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EFFECT OF FLUORIDE AND FERTILIZERS ON FLUORIDE UPTAKE AND GRAIN YIELD OF GROUNDNUT (*ARACHIS HYPOGEA*)

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ABSTRACT

A pot experiment was conducted during premonsoon and post monsoon seasons to study the grain yield and fluoride uptake of groundnut (Arachis hypogea- var TMV- 7) using NPK complex, superphosphate, urea and potash as fertilizers and water containing fluoride ion concentrations of 0, 2.5, 5.0, 10.0, 20.0, 40.0 and 80.0 ppm. Grain yield decreased with increase of fluoride ion concentration in water. Higher grain yield was observed with superphosphate at all fluoride ion concentrations when compared with other fertilizers during both seasons. Fluoride uptake was decreased with the increase of fluoride ion concentration in water. Maximum fluoride uptake was noticed with NPK complex and potash at 80 ppm during premon soon and at 40 ppm during post monsoon.

Key words : Elephant garlic, Growth parameters, Organic manures, Yield attributes.

INTRODUCTION

Fluorine is the most electronegative element and is extremely reactive. In the Earth crust, fluorine is the thirteenth most abundant element. Because of its reactivity, it exits in nature in combined state with other elements. The important compounds are fluorite (CaF_2), fluorapatite ($Ca_5(PO_4)3F$), topaz ($Al_2(OH,F)SiO_4$) and cryolite (Na_3AlF_6). They are the industrially important sources of fluoride. (Fuge & Andrews 1988). Ground water containing dissolved ions beyond the permissible limit is harmful and not suitable for domestic use. Fluoride above the desirable amount (0.6 to 1.5 mg/l) in ground water is a major problem in many parts of the world (Ayoob & Gupta 2006).

Fluoride is present in teeth, bone, thyroid gland and skin of animals. It plays an important role on the formation of dental enamel and normal mineralization in bones. Fluoride consumed above the permissible limit causes dental fluorosis. It adversely affects the central nervous system, bones and joints at high concentrations (Agarwal *et al* 1997). Excessive intake of fluoride also results skeletal fluorosis (Czarnowski *et al* 1999). Severe symptoms lead death when fluoride doses reach 250- 450 mg/ml (Luther *et al* 1995).

MATERIALS AND METHODS

Plant species are commonly sensitive 100 to 1000 times more to higher concentrations of gaseous fluoride than mammalian species. They are widely used as indicators of fluoride stress in ecosystems. The characteristic symptoms vary between plant groups and between species and the extent of injury development varies between varieties or individuals of a single species. The types of symptom expression in vascular plants may be grouped as necrosis of leaf tips and margins, chlorosis of tissues near leaf margins and between major veins, undulation, cupping or buckling of the leaf blade and accumulation of anthocyanins in tissues (Weinstein & Davison 2004). In view of the little knowledge about the effect of fluoride on grain yield and fluoride uptake by groundnut grown with different fertilizers under different fluoride ion concentrations, a study was conducted in two seasons namely pre monsoon (from April to June) and post monsoon (October to December). The study would be helpful to the researchers to carry out more detailed work in this area.

Fluoride affects the growth of plants in several ways viz, seed germination, biochemical content, dry matters etc. To evaluate the effect of fluoride ion on plants, groundnut (*Arachis hypogaea* var. TMV-7) was chosen due to its duration in growth (95-105 days). In Tamil Nadu, Kanyakumari District is the best representative for endemic fluorosis. Water used for drinking, cooking and agriculture contains fluoride ion concentration higher than the permissible limit of 1.0 ppm as prescribed by WHO (1984).

The seeds used during experiment were obtained from the Agriculture Department, Tirunelveli. The seeds were soaked in water and dipped in a solution of 0.05% bavestine to avoid fungal growth. Earthen pots of capacity 10 litres and 12 cm diameter were filled with sandy clay loam soil and farmyard manure. These pots had drainage hole at the bottom. A cotton plug was provided in the hole to check the out flow of sand from pots. The bavestine treated seeds (10 seeds) were sown about 3 cm deep in soil in each pot. Since the number of seeds per pot was more, the seedlings were thinned after 15 days of sowing and only two plants were allowed to grow under sunlight. The soil pH was analyzed (pH 6.1). The pots were watered with fluoride ion concentrations of 2.5, 5.0, 10.0, 20.0, 40.0 and 80.0 ppm. Ordinary well water with non detectable range of fluoride ion concentration was used as control. Each pot was mixed with urea, superphosphate, potash and NPK complex (17:17:17) as fertilizers. 15 g of urea, 50 g of superphosphate, 20 g of potash and 20 g NPK complex were added in the corresponding pot at the time of the preparation of the soil. A little gypsum was added to each pot. On the 17th and 34th day of sowing again 5 g of urea, 10 g of superphosphate, 5 g of potash and 10 g of NPK complex were added to each pot. On the 54th day of sowing, again 5 g of urea, 5 g of potash, and 10 g of NPK complex were added in the respective pots. Superphosphate was not added on the 54th day. The pot without chemical fertilizer was considered as control. The experiments were carried out in duplicate. After reaping the crop, seeds were collected and air dried, weighed and analyzed for fluoride uptake using fluoride ion selective electrode (Levaggi *et al* 1971).

