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RESEARCH ARTICLE

Effect of fluoride toxicity on the growth and yield of barley (*Hordeum vulagare* L.)

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SUMMARY

The effect of sodium fluoride toxicity has been studied on morphological characters *viz.*, height (cm.) / per plant, tillers / plant, number of leaves / plant, leaf area (sq.cm.) / plant, fresh and dry weight (g.) / plant, number of ears / plant, yield of seeds / M^2 and test weight (g) (1000 seeds weight) of barley cv. DL-69 and K-24. The experiment was conducted for two years in the RBD design with five treatments and four replications. The concentrations of sodium fluoride were taken as 10, 25, 50, 100 and 200 ppm along with control. In general the results of control were found maximum and minimum of 100-200 ppm doses of NaF of barley (*Hordeum Valgare* L.). In few characters 10 ppm showed threshold response.

Key Words : Sodium fluoride, Toxicity, Threshold limit, Growth, Tillers, Barley cv. DL-69 and K-24

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Barley (*Hordeum vulgare* L.) is an annual cereal grain, which serves as a major animal feed crop, with smaller amounts used for malting and in health food. It is a member of the grass family, Poaceae. It is a hardly plant able to withstand many different growing conditions. However, barley is least tolerant of hot, humid conditions, which makes it unsuitable for the subtropical regions. There are two basic types, which are classified based on the number of raws of grain seen when the heads of the stalks are viewed from above. The two types are : (2-row barley) named because there are two rows of barley kernels on the head of the stalk. Earth stalk produces between 15 and 30 kernels (Six-row barley) named because the head of the stalk contains six rows of barley kernels. Each stalk produces between 25 and 60 kernels.

Barley is rich in starch and sugar, and low in fat and protein. Before it can be used as feed or food, or as a malt, barley must be proceessed. For feed, barley is cleaned and cracked through the milling process. The degree to which the barley is milled depends on which animals are to be fed or the barley is to be fed as such or mixed with other grains in a feed ration.

Barley (*Hordeum vulgare* L.), the plant species selected for the present study is generally grown in areas where wheat can not be grown profitably either due to lack of irrigation facilities or due to the alkalinity of the soils. It is an important *Rabi* cereal crop, generally used for malting purpose and also as a substitute of wheat and rice. Barley grain is used as concentrate and straw as fodder for milch animals.

Nutritional value of barley per 100 g is as follows :

Carbohydrate - 77.7%, fat 1.2%, protein 9.9%, vitamin B6 0.3 mg., folate 23 mg, calcium 29.0 mg., iron 2.5 mg., magnesium 79.0 mg., phosphorus 221 mg., potassium 280 mg., zinc 2.1 mg., energy 350k cal.

Fluoride interferes with enzyme system, changes cellular

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metabolism, causes cytogenetic aberrations which finally exposed in the form of reduction in growth and yield of plants. Reduction in growth and yield was reported by Malik (1997) in mungbean and urdbean, Arya (1997) in onion and Kumar (2000) in pea and barley.

Nimesh (2001) conducted experiments to study the effect of fluoride toxicity on pea (*Pisum sativum* L.) and barley (*Hordeum vulgare* L.) and reported the toxic effect of 100-200 ppm NaF doses on the growth, yield, chlorophyll and protein content. Pollen and ovule sterility percentage were found more in 200 ppm dose of NaF. Chaudhary (2002) found toxic effect of fluoride on sugarbeet and garlic. The effect was seen on growth, yield, chlorophyll, total sugar and energy content. Saini (2003) studied the toxic effect of sodium fluoride on 4 varieties of onion (*Allium cepa* L.).

Saini and Singh (2005) studied the effect of NaF toxicity on four cultivars of onion (*Allium cepa* L.) Singh (2006) worked on the effect of sodium fluoride toxicity on cluster bean and lentil. The effect was seen on growth, yield, chlorophyll, protein, phosphorus, energy content and sterility percentage of pollen and ovules both. Malik and Arya (2008) studied the effect of NaF on urdbean variety T9. Reduction in growth and yield characters was reported. Malik and Arya (2008) reported the toxic effect of fluoride on growth and yield of mungbean variety P.S. 16. Malik and Arya (2008) reported the toxic effect of NaF on chlorophyll content of urdbean variety T9 and mungbean variety P.S. 16. 100-250 ppm doses were found toxic.

MATERIAL AND METHODS

The experiment was conducted during *Rabi* seasons of 2009-10 and 2010-11 on the field of Department of Botany, C.C.R. (P.G.) College, Muzaffarnagar (U.P.). The soil of the field was alluvial. Agronomic practice *viz.*, weeding, irrigations, spraying of pesticides and harvesting were done properly. The seeds of barley var DL-69 and K-24 were obtained from DWR (Directorate of Wheat Research) Karnal (Haryana). The seeds were sown in the rows at a distance of 20 cm. plant to plant and 30 cm. row to row with a depth of 5 cm. After germination, 30 days old plants were treated with different concentrations of sodium fluoride. Spraying of NaF solutions was done regularly at 15 days interval till the maturity of the crop. The data were recorded next day of each spraying *i.e.* fortnightly.

