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Sodium Fluoride (NaF_2) Impact on Producing of Pearl Millet (*Pennisetum glaucum*)

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ABSTRACT

A field experiment was conducted between 2017 and 2019 to study the effect of sodium fluoride growth, yield attributes and total yield plant^{-1},100 g weight and total yield /plant in Pearl Millet 'Pusa266' at different concentrations viz. 30, 90, 150, and 210 ppm. Higher concentration of NaF_2 displayed chlorosis and necrosis on leaves. Reduction in ear length, number of flowers year^{-1},100-seed weight and total yield was found under the NaF_2 treated plants of Northern region of India.

Key words: *Growth, Pearl millet, NaF_2,* Randomized Complete Block Design, *Total yield and Wide Area System*

Effect of Fluoride on the physiological factors like growth and production of Pearl Millet (*Pennisetum glaucum*) has not been studied in detail by earlier research workers. However,an unfavorable fluoride effect on root, shoot and leaves was reported by Bhatnagar *et al*.,1998; Wange *et al.*,1995; Nagoor,1997; Weinstein,1961. They opined that sodium fluoride accelerates the metabolic activities of the plant. Hence, a study was conducted on the effect of fluoride on the growth and yield of Pearl Millet (*Pennisetum glaucum*), as a principal food crop.

While there is every need to control pollution, which is causing increased dusts, fumes, gases and other toxic substances, a study on the effects of sodium fluoride on physiological factors and production of Pearl Millet is very much pertinent.

MATERIAL AND METHODS

A field experiment conducted between 2017 and 2019 with 'Pusa 266'pearl Millet at the research fields of Agriculture College, Dhampur, Bijnor, indicated that the soil was loamy (pH 7.2 with Electrical conductivity 1.2 dS m^{-1}, available fertilizers of nitrogen 120 kg. ha^{-1}, phosphorus 12 kg. ha^{-1}, potassium 195 kg. ha^{-1}, C 0.12%, and calcium carbonate 0.9%. Twenty micro-plots of 2.0 m × 2.0 m were made by digging the soil up to 60 cm depth and lined-up with polyethylene sheet and separated. A bund of 0.4 m was left between the two microplots. The treatments were combined and placed out in a Randomized Complete Block Design (RCBD) with 3 replicates (AOAC, 1975). Each plot comprised ridges with 3 central ridges serving as the seeds were sown on each ridge by dibbling. Thinning took place 2 weeks after weeding was done 2 and 4 wide area system by hoeing to minimize weed completion.

Pre-sowing irrigation was done comprising 0, 30, 90, 150, 210, and 1500 ppm NaF_2, and seeds of comprising Pearl Millet were sown at fortnight intend on on 1 June, and 15 June of 2017 2018 and 2019 respectively with NaF_2. Different concentrations

were applied with every irrigation till the crop reached maturity altogether irrigation was repeated thrice.

The study was done with the observation of germination of pearl millet seeds, pearl millet plant height, leaf length, and width of pearl millet, tillers showing effect of NaF_2 /plant, pearl millet ear length, and number of flowers/ ears, seeds/ plant (g), and total yield /plant. The data was recorded and analyzed statistically by using standard method (Panse and Sukhatme 1967).

RESULTS AND DISCUSSION

Propagation

Sodium fluoride (NaF_2) displayed a descending trend at different levels of concentrations the reduction was found at its peak (85.65%) at 210 ppm treatment, while the lowest value of 99.00% was registered with the control treatment (Table 1).

Plant length

An increase in thconcentration of NaF_2 resulted a decrease in the length of plant and at 150 ppm and 210 ppm concentrations significant results (64.8 cm and 62.4 cm respectively) were recorded compared to control plants (72.6 cm).

Length of leaf

The treatment with low concentration of NaF_2 resulted in restricting the leaf elongation of the cultivated plants, whereas the plants grown with the supply of 90 ppm NaF_2. Soil application 18.02 cm long and 2.16 cm broad when compared with the control treatment that16.78 cm and lengthy and leaves 2.26 cm broad leaves. On the contrary the leaves of the plant grown in soil at high concentration of NaF_2 (150 and 210 ppm) were more elongated (20.67 and 20.91 cm respectively) but were narrow is stature. These leaves exhibited an acute foliar damage at tips, margin, as well as mid-rib regions. A distinct observation was that chlorosis was followed by necrosis.