RESULTS AND DISCUSSION

Effects of fluoride and fertilizers on the fluoride uptake

a. Pre monsoon season : When the fluoride concentration was 2.5 ppm, the fluoride uptake was recorded maximum (-22.2 %) with potash, while it was minimum (-57.1%) with urea. At 5.0 ppm fluoride concentration, the fluoride uptake was minimum (-50 %) with urea and maximum (-9.1 %) in the presence of potash and NPK complex. At 10.0 ppm the concentration of fluoride uptake was found increased to a maximum of (-7.1 %) with potash, while a minimum level (-36.4 %) was noted in the presence of urea. When the concentration of fluoride was 20.0 ppm, the fluoride uptake was found minimum (-33.3 %) with urea and increased (-6.7 %) in the presence of potash and NPK complex. At 40.0 ppm, the concentration of fluoride uptake was found increased to a maximum of (-7.7 %) with NPK complex and minimum (-47.3 %) with urea. When the concentration of fluoride was 80.0 ppm, the fluoride uptake was found minimum (-25,8 %) with urea and increased maximum (4.9 %, 9.3 %) with potash and NPK complex (Table 1).

Comparative analysis on the fluoride uptake revealed that the fluoride uptake was increased a maximum of 4.9 % and 9.3 % with potash and NPK complex at 80.0 ppm of fluoride concentration when compared with other fertilizers. Potash and NPK complex were proven to accumulate maximum fluoride uptake (Singh *et al* 1979; Verma & Shukla 1988; Anil Kumar & Vijaya Bhaskara Rao 2008; Jha *et al* 2009).

Table 1 Effect of fluoride ion concentrations on fluoride uptake by groundnut with different fertilizers (Pre monsoon season).

F Conc ppm	Level of Fluoride Uptake (mg/g)				
	Control (FYM)	Potash	NPK	Urea	Superphosphate
0	0.0	0.0	0.0	0.0	0.0
2.5	0.0011	0.0009(-22.2%)	0.0008(-37.5%)	0.0007(-57.1%)	0.0008 (-37.4%)
5.0	0.0012	0.0011(-9.1%)	0.0011(-9.1%)	0.0008(-50.0%)	0.0009(-33.3%)
10.0	0.0015	0.0014(-7.1%)	0.0013(-15.4%)	0.0011(-36.4%)	0.0012(-25.0%)
20.0	0.0016	0.0015(-6.7%)	0.0015(-6.7%)	0.0012(-33.3%)	0.0013(-23.1%)
40.0	0.0028	0.0024(-16.7%)	0.0026(-7.7%)	0.0019(-47.3%)	0.0021(-33.3%)
80.0	0.0039	0.0041(4.9%)	0.0043(9.3%)	0.0031(-25.8%)	0.0033(-18.2%)

FYM- Farm yard manure, (Values in parenthesis is percentage increase or decrease over control)

b. Post monsoon season : In post monsoon season, when the fluoride concentration was 2.5 ppm, the fluoride up take was recorded maximum (-12.5 %) with potash and NPK complex and minimum (-49.9 %) with urea. At 5.0 ppm fluoride concentration, the fluoride

uptake decreased to a maximum (-71.4 %) with urea and increased (- 9.1 %) in the presence of NPK complex. At 10.0 ppm, the concentration of fluoride uptake was increase a maximum of (- 6.2 %) with superphosphate while a minimum level (- 54.5 %) was noted in the presence of urea. When the concentration of fluoride was 20.0 ppm, the fluoride uptake was found minimum (- 57.1 %) with urea and increased (- 4.8 %) in the presence of potash and NPK complex. At 40.0 ppm, the concentration of fluoride up take was found increased to a maximum of (10.3%) with NPK complex and minimum (- 36.8 %) with urea. When the concentration of fluoride was 80.0 ppm, the fluoride uptake was found minimum (- 61.9 %) with urea and increased maximum (- 9.7 %) (Table.2).

Comparative analysis on the effect of different concentrations of fluoride revealed that the uptake was found maximum during the addition of chemical fertilizers particularly potash and NPK complex.

Table 2 Effect of fluoride ion concentrations on uptake by groundnut with different fertilizers (Post monsoon season).

