Indian J.L.Sci.3(1) : 57-61, 2013

ISSN : 2277-1743 (Print)
ISSN : 2278-7879 (Online)

STUDIES ON THE EFFECT OF BRASS INDUSTRIAL EFFLUENT AND ROOT-KNOT NEMATODE ON THE GROWTH OF SOYBEAN

MANISHA KAUSHAL[a] AND G. K. SHARMA[b1]

[ab]Plant Pathology and Environmental Laboratories, P.G. Department of Botany, Hindu College, Moradabad, U.P., India

ABSTRACT

Single and joint effect of *Meloidogyne incognita* and brass and electroplating industrial effluent were studied on the plant growth and yield of soybean in artificial treatment conditions. *M. incognita* suppressed plant growth significantly but negative effects of nematode were marked by *Bradyrhizobium japonicum*. Gradual suppressed in eggmass production was observed. Nematode disease severity decreased with the increase in effluent level. Thus there was an antagonistic association between effluent and root-knot nematode.

KEYWORDS : Brass and Electroplating Industries, *Meloidogyne incognita*

Brass, electroplating and other industrial effluents containing heavy metals, carried to crop production units through irrigation, can adversely affect plant growth (Ajmal and Khan, 1984; Khan et al. ,1987). According to (Foy et al.,1978) various industrial effluents are common environmental contaminants and are being continuously added to the soil. (Parveen, 2011) conducted a study to understand the behaviour of pathogens under stress conditions, to trace out the impact of stress on the pathogenesis and pathogenicity of the organism concerned and understand and evaluate the effect of heavy metal pollution on the soil ecosystem and its effect on plant growth, which are suitable indicators for assessing soil health.

The role of nematodes as bioindicators of soil health has also been demonstrated by(Bongers and Ferris, 1999) and (Chen et al., 2003). Thus effluents from various industries greatly influence soil health (Kar et al., 2007). Soil health ultimately has its impact on soil microflora which in turn affects plant health (Langat et al., 2008).

Industrial effluents contain many heavy metals and have the tendency to be absorbed by soil coloids and there often to be released in soil solution. The toxicity of heavy metals occurring in industrial effluents found to be toxic to saprophytes and plant parasitic nematodes depend mainly upon their water solubility and method of application. Thus brass, electroplating and other industrial effluents change the physical and chemical characteristics of the soil, which in turn may have an impact on the population density of soil borne pathogens.

Moradabad is renowned for brass work and has carved a niche for itself in the handicraft industry throughout the world and is also called Brass city or Peetal Nagri (in the local language). The modern, attractive and artistic brass wares, jewellary and trophies made by skilled artisians are the main crafts. There are about 600 export units and 5000 industries in and around Moradabad. Moradabad export goods worth Rs. 3000 crore every year. Recently other products like iron sheet, metal wares, aluminum artworks and glassware have also been included on per need of the foreign buyers. Out of these large industries, a large number of small scope industries and workshops were established by workers in their houses, Moradabad has more than 500 small factories manufacturing brass, aluminum, steel and glass wares. These large and small brass industries are producing a number of effluents which are reaching in water and soil and ultimately entering in to food chain.

A wide variety of both inorganic and organic pollutants are present in industrial effluents from brass industries. Inorganic pollutants include mainly heavy metals. These heavy metal are a cause of environmental pollution. Within American and European community the 13 elements of highest concentrations are As, Cd, Co, Cr, Hg, Mn, Ni, Pb, Cu, Zn, Mg, Sn and Ti. All these heavy metals can arise from many sources most commonly arises from the purification of metals e.g. melting of steel, Cu and electroplating, mainly used in brass industries in different parts of India including Moradabad, which in a primary source of Pb, Cr, and Cd.

In the present study, an effort has been made to assess the toxic effect of brass industrial effluent on

[1]Corresponding author

development, multiplication, fecundity, number of galls of the root knot nematode, *Meloidogyne incognita* (Kofoid et al.) Chitwood and its effect on the growth of soybean.

MATERIALS AND METHODS

In this study root-knot nematode, *Meloidogyne incognita* Chitwood, one of the commonest root-knot nematode species in this area, was used. The population of *M. incognita* was raised and maintained on tomato plants in clay pots, single egg masses collected from severely infected roots of tomato growing in the Hindu College, Moradabad Campus. The species of root knot nematode was identified by close examination of the perennial patterns of the females and morphometics of the juveniles (Eisenback et al., 1981). Commercial culture of *Bradyrhizobium japonicum* obtained from the Indian Agricultural Research Institute, New Delhi, was used in the study. Prior to sowing seeds of soybean were treated with mixture of sugar, water and *B. japonicum* culture, followed by the drying in shade for half an hour before sowing.

