than 20 mg As/kg soil. People are exposed to elevated level of arsenic through contaminated drinking water. Using contaminated water in food preparations, irrigation, and industrial processes and eating contaminated food[5]. A significant loss of crop production due to high concentration (20 ppm) arsenic in plant body was recorded by a number of researchers[6]. A number of mitigation approaches have been tried to control arsenic accumulation in plants like phyto-remediation that the removal of contaminants with the help of green plants and organic soil amendments such as cow dung, vermicompost etc. also includes the mitigation of arsenic accumulation in plants which is eco-friendly and available to farmers. Incorporation of organic manures significantly reduced the arsenic uptake by different plant parts of rice is more pronounced and consistent with FYM and vermicompost[7]. Therefore, the use of organic soil amendment such as vermicompost could be an approach to alleviate the accumulation of As of rice plants. Rice (*Oryza sativa* L.) is the principle cereal staple food under the family Poaceae for 160 million people of Bangladesh. Rice sector contributes to 70% of the agricultural GDP and one-sixth of the national income of Bangladesh. Rice covers about 81% of the total cropped area and provides nearly 48% of rural development[8]. The population of Bangladesh is increasing at an alarming rate and the cultivable land is reducing due to urbanization and industrialization resulting in more shortage of food. Horizontal expansion of rice area, rice yield unit^{-1} area should be increased to meet this ever-increasing demand of food in the country. Management practices also can help for horizontal expansion of rice area and yield unit^{-1} area. Considering the above facts, the present study was under taken with the following objective:

- To find out the suitable combination of vermicompost and inorganic fertilizers to mitigate the detrimental effects of arsenic stress in BRRI dhan47 with reference to yield and nutrient content of rice.

II. Materials And Methods

Experimental site

The experiment was conducted under pot-culture at the net house and the agro-environmental chemistry laboratory of the Department of Agricultural Chemistry, Sher-e-Bangla Agricultural University, Dhaka-1207 during the Boro season.

Collection and preparation of soil

A bulk volume of soil was collected at a depth of 0-l5 cm from the experimental field of Sher-e-Bangla Agricultural University. After collection, the soils were made free from the plant roots and unnecessary materials and dried under sunlight for 2 weeks. Then the soil sieved and mixed up thoroughly and ready for potting.

Pot preparation

An amount of 8 kg soil was taken in a series of pots. The required number of plastic pots having 24 cm top, 18 cm bottom diameter and 22 cm depth were collected from the local market and cleaned before use. There were altogether 60 pots comprising 4 different treatments of arsenic to 5 different treatments of vermicompost and inorganic fertilizers with 3 replications. Water was added to the pot to bring the soil up to saturation.

Treatments of the experiment

The source of arsenic was Sodium Arsenate ($Na_2HAsO_4.7H_2O$).

Design: CRD with two factorials

Factor A: Different doses of arsenic: 04

As_0= (No arsenic applied), As_1= (10 ppm arsenic on soil weight basis), As_2= (20 ppm arsenic on soil weight basis), As_3= (30 ppm arsenic on soil weight basis)

Factor B: Different doses of vermicompost and inorganic fertilizers: 05

$\mathbf{T_o}$ = Recommended doses of vermicompost without inorganic fertilizers, $\mathbf{T_1}$ = Recommended doses of inorganic fertilizers without vermicompost, $\mathbf{T_2}$ = Recommended doses of vermicompost + inorganic fertilizers, $\mathbf{T_3}$ = Reduction of 40% of recommended doses of inorganic fertilizers + Addition of vermicompost to supplement the reduction of inorganic fertilizers, $\mathbf{T_4}$ = Reduction of 60% of recommended doses of inorganic fertilizers + Addition of vermicompost to supplement the reduction of inorganic fertilizers

Treatment combinations = 4 x 5 = 20, Replications: 3

Collection of seed

Seeds of BRRI dhan47 was collected from BRRI (Bangladesh Rice Research Institute), Joydebpur, Gazipur-1701, Dhaka.

Statistical Analysis

The data were compiled and tabulated in proper form and were subjected to statistical analysis. Analysis of variance was done following the computer package MSTAT-C program developed by Russel (1986)[9]. The mean differences among the treatments were adjusted by least significant difference (LSD) test at 5% level of significance[10].

