International Journal of Geology, Earth and *Environmental Sciences ISSN: 2277-2081 (Online)*
An Open Access, Online International Journal Available at http://www.cibtech.org/jgee.htm
2014 Vol. 4 (1) January-April, pp. 121-125/Saini and Khan
Research Article

PHYTOTOXICITY OF FLUORIDE ON A PEARL MILLET (PENNISETUM TYPHOIDES VAR. JKBH-26) AND ITS BIOACCUMULATION AT THE DIFFERENT PHASE

***Pinky Saini and T I Khan**
Indira Gandhi Centre for H.E.E.P.S., University of Rajasthan Jaipur -302004
**Author for Correspondence*

ABSTRACT
Fluoride is one of the essential elements and beneficial to human health in minute concentration but excess intake (above permissible limit i.e. 1.5ppm) of fluoride through water, food and edible substances may cause fluorosis. The objective of the present study was to study the effects of different concentration of NaF on different yield and its bioaccumulation in pearl millet (pennesitum typhoides var, JKBH-26). In a pot experiment, a pearl millet was irrigated with 2-14ppm NaF (2,4,6,8,10,12 and 14ppm). The experiment was carried out for the entire life cycle of 90 days of this pearl millet variety. Plants were harvested after 45 days (pre-stage), 60 days (peak-stage) and 90 days (post- stage) of sowing of seeds. Bioaccumulation studies of fluoride in plant parts revealed maximum accumulation in roots (9.99mg/kg) and minimum in leaves (6.852 mg/kg) in plants treated with 20mg/L NaF. Results of the study showed that use of groundwater containing high fluoride content for irrigating pearl millet plants may be detrimental to its growth and yield.

Keywords*: Fluoride, pennisetum typhoides and fluoride in plant parts (Bioaccumulation)*

INTRODUCTION
Fluoride is one of the essential and beneficial to human health if taken in permissible limits but excess intake (above permissible limit i.e. 1.5ppm) of fluoride may cause fluorosis. If interacts closely with body tissue to produce chronic disease when fluoride is consumed in excessive quantities leading to stiffening of body joint; deformation of bones mottled or chipped teeth. Fluorosis may be categorized into dental, skeletal and non-skeletal fluorosis Gupta (1999), Singh (2002). Fluoride reaches in the living organism through air, water and vegetation. Earlier it was believed that food is not a rich source of fluoride for humans but items it has high fluoride content and is therefore a rich source of dietary fluoride (Gulati *et al.*, 1993; Singer and Ophauge, 1979; and Singh *et al.*, 1993). Since plants are much more sensitive to fluoride pollution than human being and animals. According to Jacobson *et al.*, (1966), certain physiological processes are known to be markedly affected by fluoride including plant growth, chlorosis, leaf tip burn and leaf necrosis (Miller *et al.*, 1999; Elloumi *et al.*, 2005). Fluoride is absorbed by plant roots (Kamaluddin and Zwiazek, 2003) and is then transported via xylematic flow to the transpiratory and storage organs. Bioaccumulation of fluoride in different plant parts varies depending on its transfer from soil solution roots and translocation from root to shoot.
Pearl millet is cultivated with fluoride containing ground water due to erratic rain fall. In the present study, therefore, we have investigated the effects of various increased concentration of fluoride on yield and its bioaccumulation pearl millet plants, after 45, 60 and 90 days of sowing of seeds.

