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RESEARCH ARTICLE

IMPACT OF FLUORIDE ON NODULATION OF *PISUM SATIVUM*

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ABSTRACT

India is an agriculture based country and since independence, our agricultural productivity has increased significantly, but our success is largely confined to food grains and now it is urgent to increase production of pulses and other protein rich Legumes. *Pisum sativum* (Pea) is an important crop and is cultivated in almost all parts of India. Different types of pollutants, however considerably reduce agricultural productivity. Nodule formation is an important stage of life cycle of Pea and it has got significant impact on its productivity. In present study effect of fluoride on nodulation of *Pisum sativum* was investigated. It was observed that fluoride significantly reduces nodule formation, as well as dry weight of nodules. This ultimately reduces productivity of this crop.

INTRODUCTION

Indian economy is agriculture based and since independence agricultural productivity has increased significantly. Now we are self sufficient so far food grains are concerned. But Indian population is still facing a condition which is typically known as "Protein hunger". Our productivity of Pulses and other Protein rich legumes is still low, making it unavailable for people. Pea is an important legume and it contains 5% protein. Presently *Pisum sativum* is cultivated in 316.4 thousand hectare area and its production is 4.62 million tones per annum (FAO 2004). Pollution however is an important bottleneck and it is considerably reducing the output. Fluoride is an important pollutant which apart from the industrial units, is produced because of various Geo-chemical activities. Obviously, fluoride also profoundly affects agricultural production of pea. As pea is a legume, nodule formation is an important stage in its life cycle. The nodules are responsible for Nitrogen fixation which ultimately affects its productivity. Present investigation was aimed at studying impact of fluoride on nodulation and weight of nodules.

MATERIALS AND METHODS

Two verities of Pea (*Pisum sativum* Linn.), var. Arpana and Arkil, were used for present study. The seeds were obtained from L.R. Brothers, Saharanpur. Arpana variety is generally used for chhola (smooth round in shape with yellow cotyledons) while var. Arkil is used for vegetable (wrinkles in shape with green cotyledons).

Simple randomized block design was followed for plantation. The length and breadth of pea field was kept 53x20 meters = 1060 sq. meters for two varieties.

1. Number of Replication 4
2. Number of treatments 6
3. Total number of plots 48+48=96 24+24=48 for two varities of Pea.
4. Total field area 1060 sq. meters including channels, blocks and plots boarders.

The seeds of Peas (*Pisum sativum*) of uniform size were directly sown in the field at the distance of 40x15 cms row to row seeds of Pea on 5th Nov. 1999. The treatments of sodium fluoride were given at every 15th day interval (i.e. spraying of NAF solution of different concentrations fortnightly) starting with the 30 days old plants. Five concentrations of NAF solutions were applied on the plants; these were 10ppm, 25ppm, 50ppm, 100ppm and 200 ppm. Untreated plants were used as control.

RESULTS AND DUSCUSSION

It is evident form data in Table 1 & 2 that the number of nodules per plant in *Pisum sativum* varied markedly with the variation in concentrations of NaF. The maximum number of nodules is found in control and minimum in higher concentration i.e. 200 in both varieties Arpana and Arkil. The

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nodulation because of treatment differences are significant in the following order –

Table 1. Mean Number of nodules per plant

	Pisum sativum	
Concentrations	Arpana	Arkil
Control	58.0	55.6
10 ppm	53.6	52.0
25 ppm	42.3	38.0
50 ppm	35.3	35.3
100 ppm	30.3	30.3
200 ppm	28.0	26.3
C.D at 5 %	5.01	14.44
C.D at 1%	7.11	20.54

Table 2. Summary of analysis of variance showing the effect of NaF on Number of nodules per plant

Crop Plants *Pisum sativum*	In Field		
	'F' Value	Table 'F' Value	
		5%	1%
Var. Arpana	29.80*	3.33	5.64
Var. Arkil	6.42*	3.33	5.64

Pisum sativum Var. Arpana
Control 10 ppm>25ppm>50ppm to 200ppm
C.D = 5.01
Pisum sativum Var. Arkil
Control 10 ppm>25ppm>50ppm to 200ppm
C.D = 14.44
From C.D. values it was observed that in *Pisum sativum* var. Arpana and Arkil control and 10 ppm treatment were similar and both form significantly more nodules than the rest treatments.

Table 3. Mean dry weight of nodules per plant

	Pisum sativum	
Concentrations	Arpana	Arkil
Control	142.0	50.3
10 ppm	130.6	45.6
25 ppm	108.0	38.3
50 ppm	78.8	30.6
100 ppm	72.0	25.8
200 ppm	66.6	22.5
C.D at 5 %	35.20	4.98
C.D at 1%	49.92	7.05

Table 4. Summary of analysis of variance showing the effect of NaF on dry weight of nodules per plant

Crop Plants *Pisum sativum*	In Field		
	'F' Value	Table 'F' Value	
		5%	1%
Var. Arpana	7.40*	3.33	5.64
Var. Arkil	38.20*	3.33	5.64

Data relates to effect of fluoride on dry weight of nodules per plant are given in Table no 3 & 4. It indicated that the dry weight of nodules in *Pisum sativum* reduced markedly with an increase of concentration of Naf. The significant reduction in dry wight of nodules is noted in higher concentrations upto 200ppm. The normal plants produce maximum dry weight of nodules and minimum is obtained in 200ppm in both varieties of Pea.

The data are significant in the following order:
Pisum sativum Var. Arpana
Control to 10 ppm> 25 ppm to 200 ppm
C.D = 35.20
Pisum sativum Var. Arkil

Control to 10 ppm. > 25ppm>*50 to 200* ppm C.D = 35.20 The mean value of dry weight of nodules in pea plant on the basis of C.D values show that in Peas var. Arpana, control to 10 ppm and 25 ppm to 200 ppm have significant differences within the treatments while the former are significantly superior to later ones. Thus in *Pisum sativum* Arpana, significant reduction in dry weight of nodules is observed in higher concentration of sodium fluoride. Similar trend has been observed in Var. Arkil. Previously Adam and Duncan (2003) reported that fluoride has profound negative implication on nodulation of *Vicia sativa*. Soam and Agrawal (1990) have also came across similar type of results with *Vicia faba.* They explained resultant reduction in biomass as well as productivity of this crop. Rice (1974) and McCune *et al.* (1970) explained that fluoride in soil reduces hydrogenase activity and rate of respiration in root nodules. Scott (2010) has investigated in detail the overall biology of nodulation and various facters influencing this process. He observed that heavy metals and other chemicals interfere enzymatic activity, ultimately retarding nodulation. Pardo *et al.* (2013) have studied impact of heavy metals on nodulation of white lupin and its bearing on productivity. They have also correlated retardation in ovulation and productivity because of heavy metals. Results obtained during this experiment were further confirmation of the fact that fluoride has got profound adverse effect on nodulation of pea which significantly reduces nitrogen metabolism and yield. It is further confirmed by the results that Arkil variety of pea is more susceptible to fluoride than the Arpana variety.

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