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Effect of Endosulfan on seed germination, growth and nutrients uptake of fenugreek plant

Jamal A. Khan[1],*, Samiullah Khan[2], Sarwat F. Usmani[3]

[1] Department of Chemistry,. A.M.U., Aligarh
[2] Department of Applied Chemistry Z.H. College of Engineering & Tech, A.M.U., Aligarh
[3] Department of Chemistry, NIMS, University Jaipur
**Corresponding Author: Email: drjak2008@rediffmail.com Mobile: + 91-9897070446*

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ABSTRACT

The pot experiment was conducted to evaluate the role of endosulfan on the seed germination, growth and nutrients uptake of fenugreek (*Trigonella foenumgraeum* L.). The results have indicated that the endosulfan was phytotoxic even at its lower concentrations. The absorption of certain ions of nutrient elements such as Ca, Mn, Co and Cu gets facilitated at lower doses (up to 500 mg kg^{-1} soil) and thereafter an inhibitory trend for the nutrients absorption was noticed. However, the inhibitory trend for other nutrients uptake such as ions of Mg, P, K, Fe and Zn was observed throughout the entire range of endosulfan amendments. The results have been explained on the basis of toxic behavior of endosulfan on plant and soil microbes.

1. Introduction

The demands for a variety of organic pesticides are increasing many folds to maximize the crop production. Among the pesticides, endosulfan is a non-ionic systemic, contact and stomach insecticide. It is commonly used insecticide to prevent the harmful insects and mites on a variety of crops. Endosulfan is an organochlorine insecticide, which has long residual action and low solubility in water. Thus, it is highly persistent and may lead to get accumulated in animals and human through food chain (Indraningnih, 1993; Nikolenko and Amirhanov, 1993). Ignacimuth and Sarvana (1994) have reported that the endosulfan causes irreparable chromosomal damage in *Allium cepa* L. An acute toxicity of this pesticide is also reported on *Bombyx mori* (Maruthanayagam *et al.*, 1997). Sahai and Chaudhari (1995) observed that endosulfan causes severe adverse effects on the blood cells in rats. It also causes a genotoxic effect on aquatic animals (Murugappan and Guna, 1996). Ahmad et al. (1993) have reported that reproductive organs and sex hormones of neonantal rats were damaged by endosulfan. Endosulfan has been found to absorb by the plants as such and behaved phytotoxic for their growth (Kotadia and Bhalani, 1992; Sabale and Misal, 1993; Sharma and Singh, 1993). For this reason, endosulfan is banned in some parts of the world. Thus, it was thought useful to study the effect of endosulfan on seed germination, growth and nutrients uptake of fenugreek (*Trigonella foenumgaecum L.*) plant under Indian climatic conditions where its use still continue.

2. Material and Methods

The soil (0-30) used in this investigation, was collected from Malhepur village, situated on Aligarh-Ramghat Road in district Aligarh (U.P.) , India. The soil was air dried, crushed and sieved through 100 mesh (B.S.S.) sieve and then tested for mechanical composition viz. sand, silt and clay (Piper, 1950), pH, electrical conductivity, organic matter (Walky and Black, 1947) and available nitrogen viz NH_4^+-N, NO_3^--N and NO_2^-–N (Hesse, 1971) were determined. The available ions of Mg, K, Ca, Mn, Fe, Co, Cu and Zn from the soil extract were determined by atomic absorption spectrophotometer (Tandon, 1993). The available phosphorous was determined by Olsen's (1971) method. The results are given in Table 1.

Table 1:Physio-chemical Properties of Soil

Parameter	Values
pH	7.2
Electrical conductivity (dS m^{-1})	0.4500
Sand	71.08
Silt	19.72
Clay	9.20
Organic matter (%)	0.41
Available nitrogen (mg kg^{-1} soil)	
NH^+_4-N	58.00
NO^-_3-N	38.0
NO^-_2-N	9.50
Available nutrients (ppm)	
Macronutrients	
Mg	16.40
P	45.2
K	396.0
Ca	3092
Micronutrients	
Mn	7.29
Co	3.6
Fe	10.29
Cu	4.8
Zn	1.28

(Singhal and Bansal, 1978; Khan and Singh, 1996; Khan et al., 1999; Khan et al., 1999).