MATERIALS AND METHODS
A laboratory experiment was conducted to study the effect of fluoride on germination and seedling growth. Pennsitum typhoides, var. JKBH26 were germination in pot and treated with different concentration (control to 14ppm) of NaF solution prepared from stock solution. The experiment was conducted in laboratory at room temperature. This experiment continued for pre, peak and post stage. Pearl millet plants were raised from seeds in the earth pots filled with sandy-loamy soil and vermiform compost in the 5:1 ratio. 10 seeds were sown in each pot and then thinned down to five plants per pot after 15 days of germination. In the experiment, 5 replicates of each pot set viz. Control, 2ppm, 4ppm,

6ppm, 8ppm, 10ppm, 12ppm and 14ppm were taken. Determination of bioaccumulation of fluoride in various plant parts (root, shoot, leaves and seed). For the bioaccumulation study and determination of fluoride contents, all the plant parts were separately packed and oven dried for 24 hours at 80◦C: Then, the samples were powered and digested with nitric acid, followed by neutralization with aqueous KOH and analysis for fluoride was done by potentiometric method with a fluoride ion selective electrode. The fluoride content in the pre, peak and post stage was analyzed by selective ion meter Metler Toledo MA235 pH/ion Analyzer.

RESULTS AND DISCUSSION

At pre-flowering stage

Fluoride concentration in plants of pennesitum typhoides was found 0.76 mg/kg in stem, 0.052mg/kg in leaves and 0.118mg/kg in root samples of plants grown under controlled i.e. (Double distilled water) condition at pre-flowering stage. At the treatment level 2ppm fluoride was estimated 0.76 mg/kg in stem, 0.588mg/kg in leaves and 0.846mg/kg in root plant samples. Fluoride concentration increased as the concentration of NaF in the treatment levels increased. At treatment level 14ppm, fluoride concentration was observed 4.742mg/kg in stem, 4.044mg/kg in leaf and 5.826mg/kg in root samples (Table 1 and figure 1).

Table1: Fluoride analysis in different plant parts of pennisetum typhoides, var. JKBH 26 after harvesting at pre-flowering stage (45 days) in pot experiment.

		PARAMETERS (FLUORIDE mg/kg)		
S. No.	Treatment level	Root	Shoot	Leaves
1.	Control	0.118± 0.0073	0.076± 0.002249	0.052± 0.000947
2.	2ppm	0.846 ±0.0087	0.74 ±0.0033	0.588± 0.014269
3.	4ppm	1.88± 0.01652	1.69± 0.01344	1.346± 0.00465
4.	6ppm	2.472 ±0.01029	2.2 ±0.01146	1.736 ±0.00309
5.	8ppm	3.19± 0.003414	2.722 ±0.00722	2.414± 0.005211
6.	10ppm	4.004± 0.038727	3.226 0.00278	2.758± 0.0146
7.	12ppm	0.01322± 0.012322	4.542± 0.00482	3.78 ±0.007192
8.	14ppm	5.826± 0.007138	4.742± 0.018907	4.044± 0.00936

All values of mean± S.D.

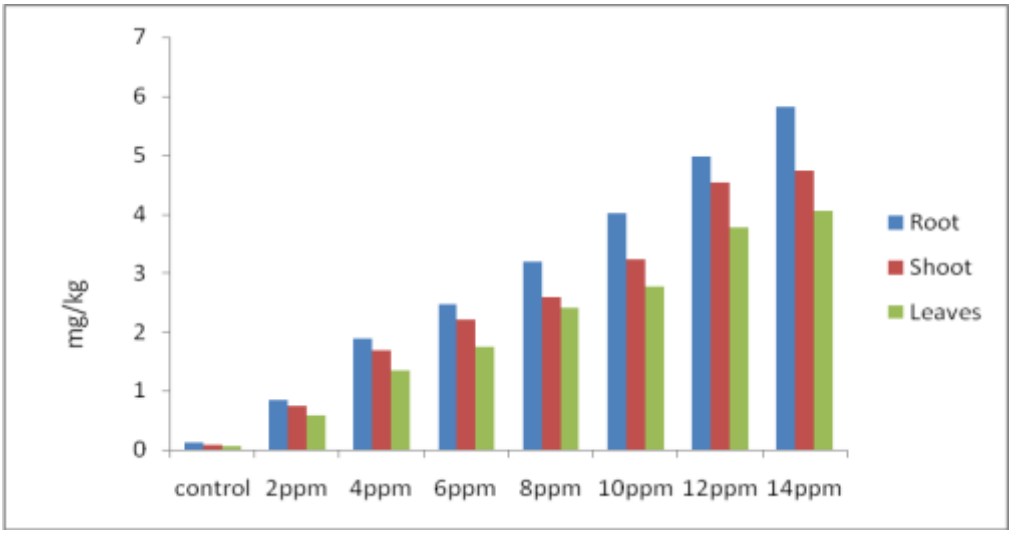

Figure 1: Accumulation of fluoride of pennesitum typhoides var, JKBH-26 (root, shoot, and leaves)