III. Results And Discussion

Number of tillers hill^{-1}

Interaction of different doses of fertilizers (vermicompost and inorganic) and different doses of arsenic showed significant variation on number of tillers hill^{-1} of BRRI dhan47 at 30, 50, 70 and 90 DAT (Table 1). At 30 DAT, the highest number of tillers hill^{-1} (7.33) was observed from the As_0T_2 treatment which was statistically similar with As_0T_4 (6.67), As_0T_0 (6.33), As_0T_3 (6.00) and As_0T_1 (5.67) and the lowest number of tillers hill^{-1} (1.33) was observed from As_3T_1 treatment which was statistically similar with As_3T_3 (2.33), As_3T_4 (2.67) and As_3T_0 (2.67). At 50 DAT, the highest number of tillers hill^{-1}(11.67) was observed from the As_0T_2 treatment which was statistically similar with As_0T_4 (10.67) and As_0T_0 (10.33) and the lowest number of tillers hill^{-1}(2.00) was observed from As_3T_1 treatment which was statistically similar with As_3T_3 (3.00) and As_3T_0 (3.33).At 70 DAT, the highest number of tillers hill^{-1} (14.67) was observed from the As_0T_2 treatment which was statistically similar with As_0T_4 (13.67) and As_0T_0 (13.33) whereas, the lowest number of tillers hill^{-1} (4.00) was observed from As_3T_1 treatment which was statistically similar with As_3T_3 (4.67) and As_3T_0 (5.00). At 90 DAT, the highest number of tillers hill^{-1} (16.33) was observed from the As_0T_2 treatment which was statistically similar with As_0T_4 (15.00) and the lowest number of tillers hill^{-1} (6.00) observed from As_3T_1 treatment which was statistically similar with As_3T_3 (6.33) and As_3T_0 (7.00). This confirms the reports of Nayak *et al*. (2007)[11] that a significant increase in number of tillers hill^{-1} due to the application of organic manure with chemical fertilizers. Holmgren *et al*. (1993)[12] and Das *et al*. (1997)[13] reported that all the growth parameters tested in their experiment viz. tiller numbers were affected by the application of arsenic.

Table 1: Interaction effect of different doses of arsenic and different doses of fertilizers (vermicompost and inorganic) on number of tillers hill^{-1} at different days after transplanting

Treatments		Number of tillers hill^{-1}			
		30 DAT	**50 DAT**	**70 DAT**	**90 DAT**
As_0	T_0	6.33 abc	10.33 ab	13.33 ab	14.33 bc
	T_1	5.67 a-e	8.00 def	11.00 cd	12.67 cd
	T_2	7.33 a	11.67 a	14.67 a	16.33 a
	T_3	6.00 a-d	8.67 cd	11.67 bc	12.33 de
	T_4	6.67 ab	10.67 ab	13.67 a	15.00ab
As_1	T_0	5.00 b-g	8.00 def	10.33 c-f	11.00 d-g
	T_1	4.33 d-i	7.00 efg	9.00 e-h	10.00 f-i
	T_2	5.33 b-f	9.67 bc	11.33 cd	14.33 bc
	T_3	4.00 e-j	7.33 d-g	9.67 d-g	10.67 e-h
	T_4	4.67 c-h	8.33 cde	11.00 cd	11.67 def
As_2	T_0	4.00 e-j	6.00 ghi	8.33 g-j	9.00 h-k
	T_1	3.33 g-j	5.00 ij	7.00ijk	8.00 j-m
	T_2	4.67 c-h	7.67def	10.67 cde	11.67 def
	T_3	3.67 f-j	5.33 hi	6.67 jkl	8.33 i-l
	T_4	4.33 d-i	6.67 fgh	8.67 f-i	9.67 g-j
As_3	T_0	2.67 ijk	3.33 klm	5.00 lm	7.00 lmn
	T_1	1.33 k	2.00 m	4.00 m	6.00 n
	T_2	3.00 h-k	4.67 ijk	7.33 h-k	8.67 i-l
	T_3	2.33 jk	3.00 lm	4.67 m	6.33 mn
	T_4	2.67 ijk	3.67 jkl	5.67 klm	7.67 k-n
LSD $_{(0.05)}$		**1.770**	**1.492**	**1.941**	**1.999**
CV (%)		**24.56**	**13.19**	**12.81**	**11.50**
Significant level		*	*	*	*