Few brass and electroplating industrial effluents was brought directly from polluted site-Kathghar in the sterilized glass containers and was analyzed for the physico-chemical parameters following APHA (1995). Two concentration (i.e. 50% diluted effluent and pure effluent) of brass and electroplating industrial effluents were used, prepared in distilled water.

Second-stage juveniles (J_2) of the Root-knot nematode were used as inoculum in the study. Second-stage juveniles were obtained by incubating egg masses, collected from the roots of tomato maintaining single egg mass culture of *M. incognita*. Egg masses ware incubated in course sieve fitted with double layered tissue paper and placed on Baermann funnel containing water. The sieves were then placed in an incubator (temp. 25^{0}C). After 72h, numbers of hatched juveniles (J_2) were collected in a beaker and number of juveniles per ml was standardized by counting the juveniles from ten, 1 ml of samples. Average number of juveniles was than calculated to represent the number of juveniles per ml of the suspension.

Seedlings of soybean (*Glycine max* L).) Merr. PK-472 were grown in clay pots (30 cm diameter) from surface sterilized seeds, Prior to seedlings, seeds were soaked in water for 24 hours and them surface sterilized seeds with 0.01 % mercuric chloride for 15 minutes. The surface sterilized seeds were sown in the pots filled with autoclaved sandy loam field soil.

Three-week-old seedlings were treated with brass and electroplating industrial effluent (500 ml/pot). The treatments were given two times during the experiment. The first treatment was given at seedlings stage and second to after 15 days. Treatment started at the time of inoculation. The concentrations of brass and electroplating industrial effluents used were 50% diluted and pure.

Each treatment was replicated five times and pots were arranged on the glasshouse benches in a complete randomized block design. At termination of the experiment, after 75 days of sowing, length and fresh and dry weights of shoots and roots were determined. Roots were virtually examined to count the functional and total nodules per plant in the experiment. Root of nematode inoculated plants were treated with phloxine B (0.15 g/l) to facilitate the counting of galls and egg masses. Fecundity was determined by excising 20 egg masses from each root system (total 100 egg masses) which were blended in 1% NaCl solution (Khan and Khan, 1994). Statistical analysis of the data was done according to the (Fisher,1950) factorial method.

RESULTS AND DISCUSSION

Plant growth of soybean (shoot and length and weight of shoot and root) and yield (number of pots) showed an improvement in presence of *B. japonicum*. But *M. incognita* significantly suppressed plant growth. Suppressions in the plant growth parameters less in the presence of root nodule bacteria. Thus least growth and yield were recorded in the pots inoculated with *M. incognita* at all levels of brass and electroplating industrial effluent (Table, 1).

Root nodulation (functional and total nodules) was affected by industrial effluent. Both levels of brass and industrial effluent suppressed root nodulation significantly and suppression gradually increased with the increase of concentration of effluent in the soil. Nodulation was decreased further in the presence of the *M. incognita* (Table, 2).

Table 1 : Effect of Brass and Electroplating Industrial Effluent on Length and Fresh Weight of Shoot and Root and Number of Pod Per Plant of Soybean Inoculated With *Bradyrhizobium japonicum* and *Meloidogyne incognita*, Singly or in Combination

Treatment	Shoot length (cm)			Root length (cm)			Shoot weight (gm)			Root weight (gm)			No. of pods		
	Effluent conc. (%)			Effluent conc. (%)			Effluent conc. (%)			Effluent conc. (%)			Effluent conc. (%)		
	0	50	100	0	50	100	0	50	100	0	50	100	0	50	100
P	58	50	49	32	29	26	20	17	15	12	10	9	44	38	34
P + Bj	69	56	53	38	31	29	25	21	18	16	11	10	53	42	38
P + Mi	54	49	47	29	26	25	18	16	14	19	9	9	39	30	29
P + Bj + Mi	61	52	48	34	29	28	22	19	17	14	11	10	45	34	31
MM	60	51	49	33	28	27	21	18	16	12	12	11	45	36	33
CD at P = 0.05	Treatments = 1.28 Effluent = 1.12 T X E = 2.26			Treatments = 1.10 Effluent = 0.91 T X E = 1.78			Treatments = 1.36 Effluent = 1.14 T X E = NS			Treatments = 0.22 Effluent = 0.19 T X E = 0.38			Treatments = 2.08 Effluent = 1.73 T X E = NS		