Presence of NaF_2 in the soil is considered as stress for timely propagation and subsequent seedling growth (Levitt, 1972). The most significant effect of stress on plant is inhibition of cell elongation. The study revealed slow growth in seed germination, root, shoot, leaf, and ear elongation which confirmed stress the impact due to NaF_2 concentration. The findings corroborate with the findings of Wang et *al.* (1995) and Nagoor (1997), who reported similar trend of results with Na F_2. The leaves of bush bean and *Gladiolus* sp. exposed to atmospheric fluorides, exhibited tip necrosis which progressed downward at lower concentrations and displaying irregularly over the leaf at higher concentration. Pushnik and Miller (1983) also opined that plants exposed to hydrogen fluoride initially exhibited changes in respiratory patterns and eventually displayed chlorosis/necrosis depending on age of the plant, duration of exposure besides fluoride concentration.

Effective tillers/plant

Number of effective tillers×plants $^{-1}$ exhibited a negative trend with the increase in the supply of NaF_2. Application of 210 ppm resulted in minimum numbers of 2.5 tillers×plant^{-1}, compared to 3.75 tillers× plant^{-1} under control plant. A significant difference in number of tillers-plants^{-1} was observed when grown in soil with 100 ppm and 200 ppm NaF_2, when compared with control plant.

Ear of length of Pearl Millet

A gradual reduction in ear length of pearl millet was registered in those plant that were treated with different concentrations of NaF_2, and it was inversely proportional to the concentration of NaF_2. At 210 ppm concentration the ear length of Pearl Millet was

Table 1. Growth and yield attributes of 'Pusa 266' Pearl Millet as influenced by different levels of NaF_2. Concentrations of Na F_2 at different concentrations (ppm)

Parameters	Control	30 ppm	90 ppm	150 ppm	210 ppm
Germination (%)	99.00 ± 0.25	95.00 ± 0.30	90.00±0.25	86.28±0.32	85.65±0.24
Plant length (cm)	72.6±1.13	71.4 ± 1.65	68.00 ± 1.66	64.8 * + 0.66	62.04 * +0.69
Leaf length (cm)	16.78 ± 0.27	19.02 ± 0.18	18.02 * ± 0.22	20.67 ±0.24	20.91 ± 0.27
Leaf width (cm)	2.26 ± 0.06	2.19 ± 0.06	2.16 * ± 0.02	2.00 ± 0.02	0.88 ± 0.04
Tiller /plant	3.75 ± 0.01	3.2 ± 0.01	2.8 ± 0 .01	2.6 * ± 0.01	2.5 * ± 0.01
Ear length (cm)	10.78 ± 0.24	9.06 ± 0.17	8.26 ± 0.23	8.05 ± 0.3	7.68 * ± 0.28
Number of flowers / ears	37.08 ± 0.97	34.10 ± 0.84	34.06 ± 0.85	33.62 * ± 0.75	29.81 ± 0.93
Number of seeds /plants	84.0 ± 1.98	84.6 ± 1.7	82.0 ± 1.57	66.5 ± 1.43	56.36 ± 1.7
100-seed weight (g)	8.16 ± 0.14	7.00 ± 0.02	6.87 ± 0.14	5.92 ± 0.14	5.78 ± 0.13
Total yield / plant (g)	7.02 ± 0.1	6.8 ± 0.15	6.1 ± 0.22	5.2 * ± 0.22	4.01 * ± 0.1

7.68 cm, which was significantly inferior treatment to control (10.78 cm).

Effect of flowers -year $^{-1}$

A descending behaviour in the number of flowers - years $^{-1}$ was manifested with every incremental increase in NaF_2. The minimum number of 29.81 flowers were associated with 210 ppm NaF_2 concentrates, when compared with control treatment (37.08). The decrease in number of flowers displayed an adverse effect of NaF_2 on differentiation of flowers.

Effect on seeds- plant^{-1}

The reduction in number of seeds plant^{-1} (56.36) was also observed with the concentration of NaF_2 (210 ppm) compared to the control treatment (84.0 – plant^{-1}).

Effect on 100-grain weight

The 100-grain weight (g) from the soil irrigated with water containing 210 ppm NaF_2 recorded significant reduction in 100-grain weight (5.78 ± 0.13) when compared with control (8.16 ± 0.14)**.** It was found that effect of NaF_2 on100-seed weight was not significantly affected in all treatments except 210 ppm.

Effect on yield-plant $^{-1}$

Significant reduction in yield-plant $^{-1}$ was noticed under the treatment of NaF_2 applied with 90, 150 and 210 ppm (6.1 g, 5.2 g, and 4.01 g) respectively when compared with control treatment (7.02 g).

The present research work corroborates with those of Schulzbach and Pack (1972), Weinsten (1961), Singh *et al.* (1979), and Pradhan (2010) by the view that fluoride induces alternations in metabolism resulting in the reduction of crop yield grown in soil applied with higher concentration of NaF_2 which can also be attributed to the fact that fluoride causes pollen sterility (Schulzbach and Pack, 1972).

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