* - Significant at 5% level

As_0 = No As applied, As_1= 10 ppm As, As_2= 20 ppm As, As_3= 30 ppm As on soil weight basis
T_o = Recommended doses of vermicompost without inorganic fertilizers, T_1 = Recommended doses of inorganic fertilizers without vermicompost, T_2 = Recommended doses of vermicompost + inorganic fertilizers, T_3 = Reduction of 40% of recommended doses of inorganic fertilizers + Addition of vermicompost to supplement the reduction of inorganic fertilizers, T_4 = Reduction of 60% of recommended doses of inorganic fertilizers + Addition of vermicompost to supplement the reduction of inorganic fertilizers

Number of filled grains panicle^{-1}

Interaction of different doses of fertilizers (vermicompost and inorganic) and different doses of arsenic showed significant influence on number of filled grains panicle^{-1}. In respect of the number of filled grains, the highest number (94.67) of filled grains was recorded from As_0T_2 which was statistically similar with As_0T_4 (92.33) and As_0T_0 (90.00) whereas, the lowest number (66.33) of filled grains panicle^{-1} recorded from As_3T_1 which was statistically similar with As_3T_3 (68.33) and As_3T_0 (69.33) (Table 2). This result agreed with Hossain *et al*. (2008)[14] who reported that number of filled grain. As the number of filled grains panicle^{-1} is a yield contributing character, increase in the number of filled grains panicle^{-1} increase the yield. The yield of rice grain was highly affected by arsenic treatments; the highest value of grains was recorded at control and sharply decreased with increasing arsenic concentration.

Number of unfilled grains panicle^{-1}

Interaction of different doses of fertilizers (vermicompost and inorganic) and different doses of arsenic showed significant influence on number of unfilled grains panicle^{-1}. The highest number of unfilled grains panicle^{-1} (23.33) was recorded from As_3T_1 which was statistically similar with As_3T_3 (21.33), As_3T_0 (20.67) and As_3T_4 (19.33). The lowest number of unfilled grains panicle^{-1} was recorded from As_0T_2 (3.67) which was statistically similar with As_0T_4 (4.33), As_0T_0 (5.67), As_0T_3 (6.00) and As_1T_2 (6.33) (Table 2). Similarly, Islam *et* *al.* (2004)[15] reported that the irrigation water added arsenic up to 0.25 ppm enhanced unfilled grains panicle^{-1} and finally the grain yield of Boro rice and the further doses of arsenic depressed the plant growth, yield and yield components.

Weight of 1000 grain

Interaction of different doses of fertilizers (vermicompost and inorganic) and different doses of arsenic showed significant influence on 1000 grain weight (g) of BRRI dhan47. The results revealed that the highest 1000 grain weight (g) was recorded from the treatment As_0T_2 (29.40) which was statistically similar with As_0T_4 (28.30) and As_0T_0 (27.60) whereas, the lowest (15.17) was recorded from the treatment As_3T_1 which was statistically similar with As_3T_3 (16.28), As_3T_0 (16.49) and As_3T_4 (17.23) (Table 2). Yang *et al*. (2004)[16] recorded that 1000 grain weight was increased by the application of organic manure with chemical fertilizers.

Grain yield (g/pot)

Grain yield of BRRI dhan47 was significantly influenced by the interaction of different doses of fertilizers (vermicompost and inorganic) and different doses of arsenic (Table 2). The highest grain yield (41.40 g/pot) was recorded from As_0T_2 and the lowest yield (24.17 g/pot) was recorded from the treatment As_3T_1. Rahman *et al.* (2009)[17] reported that the application of organic manure and chemical fertilizers increased the grain yield of rice. This result agreed with Hossain (2005)[18] who found that yield reductions of more than 40% and 60% for two popular rice varieties (BRRI dhan28 and Iratom-24) when 20 mg/kg of arsenic was added to soils, compared to the control.

Straw yield (g/pot)

Straw yield of Boro rice was significantly influenced by the interaction of different doses of fertilizers (vermicompost and inorganic) and different doses of arsenic (Table 2).The highest straw yield (62.10 g/pot)was recorded from the treatmentAs_0T_2 and the lowest yield (36.26 g/pot) was recorded from the treatment As_3T_1. This may be due to toxic effect of arsenic. Begum *et al.* (2008)[19] showed that the straw yield of Boro rice was reduced by 21.0 % for 15 ppm As treatment and 65.2 % due to 30 ppm As.