For pot experiments, the soil was dried, crushed and sieved and then it was filled in earthen ware pots (1 kg per pot) containing varying quantities of endosulfan (0, 250, 500, 750 and 100 mg kg^{-1} soil). The soil, in each pot was then wetted with distilled water to about 60% of its water holding capacity. Out of the certified ten seeds of fenugreek, procured from the Quarsi Agricultural farm, Aligarh (U.P.), India, were sown in each pot for every treatment. Each set were taken in three replicates. The pots were kept at 35$\pm$ 1^oC in a green house, while maintaining moisture levels by adding distilled water, when necessary. After seed germination, these were equally thinned and allowed to grow for a total period of 90 days. The physiological parameters such as seed germination, number of leaves, shoot and root length and fresh and dry shoot weights were examined. The results are recorded in Table 3. Plants were then removed from the pots and properly washed with distilled water. These were dried and grounded and were used for the determination of nutrient elements. Out of these, one gram samples of each treatment was digested with 10 mL of acids mixture containing HNO_3: $HClO_4$ (4:1). The digested samples were heated on a hot plate till brown fumes ceases and converted into a syrupy liquid along with some white fumes (Piper, 1966). These were dissolved in 5 mL of conc. HCl and dilutedwith water. To obtain the clear solutions, these were filtered and then adjusted to a volume of 50 mL with distilled water in each case. The amounts of available K and Na were measured in these solutions by using "Systronics" flame photometer. The quantity of calcium plus magnesium ions was determined by EDTA titration using Eriochrome Black-T indicator at pH 10 (Jackson, 1958). The amount of magnesium was then calculated by subtracting the value of Ca from the total (Ca & Mg). The concentration of available Mn, Fe, Co, Cu and Zn ions were estimated by double beam atomic absorption spectrophotometer (GBC 902). The amount of P was estimated by spectrophotometeric procedure at 470 nm by using vanadomolybdate solution as colouring agent (Chopra, 1979). The results are recorded in Table 2.

Table 2: Effect of endosulfan on the nutrients uptake of fenugreek plant

Nutrients	**Doses of endosulfan (mg kg^{-1} soil)**				
	0	25	500	750	1000
	Concentration of Nutrients Uptake (ppm)				
Mg	4500	4310	3800	3123	2432
P	4031	3530	3000	23.06	1608
K	28000	24000	20860	16083	12000
Ca	13635	15400	15520	14000	12630
Mn	60.1	75.3	90.1	80.3	60.4
Fe	70.3	90.2	120.4	135.1	165.0
Co	0.046	0.159	0.270	0.190	0.140
Cu	7.3	10.4	14.2	12.0	9.9
Zn	32.0	39.0	43.2	53.4	65.9
Values are mean of three replicates					

3. Results and Discussion

It is evident from Table 1 that the soil, used in this investigation, was nearly neutral (pH 7.2) in reaction which, is fairly good for the survival of soil microorganisms, which are responsible for the maintenance of soil fertility. The soluble salt contents are low as revealed by low electrical conductivity. The soil was sandy loam with low clay and organic matter contents indicating a meager adsorptive power for the used organic pesticide on its surfaces. However, it contains a considerable amount of available nutrient elements viz. Mg, P, K, Ca, Mn, Co, Cu and Zn. Hence, the soil is fairly good to conduct the research for the role of organic chemicals used in soil environment where clear changes could be visualized without masking effect posed by the excess nutrients as contained in a fertile soil. Thus, Aligarh soil has become a fascinating field of soil research in recent years.

The results on the chemical analysis (Table 2) of fenugreek grown on endosulfan amended soil indicate that the concentration of Ca, Ma, Co, and Cu uptake were found to increase at its lower doses (up to 500 mg kg^{-1} soil) and thereafter an inhibitory trend was noticed. However, the concentration of Mg, P, K, Fe and Zn absorption were restricted in presence of endosulfan even at its lower levels. The physiological observations (Table 3) of fenugreek plant indicate that the natural soil could very well support the germination and growth for this plant. However, the application of varying quantities of endosulfan in a series of pot experiments revealed that it is phytotoxic even at lower doses with regards to seed germination, growth and nutrients uptake. The effect becomes more severe with increasing levels of the insecticide. The inhibitory effect on seed germination, growth and nutrients uptake of fenugreek might be due to the toxic effect of endosulfan on Azetobactor spp., Rhizobium spp., Cellulolytic microorganism, phosphate dissolving microbes and other soil microorganisms (Smith, 1945; Chiaro, 1953; Mahmoud et al., 1970; Parr, 1974; Khan et al, 1987), which determines the soil fertility. It may also be due to the inhibition in number of nodules, lateral roots in nodulating legumes and mycorhizal symbioses and that can alter the growth and activity of nitrifying bacteria viz. Nitrosomonas and Nitrobacter. The possibility of chromosomal damage (Ignacimuthu and Sarvana, 1994) posed by higher level of endosulfan adsorption in fenugreek plant grown in soil of low adsorptive capacity (Tiwari et al., 1994).

Table 3: Effect of endosulfan on the seed germination and growth of fenugreek plant

Doses of endosulfan (mg kg^{-1} soil)	Parameters					
	SG (%)	NL (per plant)	SL (cm/plant)	RL (g/plant)	SW_f (g/plant)	SW_d (g/plant)
0	90.3	10.3	37.8	32.0	3.6	1.3
25	83.3	8.0	31.2	28.3	2.4	0.86
500	76.6	7.6	28.1	23.2	2.2	0.79
750	66.6	7.0	22.0	18.0	1.8	0.65
1000	60.0	6.6	14.3	12.2	1.2	0.48

SG=Seed germination, RL=Root length, SW_f=Fresh shoot weight, NL=No.of leaves, SL=Shoot length, SW_d=Dry shoot weight

Values are mean of three replicates

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