At peak flowering stage

Fluoride concentration was estimated 0.138mg/kg in stem, 0.084mg/kg in leaves and 0.18mg/kg in root samples of plants grown under controlled (i.e. Double distilled water) condition at peak-flowering stage. At the treatment 0.97mg/kg in stem, 0.752mg/kg in leaf and 2.112 mg/kg in root plant samples. Fluoride concentration increased as the concentration of NaF in the treatment levels increased. At treatment level 14ppm, fluoride concentration was estimated 5.398mg/kg in stem, 4.244mg/kg in leaves and 7.238mg/kg in root samples (Table 2 and figure 2).

Table2: Fluoride analysis in different plant parts of pennisetum typhoides, var. JKBH 26 after harvesting at peak-flowering stage (60 days) in pot experiment.

		PARAMETERS (FLUORIDE mg/kg)		
S. No.	Treatment level	Root	Shoot	Leaves
1.	Control	0.18 ±0.006618	0.138± 0.00954	0.084± 0.00164
2.	2ppm	2.112 ±0.00560	097± 0.01251	0.752 ±0.0052
3.	4ppm	3.44± 0.00825	2.344 ±0.00324	1.782± 0.0026
4.	6ppm	4.818± 0.0052	3.764 ±0.0162	2.4± 0.00419
5.	8ppm	5.812 ±0.00481	4.696 ±0.00304	3.454± 0.00297
6.	10ppm	6.056 ±0.00850	4.472± 0.0060	3.722 ±0.00899
7.	12ppm	6.998 ±0.01684	4.954± 0.0076	3.938 ±0.01864
8.	14ppm	7.238± 0.00426	5.398 ±0.0169	4.244± 0.00382

All values of mean± S.D.

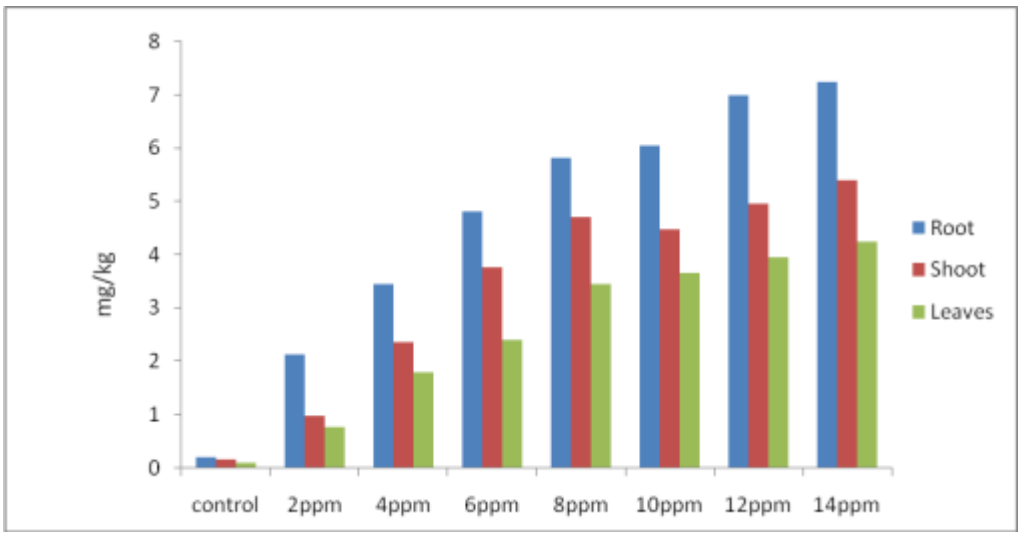

Figure 2: Accumulation of fluoride of pennesitum typhoides var, JKBH-26 (root, shoot and leaves)