Table 2: Interaction effect of different doses of arsenic and different doses of fertilizers (vermicompost and inorganic) on number of filled grains panicle^{-1}, unfilled grains panicle^{-1}, 1000 grain weight, grain and straw yield

Treatments		Number of filled grains panicle^{-1}	Number of unfilled grains panicle^{-1}	1000 grain weight (g)	Grain yield (g/pot)	Straw yield (g/pot)
As_0	T_0	90.33 abc	5.67 ijk	27.60 ab	39.60 c	59.40 c
	T_1	86.33 cde	6.67 ijk	25.30 cd	37.30 e	55.95 e
	T_2	94.67 a	3.67 k	29.40 a	41.40 a	62.10 a
	T_3	88.67 bcd	6.00 ijk	26.50 bc	38.50 d	57.75 d
	T_4	92.33 ab	4.33 jk	28.30 ab	40.30 b	60.45 b
As_1	T_0	81.33 efg	8.33 g-j	21.20 efg	32.30 h	48.30 h
	T_1	79.33 fgh	11.33 e-h	19.11 ghi	30.11 j	45.16 k
	T_2	85.67cde	6.33 ijk	23.20 de	34.20 f	51.30 f
	T_3	80.00 fgh	9.67 f-i	20.10 fgh	31.10 i	46.65 i
	T_4	83.67 def	7.67 h-k	22.30 ef	33.30 g	49.95 g
As_2	T_0	75.33 h-k	13.33 def	18.40 hij	28.40 l	42.60 m
	T_1	73.67 i-m	15.33 cde	16.88 jk	26.88 n	40.32 o
	T_2	78.67 f-i	11.33 e-h	20.80 fg	30.80 i	46.20 j
	T_3	74.67 h-l	14.67 de	17.95 hij	27.95 m	41.93 n
	T_4	76.33 g-j	12.67 efg	19.20 ghi	29.20 k	38.24 l
As_3	T_0	69.33 lmn	20.67 ab	16.49 jk	25.49 p	38.70 r
	T_1	66.33 n	23.33 a	15.17 k	24.17 q	36.26 t
	T_2	71.67 j-n	17.33 bcd	17.48 ij	26.48o	39.72 p
	T_3	68.33 mn	21.33 ab	16.28 ijk	25.28 p	37.92 s
	T_4	70.33 k-n	19.33 abc	17.23 ijk	26.23 o	39.35 q
LSD $_{(0.05)}$		**5.551**	**4.402**	**2.216**	**0.326**	**0.261**
CV (%)		**4.24**	**22.32**	**6.41**	**0.63**	**0.34**
Significant level		*	*	*	*	*

* - Significant at 5% level

As_0 = No As applied, As_1= 10 ppm As, As_2= 20 ppm As, As_3= 30 ppm As on soil weight basis

T_o = Recommended doses of vermicompost without inorganic fertilizers, T_1 = Recommended doses of inorganic fertilizers without vermicompost, T_2 = Recommended doses of vermicompost + inorganic fertilizers, T_3 = Reduction of 40% of recommended doses of inorganic fertilizers + Addition of vermicompost to supplement the reduction of inorganic fertilizers, T_4 = Reduction of 60% of recommended doses of inorganic fertilizers + Addition of vermicompost to supplement the reduction of inorganic fertilizers.

CHEMICAL COMPOSITION

Nitrogen (N) content in grain

Interaction of different doses of fertilizers (vermicompost and inorganic) and different doses of arsenic had significant influence on nitrogen (N) content in grain (Table 3). The highest N (1.86%) in grain was observed from the treatment As_0T_0 which was statistically similar with As_0T_4 (1.81%) and the lowest N (0.86%) in grain was observed from As_3T_1 which was statistically similar with As_0T_0 (0.93%). Khatik and Dikshit (2001)[20] reported that the increasing concentration of N in grain, straw and root of organic manure treated plots indicate that organic manures increased the availability of N in the soil which in-turn increased the N contents in grain, straw and root of rice.

