CHEMICAL APPROACH FOR MANAGING ROOT-KNOT NEMATODE, *MELOIDOGYNE INCOGNITA* RACE 2, INFECTING JUTE

M.R. Khan

Department of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal, India, Email: mrkhanbckv@rediffmail.com

Summary. Field experiments were conducted for three consecutive years with different nematicides, viz. carbofuran 3G at 2 kg a.i./ha, phorate 10G at 2 kg a.i./ha, sebuphos 10G at 2 kg a.i./ha, fenamiphos or benfuracarb 10G at 2 kg a.i./ha as soil applicants and carbosulfan 25ST at 3% w/w as seed treatment, for controlling root-knot nematode, *Meloidogyne incognita* race 2, in jute. The only effective and economical approach was seed treatment with carbosulfan 25ST at 3% w/w. However, soil applications of carbofuran and fenamiphos at 2 kg a.i./ha were also found effective in increasing fibre yield of jute. Good results were also obtained when seeds of jute were treated with carbosulfan 25ST at 3% w/w followed by soil application of fenamiphos 10G, phorate 10G, or sebuphos 10G at 2 kg a.i./ha. A reduction of root galling was observed in plots treated with sebuphos at 2 kg a.i. /ha.

Jute (*Corchorus capsularis* L. and *C. olitorius* L.) is one of the most important fibre crops in West Bengal and the root-knot nematode, *Meloidogyne incognita* (Kofoid *et* White) Chitw. race 2, is one of the more serious constraints for cultivation of jute. Several attempts (Mishra *et al.*, 1987; Mahanta *et al.*, 1992) have been made to manage root-knot nematode in jute but, under the intensive cultivation systems of the alluvial soils of West Bengal, none has proved effective. Moreover, no cultivars of jute resistant or tolerant to root-knot nematode are so far available. Therefore, an investigation was carried out to assess the efficacy of nematicides used as seed treatments, applied to soil or as a combination of the two procedures for reducing damage caused by root-knot nematode in jute.

MATERIALS AND METHODS

The experiments were carried out for three consecutive years (1999, 2000 and 2001) during the growing season April-August (average maximum temperature 33 ^{0}C, minimum temperature 26 ^{0}C for all the thee years; total rainfall 1322 mm, 1094 mm and 893 mm in 1991, 2000 and 2001, respectively) in farmers' fields (sandy loam soil) at two different locations of Nadia district, West Bengal. The selected fields were infested with *Meloidogyne incognita* race 2 and were divided into 40 plots each of 3 m x 2 m. All plots were sown with jute cv. JRO-632 in 1999 and cv. JRO-524 in 2000 and 2001, spaced 25 cm between rows and 10 cm along the row. There were 10 treatments (Tables I-III), each replicated four times. They comprised seed treatment with carbosulfan 25ST at 3% w/w, soil application of carbofuran 3G, phorate 10G, sebuphos 10G, and fenamiphos 10G (1999) or benfuracarb (2000 and 2001), all at 2 kg a.i./ha, and combinations of the mentioned seed and soil treatments. Four plots were not treated and served as controls. Seeds were treated with a powder formulation of carbosulfan by adding gums as an adhesive agent, mixed to ensure uniform coating of the seeds and spread over polythene sheet for drying under shade at room temperature. Granular nematicides were mixed with friable soils and placed in the rows during sowing of jute seeds. The initial soil population densities of *M. incognita* (J_2) was determined by collecting soil samples from the entire field after final land preparation and the final population was determined from individual plots at harvest. Nematodes were extracted by Cobb's decanting and sieving technique followed by a modified Baermann technique, and the population was estimated by counting the numbers in sub-samples with the help of a multi-chambered counting slide under a stereoscopic microscope. Infected roots were stained by the NaOCl-Acid Fuchsin method (Byrd *et al.*, 1983). Species and race of *Meloidogyne* was confirmed on the basis of perineal pattern and host differential test, respectively (Anonymous, 2001).

Upon harvesting, plant stand, basal diameter, shoot length, shoot weight (fresh and dry of 10 plants), fibre yield and root galling index on a 0-5 scale (0 = no gall, 1 = 1-2 galls, 2 = 3-10 galls, 3 = 11-30 galls, 4 = 31-100, 5 = >100 galls per plant root system) of each root system were determined. Agronomic management practices were followed as per farmers' practices.