F Conc	Level of Fluoride Uptake (mg/g)				
ppm	Control (FYM)	Potash	NPK	Urea	Superphosphate
0	0.0	0.0	0.0	0.0	0.0
2.5	0.0009	0.0008(-12.5%)	0.0008(-12.5%)	0.0006(-49.9%)	0.0007(-28.6%)
5.0	0.0012	0.0009(-33.3%)	0.0011(-9.1%)	0.0007(-71.4%)	0.0009(-33.3%)
10.0	0.0017	0.0013(-30.7%)	0.0015(-13.3%)	0.0011(-54.5%)	0.0016(-6.2%)
20.0	0.0022	0.0021(-4.8%)	0.0021(-4.8%)	0.0014(-57.1%)	0.0019(-15.8%)
40.0	0.0026	0.0028(7.1%)	0.0029(10.3%)	0.0019(-36.8%)	0.0021(-23.8%)
80.0	0.0034	0.0029(-17.2%)	0.0031(-9.7%)	0.0021(-61.9%)	0.0029(-17.2%)

FYM- Farm yard manure, (Values in parenthesis is percentage increase or decrease over control)

Effect of fluoride and fertilizers on the grain yield

a. Pre monsoon : Extrapolations from the study on groundnut under different concentrations of fluoride revealed that at 0 ppm fluoride concentration; the grain yield was maximum 51.8 g in FYM and lowest 32.4 1g with NPK complex. At 2.5 ppm fluoride concentrations, groundnut yield was increased to 43.6 g with FYM and decreased to 21.7 g with NPK complex. At 5.0 ppm fluoride concentrations, the maximum groundnut yield was 43.1 g with FYM and minimum was 22.2 g with NPK complex observed. At 10.0 ppm fluoride concentrations, the maximum groundnut yield was 37.56 g with FYM and minimum was 23 g with NPK complex. At 20.0 ppm fluoride concentrations, the maximum groundnut yield was 37.6 g with FYM and minimum was 22.2 g with NPK complex. At 40.0 ppm concentrations, the maximum groundnut yield was 29.9 g with superphosphate and minimum

was 20.4 g with NPK complex. At 80.0 ppm fluoride concentrations, the maximum yield was 28.2 g with superphosphate and minimum was 20.1 g with NPK complex. A comparative analysis on the grain yield indicated decrease in yield with an increasing fluoride concentration; FYM and superphosphate were found to be the best fertilizer under these conditions. (Singh *et al* 1979; Verma & Shukla 1988; Anil Kumar & Vijaya Bhaskara Roa 2008; Jha *et al* 2009).

Table 3 Effect of fluoride ion concentrations on the yield of groundnut using different fertilizers (Pre monsoon season)

F Conc (ppm)	Grain Yield (g)				
	Control (FYM)	Potash	NPK Complex	Urea	Superphosphate
0	51.8	41.6	32.4	44.4	45.9
2.5	43.5	35.3	21.7	23.2	42.2
5.0	43.1	35.1	22.2	25.7	35.5
10.0	38.6	36.3	23.0	24.9	34.1
20.0	37.6	22.2	29.4	24.5	30.7
40.0	29.3	25.5	20.4	21.2	29.9
80.0	27.2	24.6	20.1	20.1	28.2

FYM- Farm yard manure, (Values in parenthesis is percentage increase or decrease over control)

b. Post monsoon season : At 0 ppm fluoride concentration, the groundnut yield was maximum 47.6 g with FYM and minimum 33.2 g with potash. At 2.5 ppm fluoride concentration, the kernel yield was maximum 40.6 g with FYM and minimum 22.9 g with NPK complex. At 5.0 ppm fluoride concentration, the grain yield was maximum 39.5 g with FYM and minimum 24.9 g with NPK complex. At 10.0 ppm fluoride concentration, the grain yield was maximum 37.6 g with FYM and minimum 25 g with NPK complex. At 20.0 ppm fluoride concentration, the grain yield was maximum 37 g with FYM and minimum 23.9 g with Potash. At 40.0 ppm fluoride concentration, the grain yield was maximum 28.2 g with FYM and minimum 21 g with urea. At 80.0 ppm fluoride concentration, the grain yield was maximum 28 g with Superphosphate and minimum 21.1 g with NPK complex (Table 4).

It is noted that chemical fertilizers have no effect on grain yield of groundnut under different fluoride concentrations. FYM happens to be the best manure for the cultivation of groundnut. In the absence of fluoride concentration when chemical fertilizers are used, the yield decreased. These findings also portray that at maximum fluoride concentrations, the yield is maximum with superphosphate and that fluoride uptake among groundnut decreases with the increase in fluoride ion concentrations in water and the maximum uptake was with NPK Complex and potash at high concentrations.

Table 4 Effect of fluoride ion concentrations on the yield of groundnut using different fertilizers (Post monsoon season)

F Conc (ppm)	Grain Yield (g)				
	Control(FYM)	Potash	NPK Complex	Urea	Superphosphate
0	47.6	33.2	38.9	40.6	41.4
2.5	40.6	28.0	22.9	23.7	40.1
5.0	39.5	26.5	24.9	34.1	34.2
10.0	37.6	26.0	25.0	31.4	32.0
20.0	37.0	24.0	28.0	24.0	30.0
40.0	28.2	23.0	23.1	21.0	27.5
80.0	25.5	22.3	21.1	20.0	28.0

FYM- Farm yard manure, (Values in parentheses are percentage increase or decrease over control)

It is observed that the maximum fluoride uptake was recorded with potash and NPK complex at higher concentrations of fluoride other fertilizer applications. Maximum kernel yield was recorded with FYM and supersphosphate at different concentrations of fluoride.

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