RESULTS AND DISCUSSION

The effect of fluoride toxity on the morphological characters of Barley (*Hordeum vulgare* L.) is presented in Table 1 and 2. The maximum data was recorded in control and minimum was found in the higher concentrations (200 ppm) in all the characters in both year (2009-10 and 2010-2011). In cv. DL-69 the maximum plant height 53.18 cm, number of tillers / plant 14.43, number of leaves / plant 52.95, leaf area (sq. cm.) 1069.86 were found in control while height 42.70 cm., number of tillers 8.95, number of leaves 33.23 and leaf area 625.60 (sq cm.) were found in 200 ppm dose of NaF in 2010-11. The maximum fresh weight 4326.46 (g) and dry weight 643.66 (g) was found in control and minimum fresh weight 2034.51 (g) and dry weight 317.38 (g) was found in the 200 ppm dose of NaF. Similarly maximum numbers of ears / plant 21.22, yield of seeds / M^2 1484 (g) and 1000 seeds weight 53.3 (g) was fond in control. Minimum data was recorded in 200 ppm dose of NaF *viz.*, number of ears 12.71, yield of seeds / M^2 569 (g) and 1000 seeds weight 43.2 (g). The results of the all nine character were significant at 5% level of significance.

Similar results have been illustrated of cv. K-24 in Table 1 and 2. The performance of DL-69 was found better than CV K-24 in all the nine characters studied.

As suggested by Chang and Thompson (1966) fluoride affects nucleic acids during the growth of seedling roots. They reported that the treatment of corn seeds with fluoride reduces

Table 1 : Effect of fluoride toxicity on the growth of Barley (*Hordeum Vulgare* L.) (2010-11)

Sr. No.	Variety	Concentrations of NaF	Mean height (cm)/plant	Mean number of tillers/plant	Mean number of leaves/plant	Mean leaf area (sq.cm.)/ plant	Mean fresh weight (g)/plant	Mean dry weight (g)/plant
1.	Barley CV.DL.69	Control	53.18	14.43	52.95	1069.86	4326.46	643.66
		10 ppm	52.10	13.93	50.55	1021.83	3857.93	575.36
		25 ppm	50.41	13.28	47.08	907.96	3587.71	529.11
		50 ppm	48.68	11.91	43.78	777.80	3187.61	485.08
		100 ppm	46.08	10.58	37.71	694.70	2614.78	404.40
		200 ppm	42.70	8.95	33.23	625.60	2034.51	317.38
2.	Barley CV.K-24	Control	51.80	14.06	51.65	1056.31	4316.81	640.00
		10 ppm	50.50	13.60	49.15	1010.63	3849.18	571.00
		25 ppm	48.21	13.05	45.46	883.56	3577.00	524.91
		50 ppm	46.18	11.60	42.18	751.26	3179.21	479.75
		100 ppm	43.51	10.31	35.63	671.21	2605.41	399.25
		200 ppm	40.66	8.65	31.40	609.70	2024.95	312.71

Table 2 : Effect of fluoride toxicity on yield of barley (*Hordeum Vulgare* L.) (2010-11)

Sr. No.	Variety	Concentrations of NaF	Number of ears per plant	Yield of seeds (grains) g./ m^2	1000 test weight
1.	Barley CV.DL.69	Control	21.22	1484	53.3
		10 ppm	20.51	1371	52.5
		25 ppm	18.50	1252	50.0
		50 ppm	17.36	954	49.8
		100 ppm	14.81	779	44.0
		200 ppm	12.71	569	43.2
2.	Barley CV.K-24	Control	21.20	1478	52.4
		10 ppm	20.60	1366	52.2
		25 ppm	18.60	1260	50.0
		50 ppm	17.30	955	49.4
		100 ppm	14.60	788	43.8
		200 ppm	12.42	570	43.0

RNA content of 3 mm root tips on a cell basis. Chang (1968) observed the effect of fluoride on nucleotides and ribonucleic acid in germinating corn seedling roots. Fluoride alters markedly the base composition of the corn seedling root RNA. The relative content of cytosine decreased as the material was treated with higher levels of fluoride. The results of present investigation are similar to the findings of Arya (1971), Sunita Kumari and Agarwal (1980), Agarwal (1979), Arya (1997), Singh (1992) and Malik (1997).

Arya (1971) reported that the amount of growth suppression was directly related to the concentration of fluoride ion, accumulated in various parts of the plants. The reduced number and weight of all parts, including the root-system, indicated a definite reduction in the accumulation of synthesized foods.

Singh (2013) conducted experiments on two varieties of wheat (HD-2009 and PBW-226) and two varieties of barley (DL-69 and K-24) during the years 2009-10 and 2010-11. She observed the effect of NaF on these crop plants. The toxic effect of fluoride was found maximum on higher concentration (200 ppm). Control treatment showed best performance for all the growth and yield characters in barley (Table 1 and 2). Similar results were also found by various workers (Agrawal, 1979 on barley, Arya and Rathore, 1988 on growth parameters of barley, Malik, 1997 on urdbean and mungbean, Malik and Arya, 2008 on the growth and yield of mungbean, Nimesh, 2001 on the growth and productivity of pea and barley, Neeru 2011 on cowpea, Singh, 1992 on wheat, barley and tricale and Arya, 1997 on onion and broad bean.

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