At post-flowering stage

Fluoride concentration was estimated 0.330mg/kg in shoot, 0.148mg/kg in leaves, 0.526mg/kg in root and 0.42mg/kg in seed samples of plants grown under controlled i.e. (Double distilled water) condition at post-flowering stage. At the treatment level 2ppm fluoride was estimated 1.57mg/kg in shoot, 1.238 mg/kg in leaves, 2.85mg/kg in root and 2.372mg/kg in seed samples. Fluoride concentration increased as the concentration of NaF in the treatment levels increased. At treatment level 14ppm, fluoride concentration was estimated 7.836mg/kg in stem, 6.852mg/kg leaves, and 10.406 mg/kg in roots and 9.99mg/kg in seed samples of plant (Table 3 and figure 3).

Table 3: Fluoride analysis in different plant parts of pennisetum typhoides, var. JKBH 26 after harvesting at post-flowering stage (90 days) in pot experiment

		PARAMETERS (FLUORIDE mg/kg)			
S. No.	Treatment level	Root	Shoot	Leaves	Seed
1.	Control	0.526± .00486	0.33± 0.0059	0.148 ±0.00106	0.42± 0.0081
2.	2ppm	2.85 ±0.00409	1.57 ±0.0025	1.238 ±0.0045	2.372 ±0.0033
3.	4ppm	5.126± 0.0758	3.55± 0.0186	3.234± 0.0027	4.372± 0.0129
4.	6ppm	6.04± .00896	4.012± 0.00715	3.47± 0.0052	4.808± .01918
5.	8ppm	6.49± 0.0179	4.582± 0.0073	4.12± 0.0086	5.52± 0.0038
6.	10ppm	6.98± 0.0172	5.182± 0.0036	4.954± 0.0129	6.276± 0.0028
7.	12ppm	9.224± 0.0116	6.798± 0.0031	5.616± 0.0023	7.936± 0.0126
8.	14ppm	10.406± 0.008	7.836 ±0.0026	6.852 ±0.007	9.99± 0.0158

All values of mean± S.D.

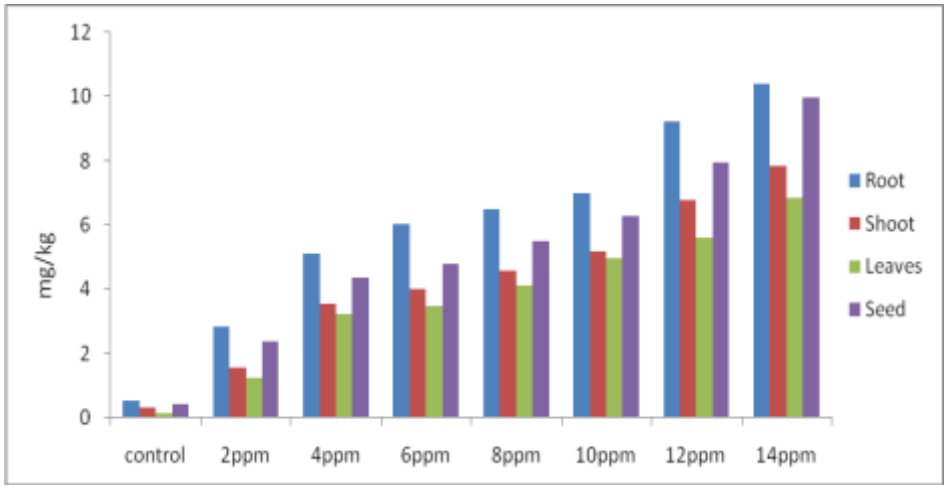

Figure 3: Accumulation of fluoride of pennesitum typhoides var, JKBH-26 (root, shoot, leaves and seed)