Table 3: Interaction effect of different doses of arsenic and different doses of fertilizers (vermicompost and inorganic) on N, P, K and As content in grain

Treatments		Grain			
		%N	**%P**	**%K**	**As (ppm)**
As_0	T_0	1.74 bc	0.88 bc	0.44 ab	0.00 o
	T_1	1.63de	0.77de	0.40 a-d	0.00 o
	T_2	1.86 a	0.97 a	0.47 a	0.00 o
	T_3	1.70cd	0.82cd	0.43abc	0.00 o
	T_4	1.81 ab	0.92 ab	0.45 a	0.00 o
As_1	T_0	1.47 gh	0.61 g	0.35 a-g	0.94 l
	T_1	1.36 ij	0.51 h	0.32 a-i	1.39 j
	T_2	1.59 ef	0.71ef	0.38 a-e	0.61 n
	T_3	1.43 hi	0.52 h	0.34 a-h	1.15 k
	T_4	1.52 fg	0.65 fg	0.37 a-f	0.77 m
As_2	T_0	1.19 lm	0.36 jk	0.25 d-j	1.81 g
	T_1	1.09 no	0.27 lm	0.21f-j	2.31 e
	T_2	1.29 jk	0.46 hi	0.28 b-j	1.66 i
	T_3	1.13 mn	0.32 kl	0.23e-j	1.96 f
	T_4	1.24 kl	0.41ij	0.26c-j	1.74 h
As_3	T_0	0.93 qr	0.13 op	0.16 ij	2.69 c
	T_1	0.86 r	0.07 p	0.13 j	3.13 a
	T_2	1.04 op	0.21 mn	0.20 g-j	2.62 d
	T_3	0.94 q	0.10 op	0.15 j	2.78 b
	T_4	0.99 pq	0.17 no	0.19 hij	2.65cd
LSD $_{(0.05)}$		**0.07380**	**0.07380**	**0.1650**	**0.05218**
CV (%)		**3.32**	**8.23**	**2.39**	**2.35**
Significant level		*	*	*	*

* - Significant at 5% level

As_0 = No As applied, As_1= 10 ppm As, As_2= 20 ppm As, As_3= 30 ppm As on soil weight basis

T_o = Recommended doses of vermicompost without inorganic fertilizers, T_1 = Recommended doses of inorganic fertilizers without vermicompost, T_2 = Recommended doses of vermicompost + inorganic fertilizers, T_3 = Reduction of 40% of recommended doses of inorganic fertilizers + Addition of vermicompost to supplement the reduction of inorganic fertilizers, T_4 = Reduction of 60% of recommended doses of inorganic fertilizers + Addition of vermicompost to supplement the reduction of inorganic fertilizers.

Phosphorus (P) content in grain

Interaction of different doses of fertilizers (organic and inorganic) and different doses of arsenic had significant influence on phosphorus (P) content in grain (Table 3). The highest P (0.97%) in grain was observed from the treatment As_0T_2 which was statistically similar with As_0T_4 (0.92%) and the lowest P (0.07%) in grain was observed from As_3T_1 which was statistically similar with As_3T_3 (0.10%) and As_3T_0 (0.13%). Guan (1989)[21] reported that organic manures increased the P concentrations in grain, straw and root of rice.

Potassium (K) content in grain

Interaction of different doses of fertilizers (vermicompost and inorganic) and different doses of arsenic had significant influence on potassium (K) content in grain (Table 3). The highest K (0.47%) in grain was observed from the treatment As_0T_2 which was statistically similar with As_0T_4 (0.45%), As_0T_0 (0.44%) and As_0T_3 (0.43%). whereas, the lowest K (0.13%) in grain was observed from As_3T_1which was statistically similar with As_3T_3 (0.15%), As_3T_0 (0.16%) and As_3T_4 (0.19%).

Arsenic (As) content in grain

Interaction of different doses of fertilizers (vermicompost and inorganic) and different doses of arsenic had significant influence on arsenic (As) content in grain (Table 3). The highest As (3.13 ppm) in grain was observed from the treatment As_3T_1 whereas, the lowest As (0 ppm) in grain was observed from As_0T_0which was statistically similar with As_0T_1 (0 ppm), As_0T_2 (0 ppm), As_0T_3 (0 ppm) and As_0T_4 (0 ppm). The As content in grain was lower by the treatment (T_2) containing more vermicompost because worms reduced the arsenic availability through the formation of an insoluble and stable arseno-organic complexes. Das *et al*. (2008)[22] stated that the addition of organic matter in paddy field reduced the arsenic availability through the formation of an insoluble and stable arseno-organic complexes and their adsorption on to organic colloids of soil solutions.