RESULTS AND DISCUSSION

Applications of nematicides as seed treatment or seed-cum-soil application were found to give the best control. Among the nematicides, fenamiphos 2 kg

Table I. Management of root-knot nematode, *Meloidogyne incognita*, in jute (cv. JRO-632) through application of nematicides in 1999.

Treatment	Plant stand (number)	Basal diameter (cm)	Shoot length (cm)	Shoot weight (g) of 10 plants		Fibre yield (kg/plot)	% increase over control	Gall index (0-5)	Mean final population (J_2/200 cm^3 soil)
				dry	fresh				
T_1 - Carbosulfan 25ST at 3%w/w	188	3.8	203.5	256.2	650.0	1.25	22.5(+)	4.55	184
T_2 - Carbofuran 3G at 2 kg a.i/ha	296	3.8	198.7	231.2	587.5	1.43	40.2(+)	4.03	214
T_3 - Phorate 10G at 2 kg a.i/ha	243	3.8	188.0	243.7	637.5	1.28	20.5(+)	4.63	258
T_4 - Sebuphos 10G at 2 kg a.i/ha	235	3.8	259.0	287.5	662.5	1.34	31.3(+)	3.73	189
T_5 - Fenamiphos 10G at 2 kg a.i/ha	300	4.2	207.3	293.7	750.0	1.71	67.7(+)	4.18	234
T_6 - (T_1 + T_2)	281	3.7	194.7	232.5	537.5	1.50	47.6(+)	4.50	184
T_7 - (T_1 + T_3)	208	4.0	207.0	275.0	700.0	1.28	25.5(+)	4.03	201
T_8 - (T_1 + T_4)	245	3.7	196.0	262.5	800.0	1.20	17.6(+)	4.23	200
T_9 - (T_1 + T_5)	277	5.4	210.5	250.0	575.0	1.73	69.6(+)	4.23	162
T_{10} - (control)	161	3.9	210.0	262.5	687.5	1.02	-	4.73	335.00
CD (p = 0.05)	38.27	ns	42.00	ns	ns	0.18		-	76.71

* ns = Non-significant at 5% level. Pre-sowing nematode population 231 J_2 per 200 cm^3 soil. Date of sowing: May 29, 1999; harvesting: August 20, 1999.
Gall index: 0 = No gall, 1 = 1-2 galls, 2 = 3-10 galls, 3 = 11-30 galls, 4 = 31-100, 5 = >100 galls per plant root system.

Table II. Management of root-knot nematode, *M. incognita*, in jute (cv. JRO-524) through application of nematicides in 2000.

Treatment	Plant stand (number)	Basal diameter (cm)	Shoot length (cm)	Shoot weight (g) of 10 plants		Fibre yield (kg/plot)	% increase over control	Gall index (0-5)	Mean final population (J_2/200 cm^3 soil)
				dry	fresh				
T_1 - Carbosulfan 25ST at 3%w/w	196	3.4	191.1	195.0	638.7	1.28	17.4(+)	3.2	1,191
T_2 - Carbofuran 3G at 2kg a.i/ha	196	3.3	156.7	160.0	546.2	1.21	11.0(+)	3.9	2,077
T_3 - Phorate 10G at 2 kg a.i/ha	196	3.4	144.3	180.0	630.0	1.29	18.3(+)	3.3	1,231
T_4 - Sebuphos 10G at 2 kg a.i/ha	190	3.4	163.6	198.7	665.0	1.13	12.8(+)	2.8	1,629
T_5 - Benfuracarb at 2 kg a.i/ha	204	3.4	191.8	182.5	617.5	1.28	17.4(+)	3.6	2,756
T_6 - (T_1 + T_2)	180	3.7	174.6	192.5	648.7	1.27	16.5(+)	3.8	2,081
T_7 - (T_1 + T_3)	192	3.6	118.7	203.7	687.5	1.30	19.2(+)	3.6	2,021
T_8 - (T_1 + T_4)	192	3.6	198.2	195.0	678.7	1.31	20.1(+)	2.6	2,332
T_9 - (T_1 + T_5)	198	3.5	204.4	216.2	750.0	1.29	18.3(+)	2.8	1,560
T_{10} - (control)	160	3.5	161.0	197.5	671.2	1.09	-	3.7	3,543
CD (p = 0.05)	32.4	ns	36.36	ns	74.75	0.10	-	0.83	-

*ns = Non-significant at 5% level. Initial nematode population 347 J_2 per 200 cm^3 soil. Date of sowing: May 26, 2000; harvesting: August 11, 2000.
Gall index: 0 = No gall, 1 = 1-2 galls, 2 = 3-10 galls, 3 = 11-30 galls, 4 = 31-100, 5 = >100 galls per plant root system.