Table 3 shows the bioaccumulation of fluoride at peak-flowering stage in different parts of pearl millet at various concentration of NaF. Bioaccumulation of fluoride was highest in roots and lowest in leaves. In 14ppm NaF treated plants, mean fluoride content in the root and shoot was10.406 mg/kg and 7.836mg/kg respedtively. In comparison to roots, leaves accumulated least fluoride which was 6.852mg/kg. Owing to its low mobility, fluoride accumulated more in plant roots than in other plant parts. Similar findings have been reported by Gautam and Bhardwaj (2010) and same similar Bhargava and Bhardwaj (2011).
Results reported in this study show that fluoride treatment is detrimental to the growth and yield of pearl millet especially at higher concentrations (12mg/kg and 14mg/kg NaF concentration). Bioaccumulation of fluoride in pearl millet creates third source of fluoride to human population resulting in food- borne fluorosis, primary source being water.

ACKNOWLEDGEMENT
The authors are grateful to the Director, Indira Gandhi Centre for HEEPS and faculty of Environmental Science, University of Rajasthan, for providing necessary facilities. One of the author thanks the IGC for HEEPS for Departmental Scholarship.

REFERENCES
Bhargava D and Bhardwaj N (2011). Phytotoxicity of Fluoride on a Wheat Variety (*Triticum aestivum* var. Raj.4083) and its Bioaccumulation at the Reproductive Phase. *Asian Journal of Experimental Science* **25**(1) 37-40.

Elloumi N, Abdallab FB, Mezghani I, Rhoua A, Boukhris M and Tunisia S (2005). Effect of fluoride on almond seedling in culture solution. *Fluoride* **38** 193-198.
Gautam R and Bhardwaj N (2010). Bioaccumulation of fluoride in different plant parts of *Hordeum vulgare (Barley)* var. RD-2683 from irrigation water. *Fluoride* **43** 57-60.
Gulati P, Singh V, Gupta MK, Vaidya V, Dass S and Prakash S (1993). Studies on leaching fluoride in tea infusion. *Science of the total Environment* **138**(1-3) 213-227.
Gupta SK (1999). Environmental Health perspective of fluorosis in children. Ph D. Thesis, University of Rajasthan, Jaipur.
Jacobson JS, Weinstein LH, Mc Cune DC and Hitchk AE (1966). The Accumulation of fluoride by plants. *Journal of the Air pollution control Association* **16** 412-417.
Kamaluddin M and Zwiasek JJ (2003). Fluoride inhibits root water transport an affects leaf expansion and gas exchange in aspan (Popular treuloides) seedling. *Physiologia Plantarum* **117** 368-375.
Maclean DC and Schneider RE (1981). Effect of gaseous hydrogen fluoride on the yield of field-grown wheat. *Environmental Pollution (Series A)* **24** 39-44.
Mc Nulty IB and Newman DW (1961). Mechanisms of fluoride Induced chlorosis. *Plant physiology* **36** 385-388.
Murray G (1981). Fluoride cycles 1 a estuarine ecosystem. *Science of the Total Environment* **17** 233-241.
Sable D, Khan TI and Saxena R (2006). Effect of Sodium Fluoride on cluster bean (Cyamopsis tetragonoloba) seed germination and seedling growth. *Fluoride* **30**(3) 228- 230.
Singer L and Ophauge R (1979). Total fluoride intake in children. *Pediatrics* **63** 460.
Singh A (2000). *Fluoride pollution*: A case study of Dausa District. Ph D. Thesis, University of Rajasthan, Jaipur.
Singh V, Gupta MK, Rajwanshi P, Srivastava S and Dass S (1993). Studies on ingestion of fluoride trough tobacco, panmasala and tooth paste. *Indian Journal of Environmental Health* **53** 215-220.