Nitrogen (N) content in straw

Interaction of different doses of fertilizers (vermicompost and inorganic) and different doses of arsenic had significant influence on nitrogen (N) content in straw (Table 4). The highest N (1.36%) in straw was observed from the treatment As_0T_0 which was statistically similar with As_0T_4 (1.31%) and the lowest N (0.36%) in straw was observed from As_3T_1 which was statistically similar with As_3T_3 (0.40%) and As_3T_0 (0.43%).

Phosphorus (P) content in straw

Interaction of different doses of fertilizers (vermicompost and inorganic) and different doses of arsenic had significant influence on phosphorus (P) content in straw (Table 4). The highest P (0.92%) in straw was observed from the treatment As_0T_2 which was statistically similar with As_0T_4 (0.87%) and the lowest P (0.02%) in straw was observed from As_3T_1 which was statistically similar with As_3T_3 (0.05%).

Potassium (K) content in straw

Interaction of different doses of fertilizers (vermicompost and inorganic) and different doses of arsenic had significant influence on potassium (K) content in straw (Table 4). The highest K (1.70%) in straw was observed from the treatment As_0T_2 and the lowest K (0.41%) in straw was observed from As_3T_1.

Arsenic (As) content in straw

Interaction of different doses of fertilizers (vermicompost and inorganic) and different doses of arsenic had significant influence on arsenic (As) content in straw (Table 4). The highest As (6.02 ppm) in straw was observed from the treatment $As_3T_1$and the lowest As (0 ppm) in straw was observed from As_0T_0which was statistically similar with As_0T_1 (0 ppm), As_0T_2 (0 ppm), As_0T_3 (0 ppm) and As_0T_4 (0 ppm).

Table 4: Interaction effect of different doses of arsenic and different doses of fertilizers (vermicompost and inorganic) on N, P, K and As content in straw

Treatments		Straw			
		%N	%P	%K	As (ppm)
As_0	T_0	1.24 bc	0.83 b	1.58 c	0.00 n
	T_1	1.13 de	0.72 c	1.46 d	0.00 n
	T_2	1.36 a	0.92 a	1.70 a	0.00 n
	T_3	1.20 cd	0.77 c	1.53c	0.00 n
	T_4	1.31 ab	0.87 ab	1.64b	0.00 n
As_1	T_0	0.97 g	0.56 e	1.23 g	2.35 k
	T_1	0.86 hi	0.46 fg	1.11 h	3.41 h
	T_2	1.09 ef	0.66d	1.35e	1.55 m
	T_3	0.93 gh	0.47f	1.18 g	2.81 j
	T_4	1.02 fg	0.60e	1.29 f	1.93 l
As_2	T_0	0.69 kl	0.31 ij	0.83 k	3.43 h
	T_1	0.59 m	0.22 k	0.71 l	4.61 f
	T_2	0.79 ij	0.41 gh	0.95 i	3.26 i
	T_3	0.63 lm	0.27 jk	0.78 k	3.57 g
	T_4	0.74 jk	0.36 hi	0.89 j	3.32 i
	T_0	0.43 op	0.08 mn	0.53 n	5.21 c
	T_1	0.36 p	0.02 o	0.41 o	6.02 a

As_3	T_2	0.54 mn	0.16 l	0.65 m	5.02 e
	T_3	0.40 op	0.05 no	0.48 n	5.35 b
	T_4	0.49 no	0.12 lm	0.60 m	5.10d
LSD $_{(0.05)}$		**0.09039**	**0.05218**	**0.05218**	**0.07380**
CV (%)		**6.73**	**6.73**	**2.58**	**1.40**
Significant level		*	*	*	*

* - Significant at 5% level

As_0 = No As applied, As_1= 10 ppm As, As_2= 20 ppm As, As_3= 30 ppm As on soil weight basis
T_o = Recommended doses of vermicompost without inorganic fertilizers, T_1 = Recommended doses of inorganic fertilizers without vermicompost, T_2 = Recommended doses of vermicompost + inorganic fertilizers, T_3 = Reduction of 40% of recommended doses of inorganic fertilizers + Addition of vermicompost to supplement the reduction of inorganic fertilizers, T_4 = Reduction of 60% of recommended doses of inorganic fertilizers + Addition of vermicompost to supplement the reduction of inorganic fertilizers.