Table III. Management of root-knot nematode, *M. incognita*, in jute (cv. JRO-524) through application of nematicides in 2001.

Treatment	Plant stand (number)	Basal diameter (cm)	Shoot length (cm)	Shoot weight (g) of 10 plants		Fibre yield (kg/plot)	% increase over control	Gall index (0-5)	Mean final population (J_2/200 cm^3 soil)
				dry	fresh				
T_1 - Carbosulfan 25ST at 3%w/w	214	2.8	216.0	182.5	376.2	1.05	28.0 (+)	3.0	8,187
T_2 - Carbofuran 3G at 2kg a.i/ha	192	2.9	189.5	126.2	367.5	0.89	8.5(+)	3.4	7,380
T_3 - Phorate 10G at 2 kg a.i/ha	204	2.7	189.5	120.0	366.2	1.02	24.4(+)	3.4	8,576
T_4 - Sebuphos 10G at 2 kg a.i/ha	196	2.9	193.9	143.7	418.7	0.90	17.0(+)	2.7	7,789
T_5 - Benfuracarb at 2 kg a.i/ha	184	3.0	204.8	138.7	380.0	0.83	5.0(+)	3.7	8,315
T_6 - (T_1 + T_2)	210	2.8	196.4	121.2	355.0	1.02	24.4(+)	3.3	7,500
T_7 - (T_1 + T_3)	196	2.7	192.1	126.2	361.2	1.13	37.8(+)	3.4	10,474
T_8 - (T_1 + T_4)	208	3.2	205.6	130.3	365.4	1.16	41.4(+)	3.0	6,231
T_9 - (T_1 + T_5)	208	2.9	201.9	132.6	401.7	1.04	26.8 (+)	3.5	7,484
T_{10} - (control)	169	2.94	179.2	121.4	345.2	0.82	-	4.4	12,879
CD (p = 0.05)	18.47	ns	24.00	ns	ns	0.18	-	-	-

* ns = Non-significant at 5% level. Initial nematode population 391 J_2 per 200 cm^3 soil. Date of sowing: May 16, 2001; harvesting: August 21, 2001.

Gall index: 0 = No gall, 1 = 1-2 galls, 2 = 3-10 galls, 3 = 11-30 galls, 4 = 31-100, 5 = >100 galls per plant root system.

a.i./ha was the most effective as it increased fibre yield of jute (JRO-632) by 68% (Table I), being particularly effective when the initial population of the nematode in soil was relatively low. This was followed by carbofuran at 2 kg a.i./ha, which gave up to 40% and 47% increase of fibre yield when applied to soil alone and in combination with carbosulfan as seed treatment, respectively (Table I). Mishra *et al.* (1987) also observed that carbofuran at 1 kg a.i./ha was effective in reducing the nematode population (J_2) and increasing fibre yield of jute. Similarly, Senapati and Ghosh (1992) also recorded greatest suppression of root-knot nematode infestation in jute with the application of carbofuran at 2 kg a.i./ha under a jute-paddy rotational system. However, our results revealed that seed treatment with carbosulfan was the most effective and economical means for protecting jute from nematode attack. This treatment increased fibre yield by 28% even with the highest initial soil population density of the nematodes (391/200 cm^3). Mahanta *et al.* (1992) found that soaking jute seed in a solution of carbosulfan 0.2% reduced root galling and egg mass production of *M. incognita*. However, combining carbosulfan as seed treatment with soil application of phorate at 2 kg a.i./ha and sebuphos at 2 kg a.i./ha provided higher yields than when they were applied alone (Tables II and III). The effects of all treatments on plant growth parameters, except for that of shoot length, were not significant. The final nematode population (J_2) in soil at harvest of the crop was very high, though it was substantially lower than in control plots. The soil population of *M. incognita* was so high in the experimental plots of the years 2000 and 2001 that application of granular nematicides to soil could not reduce the nematode population below the damage threshold level. Gall indices did not vary with the soil population of *M. incognita*. However, a reduction in the root gall index was observed in the plots treated with sebuphos at 2 kg a.i./ha. Considering the efficacy, economy and environmental consequences, seed treatment with carbosulfan 25ST at 3% w/w was the most practical approach to protect jute from root-knot nematodes during the early development stage of the crop.

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