Bj = *Bradyrhizobium japonicum* Mi = *Meloidogyne incognita* MM = Mean of means

Each value is the mean of five replicates

Table 2 : Effect of Brass and Electroplating Industrial Effluent on Functional and Total Number of Bacterial Nodules/plant of Soybean Plants Inoculated With *Bradyrhizobium japonicum* and *Meloidogyne incognita*, Singly or in Combination

Treatment	Number of functional nodules				Total number of nodules			
	Effluent conc. (%)				Effluent conc. (%)			
	0	50	100	MM	0	50	100	MM
P	-	-	-	-	-	-	-	-
P + Bj	195	111	87	131	218	147	115	160
P + Mi	-	-	-	-	-	-	-	-
P + Bj + Mi	151	101	76	109	183	141	106	143
MM	173	106	81	-	200	144	110	-
CD at P = 0.05	Treatment = 2.18 Effluent = 2.68 Treatment X Effluent = 3.84				Treatment = 2.11 Effluent = 2.71 Treatment X Effluent = 3.82			

Bj = *Bradyrhizobium japonicum* Mi = *Meloidogyne incognita* MM = Mean of means

Each value is the mean of five replicates

Inoculation of plants with the root nodule bacteria suppressed the number of root galls and egg masses of *M. incognita*. Treatment of the nematode inoculated plants with or without the root nodule bacteria to brass and electroplating industrial effluent, suppressed root galls and egg mass numbers. The fecundity of the nematode was greater in the presence of the root nodule bacteria. Like egg masses, fecundity of the nematode was also adversely affected by industrial effluent of both the concentrations. Presence of *B. japonicum* caused significant reduction in the number of females of *M. incognita*. The number of female was reduced, when the nematode-inoculated plants were treated with effluent (Table ,3).

Plant growth increased in the presence of *B. japonicum*. This favourable effect was apparently due to root nodulation and symbiotic nitrogen fixation, which were beneficial. Attack of root-knot nematodes on several kinds of crops and resulting reduction in plant growth and yield (Sasser, 1980 & Sasser and Carter, 1982) are well established. *M. incognita* suppressed plant growth. Reduction in plant growth due to root-knot nematode infection is caused by dysfunctioning of the absorption and

Table 3 : Effect of Brass and Electroplating Industrial Effluent on Number of Galls, Eggmasses and Females and The Fecundity of *M. incognita* on Soybean Inoculated or Not With *B. japonicum*.

Treatment	Number of galls			Number of eggmasses			Number of females			Fecundity		
	Effluent conc. (%)			Effluent conc. (%)			Effluent conc. (%)			Effluent conc. (%)		
	0	50	100	0	50	100	0	50	100	0	50	100
P	-	-	-	-	-	-	-	-	-	-	-	-
P + Bj	-	-	-	-	-	-	-	-	-	-	-	-
P + Mi	54	41	31	31	21	14	71	51	35	401	390	372
P + Bj + Mi	43	39	29	28	20	12	60	50	31	412	398	380
MM	48	40	30	28	20	13	65	50	33	406	394	376
CD at P = 0.05	Treatments = 2.26 Effluent = 2.78 T X E = 3.88			Treatments = 1.84 Effluent = 2.25 T X E = NS			Treatments = 2.13 Effluent = 2.62 T X E = 3.82			Treatments = NS Effluent = 15.62 T X E = NS		

supply of water and minerals to the infected plant because of various anatomical and biochemical changes induced by the nematode.

Presence of *B. japonicum* adversely affected the number of galls and egg masses of *M. javanica*; in sequential inoculation. Husaini and Seshadri (1975) and (Bopaiah et al., 1976) also observed reduced disease intensity due to poor penetration of the nematode juveniles. B. japonicum may have induced resistance against juvenile penetration of the nematode (Tu, 1980), leading to the reduced root galling (Fazal et al., 1992). Thus beneficial effects of *B. japonicum* marked the harmful effects of *M. incognita*. Nitrogen plays and important role in disease resistance of plants. The both levels of industrial effluent were harmful for plant growth because heavy metals are present in it.

ACKNOWLEDGMENTS

The author thanks the Head & Staff, Department of Botany, Hindu College, Moradabad for the laboratory facilities.

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