Nitrogen (N) content in root

Interaction of different doses of fertilizers (vermicompost and inorganic) and different doses of arsenic had significant influence on nitrogen (N) content in root (Table 5). The highest N (1.06%) in root was observed from the treatment As_0T_2 and the lowest N (0.06%) in root was observed from As_3T_1 which was statistically similar with As_3T_3 (0.10%) and As_3T_0 (0.13%).

Table 5: Interaction effect of different doses of arsenic and different doses of fertilizers (vermicompost and inorganic) on N, P, K and As content in root

Treatments		Root			
		%N	**%P**	**%K**	**As (ppm)**
As_0	T_0	0.94 b	0.93 b	1.05 bc	0.00 j
	T_1	0.83 cd	0.82 c	0.97 de	0.00 j
	T_2	1.06 a	1.02 a	1.13 a	0.00 j
	T_3	0.90bc	0.87c	1.02cd	0.00 j
	T_4	0.97b	0.97 ab	1.09 ab	0.00 j
As_1	T_0	0.67 fg	0.66 e	0.88fg	4.81 h
	T_1	0.56hi	0.56 fg	0.79 h	5.28 f
	T_2	0.79 de	0.76 d	0.96 e	4.71 i
	T_3	0.63 gh	0.57 f	0.84 gh	4.92 g
	T_4	0.72 ef	0.70 e	0.92ef	4.75hi
As_2	T_0	0.39 kl	0.41 ij	0.64 jk	5.57 e
	T_1	0.29 mn	0.32 k	0.55 lm	6.47 c
	T_2	0.49 ij	0.51 gh	0.73 i	5.32 f
	T_3	0.33 lm	0.37 jk	0.60 kl	5.84 d
	T_4	0.44 jk	0.46 hi	0.68ij	5.35 f
As_3	T_0	0.13 pq	0.18 mn	0.44 n	6.54 c
	T_1	0.06 q	0.12 o	0.34 o	7.19 a
	T_2	0.24 no	0.26 l	0.54 m	6.48 c
	T_3	0.10 q	0.15 no	0.44 n	6.63 b
	T_4	0.19 op	0.22 lm	0.50 m	6.52 c
LSD $_{(0.05)}$		**0.07380**	**0.05218**	**0.05218**	**0.07380**
CV (%)		**7.72**	**6.80**	**4.12**	**0.95**
Significant level		*	*	*	*

* - Significant at 5% level

As_0 = No As applied, As_1= 10 ppm As, As_2= 20 ppm As, As_3= 30 ppm As on soil weight basis
T_o = Recommended doses of vermicompost without inorganic fertilizers, T_1 = Recommended doses of inorganic fertilizers without vermicompost, T_2 = Recommended doses of vermicompost + inorganic fertilizers, T_3 = Reduction of 40% of recommended doses of inorganic fertilizers + Addition of vermicompost to supplement the reduction of inorganic fertilizers, T_4 = Reduction of 60% of recommended doses of inorganic fertilizers + Addition of vermicompost to supplement the reduction of inorganic fertilizers.

Phosphorus (P) content in root

Interaction of different doses of fertilizers (vermicompost and inorganic) and different doses of arsenic had significant influence on phosphorus (P) content in root (Table 5). The highest P (1.02%) in root was observed from the treatment As_0T_2 which was statistically similar withAs_0T_4 (0.97%) and the lowest P (0.12%) in root was observed from As_3T_1 which was statistically similar with As_3T_3 (0.15%).

Potassium (K) content in root

Interaction of different doses of fertilizers (vermicompost and inorganic) and different doses of arsenic had significant influence on potassium (K) content in root (Table 5). The highest K (1.13%) in root was observed from the treatment As_0T_2 which was statistically similar with As_0T_4 (1.09%) and the lowest K (0.34%) in root was observed from As_3T_1.

Arsenic (As) content in root

Interaction of different doses of fertilizers (vermicompost and inorganic) and different doses of arsenic had significant influence on arsenic (As) content in root (Table 5). The highest As (7.19ppm) in root was observed from the treatment As_3T_1 and the lowest As (0 ppm) in root was observed from As_0T_0 which was statistically similar with As_0T_1 (0 ppm), As_0T_2 (0 ppm), As_0T_3 (0 ppm) and As_0T_4 (0 ppm).

IV. Conclusion

Arsenic toxicity adversely affects all the yield related attributes of BRRI dhan47. Use of vermicompost with inorganic fertilizers decreased the adverse effects of high arsenic toxicity on rice plant and improved all the traits mentioned above.

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