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REGULAR ARTICLE

EFFECT OF SODIUM FLUORIDE ON SEED GERMINATION AND SEEDLING GROWTH OF *Triticum aestivum* VAR. RAJ. 4083

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SUMMARY

Fluoride contamination in water, soil and plants has been a continuing problem in the world. The effects of 4, 8, 12, 16 and 20 mg/L sodium fluoride (NaF) were studied on *Triticum aestivum* var. Raj. 4083 seeds and seedling growth. After 7 days of treatment with control, 100% germination occurred, but at 20 mg NaF/L, germination was reduced to 88%. Physiological parameters, viz., root length, shoot length and dry weight decreased with increasing NaF concentration. At 20mg NaF/L, the average root length, shoot length and dry weight were reduced by 36.6%, 24% and 20.54% respectively. At 20 mg NaF/L, Vigor index was reduced by 37.20% compared to control. The chlorophyll content of the leaves was also reduced monotonically. At 20mg NaF/L, it was 0.074 mg/g which was 27.45% lesser compared to control. Ascorbic acid content initially decreased and then increased with increasing concentration of NaF (20mg/L).So our study concludes that sodium fluoride has significant impact on seed germination and seedling growth of wheat.

Key words: Ascorbic Acid, Chlorophyll, Physiological parameters, *Triticum aestivum*, Vigor Index
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1. Introduction

Fluoride ion at high concentrations is known to cause several health hazards to human population and livestock including dental and skeletal fluorosis. It is known that fluoride, when taken up by plants, is likely to prove toxic [1]. Certain fluoride salts are metabolic inhibitors and previous studies have shown that fluoride affects a wide range of plant processes [2]. Fluoride affects a wide range of physiological processes including plant growth, chlorosis, leaf tip burn and leaf necrosis [3-5]. The productivity and consumption of wheat is highest in India as well as in the state of Rajasthan.

In all the 33 districts of Rajasthan, groundwater is known to have elevated levels of fluoride. In these districts, wheat is cultivated with fluoride contaminated groundwater due to scarcity of surface water and rains. In the view of this problem, experiment has been conducted to assess the effect of fluoride on germination and seedling growth of wheat. The importance of seed germination in plant growth is widely recognized, and its study has been used as a model for investigating fluoride toxicity by various researchers [6-11].

2. Materials and Methods

Seeds of *Triticum aestivum* var. Raj. 4083 were obtained from Agriculture Research Station, Durgapura, Jaipur and germination experiment was performed. 20 sterilized seeds were placed in individual petri dishes labeled as control and NaF concentrations viz. 4mg/L, 8mg/L, 12mg/L, 16mg/L and 20mg/L. The pre-sterilized petri-dishes were lined with filter paper, moistened from below with sterilized cotton pads. 3 replicates were taken for each respective concentration of fluoride and control. 5-10 ml of sodium fluoride solutions were added to each petri-plate on 1st, 3rd, 5th and 7th day of treatment. The petri-plates were incubated in B.O.D. incubator at 25^0C. The experiment was terminated after 7 days. Germination percentage was recorded after 48 hours. Root

length, shoot length, chlorophyll and ascorbic acid were estimated after 7 days of initiation of experiment. Chlorophyll content was measured by Arnon's method [12]. Ascorbic acid was estimated by method by Mukherjee et al [13]. Vigor index was calculated as per equation by Anderson et al [14].

Vigor Index = (Root length + Shoot length) x Germination percentage

Then, seedlings were wrapped in labeled blotting paper, oven dried at 80^0C for 24 hours and then dry weight was recorded.

3. Results

Findings of seed germination and seedling growth experiment show a decreasing trend in germination percentage with increasing concentration of sodium fluoride (Table 1). At 20mg/L NaF concentration, maximum phytotoxicity on percentage germination was observed (88%). Root length was more affected compared to shoot length. Reduction in root length was by 29.55% and 36.60% at 16mg/L and 20mg/L NaF concentration, compared to control. The decrease in shoot length was by 24% at 20mg/L NaF concentration, compared to control. Dry weights were reduced by 1.62% (0.182g) at 4mg/L, 3.24% (0.179g) at 8mg/L, 14.59% (0.158g) at 12mg/L, 18.91% (0.150g) at 16 mg/L and 20.54% (0.147g) at 20mg/L compared to control (0.185g). Vigor index also showed a decreasing trend with increasing fluoride concentration. Total chlorophyll was also affected by fluoride toxicity. At 20mg/L NaF concentration, it was 0.074 mg/g which was reduced by 27.45% compared to control (0.102 mg/g). There was 12.88% increase in ascorbic acid at 20 mg/L NaF concentration compared to control.

Table 1: Effect of increasing NaF concentrations on physiological and biochemical characters of wheat variety *Triticum aestivum* var. Raj. 4083 in a 7 days experiment.

Concentration (NaF)	Control	4mg/L	8mg/L	12mg/L	16mg/L	20mg/L
% Germination	100%	96%	95%	91.5%	90%	88%
Shoot length (cm)	6.85 ± 0.04	5.98 ± 0.06	5.78 ± 0.05	5.52 ± 0.04	5.04 ± 0.04	5.00 ± 0.03
Root length (cm)	3.79 ± 0.01	3.68 ± 0.02	3.36 ± 0.01	3.06 ± 0.02	2.67 ± 0.01	2.40 ± 0.01
Dry weight (g)	0.185 ± 0.00	0.182 ± 0.00	0.179 ± 0.00	0.158 ± 0.00	0.150 ± 0.01	0.147 ± 0.00
Vigor Index	1037	927.36	868.30	785.07	693.90	651.20
Chlorophyll (mg/g)	0.102 ± 0.12	0.10 ± 0.14	0.096 ± 0.10	0.084 ± 0.09	0.080 ± 0.08	0.074 ± 0.16
Ascorbic acid (mg/g)	1.42	1.38	1.44	1.49	1.56	1.63

4. Discussion

The increasing concentrations of NaF shows phytotoxic effects on physiology and biochemical parameters of seedling growth. Sodium fluoride might affect some developmental processes in germinating cereals. Weinstein suggested that NaF might inhibit carbohydrate metabolism of germinating seedlings [2].

Similar to the present study, earlier studies confirm that fluoride causes a reduction in the chlorophyll content of foliage [3]. The biochemical basis of this effect may be a consequence of inhibition by fluoride of incorporation of γ-aminolevulinic acid into chlorophyll synthetic pathway [15].

Ascorbic acid is an antioxidant that plays an important role in protection against physiological stress [16]. Ascorbic acid initially decreased and then increased with increasing NaF concentration to 20mg/L. This might be due to binding of fluoride with ascorbic acid oxidase enzyme thereby inhibiting the breakdown of ascorbic acid in the plant system [11]. Fluoride containing groundwater used for irrigation in most regions of Rajasthan results in stress

condition and affects cereal growth in early stages of plant life. Such knowledge is potentially useful for farmers to help them avoid excessive application of fluoride containing fertilizers and fluoride containing groundwater to enhance crop growth.

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