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EVALUATION OF YIELD LOSSES IN RICE DUE TO *HIRSCHMANNIELLA GRACILIS* (de MAN, 1880) LUC & GOODEY, 1963 (TYLENCHIDA : NEMATODA) AT HOOGHLY (WEST BENGAL)

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ABSTRACT

During monsoon season in 1979, an experiment was conducted at Chinsurah Rice Research Station, District Hooghly (West Bengal) to estimate the yield losses in paddy crop due to *Hirschmanniella gracilis*. The seedlings of 'Jaya' variety of rice were transplanted on 18th August, 1979. The field was divided into 24 subplots (4×4 m each) in which the following treatments were replicated six times and randomized : T_1=Treated with carbofuran granules, T_2=Native population of *H. gracilis*, T_3=Inoculation to soil by incorporating 500 gm/subplot infested chopped roots (4300 nematodes), T_4=Inoculation to soil by incorporating 1 Kg/subplot infested chopped roots (8600 nematodes).

The loss was again estimated during the monsoon season in 1981 by applying the same dose of carbofuran granules. This time, the chopped roots were not incorporated in the main field because of their insignificant role in 1979. Instead of T_3 and T_4 treatments mentioned above in 1979, a new treatment was introduced in 1981 by treating half of the seed bed by carbofuran granules.

The results reveal that the application of carbofuran granules brings down the population of *H. gracilis* in soil as well as in roots significantly. In treated subplots, the significant improvement in the root and shoot length, plant and root weight and the yield has been found directly related with the decline of *H. gracilis* population in soil and roots. The loss in yield due to native/inoculated population of *H. gracilis* has been calculated 12·05 to 13·61% in 1979 and 18·33 to 19·22% in 1981.

INTRODUCTION

During recent years, a considerable work has been done on different aspects of nematode pests associated with paddy crop in India (Das & Rao, 1970 ; Mathur & Prasad, 1971, '74a', '74b', '74c' ; Muthukrishnan, *et al.*, 1979 ; Prasad & Rao, 1974 ; Ramana & Rao, 1977 ; Rao, 1970. Mathur & Prasad (1971) reported that *Hirschmanniella oryzae* (Soltwedel, 1889) Luc & Goodey, 1963 occurs at least in 12 states of the Indian union. Recent reports from different research centres have revealed that *Hirschmanniella* spp. are most serious and widely distributed pests of rice. Baqri *et al.*, (1983) have reported that every paddy field in Burdwan district of W. Bengal was found infested by *Hirschmanniella gracilis* (de Man, 1880) Luc & Goodey, 1963.

Several field experiments have been conducted by various workers at Thailand and Japan to evaluate the yield losses in rice

caused by the rice root nematodes by applying different dosages of different chemicals (DD, EDB, DBCP, etc.). In India, Panda & Rao (1971) and Rao & Biswas (1974) have estimated the yield losses in rice under inoculated conditions in pots caused by *Hirschmanniella mucronata* (Das, 1960) Luc & Goodey, 1963 and *Meloidogyne incognita* (Kofoid & White, 1919) Chitwood, 1949 respectively.

The present investigations were initiated in 1979 at Chinsurah Rice Research Station, Hooghly (W. Bengal) by applying carbofuran granules and inoculating *H. gracilis* in an already infested field from the same species. Applying the same dose of carbofuran granules, the results were confirmed in 1981.

Carbofuran was selected because it has been reported to be effective against various plant parasitic nematodes by bringing down their population (Di Sanzo, 1969 ; Di Sanzo, 1973 ; Siddiqui & Khan, 1974 ; Overman & Jones, 1975 ; Bonnemaison, 1975 ; Verma *et al.*, 1978 ; Varma, Prasad & Mathur, 1980 ; and others). Moreover, carbofuran in granular form is not only less expensive but also easily available in the market.

Materials and Methods

The nursery bed of 'Jaya' variety was prepared in an adjacent field during July 1979. The main field was divided into 24 subplots (4 × 4 m each) which were separated from each other by 0·5 m bund. One month old seedlings were transplanted on 18th August, 1979 at 15 × 20 cm space. Recommended cultural practices of rice were followed. No other pesticides or weedicides were applied in the field during the present course of investigation. In the main field, the following four treatments were replicated six times and randomised :

T_1 = Treatment with carbofuran granules 1 Kg. a.i./ha, one day before seedlings transplantation and 50 days after seedlings transplantation.

T_2 = Native population in the soil.

T_3 = Inoculation to soil by incorporating 500 gm/subplot infested chopped roots (4300 nematodes).

T_4 = Inoculation to soil by incorporating 1 Kg./subplot infested chopped roots (8600 nematodes).

The loss assessed in 1979 was confirmed by conducting another experiment at Chinsurah during the monsoon season in 1981. The same dose of carbofuran granules was applied in the main field. This time, a new presowing treatment was introduced by treating half of the seed bed by carbofuran granules (1 Kg. a.i./ha). The seed bed treatment was introduced to assess the loss in growth of seedlings due to rice root nematodes. T_3 and T_4 treatment, mentioned above, were not taken into consideration because the inoculation of *H. gracilis* by incorporating infested chopped roots did not make any significant difference in 1979. The following three treatments were replicated eight times and randomised in 1981.

T_1 = Main field treated with carbofuran granules, seedlings from carbofuran treated seed bed.

T_2 = Main field with native population, seedlings from carbofuran treated seed bed.

T_3 = Main field with native population, seedlings from untreated seed bed.

The soil samples were collected from five spots at random from each subplots for counting *H. gracilis* population a day before inoculation or first application of carbofuran granules. 30 days after seedlings transplantation, prior to second application of carbofuran granules and prior to hervesting. The *H. gracilis* population was counted from 200 ml soil. From each subplot, 10 plants were rooted out on the day of each sampling to note the length of root and shoot (cm), number of flowering/nonflowering tillers, weight of total plant and roots separately (gm) and also the nematode population in 5 gm roots.

The extraction of nematodes was done through modified Baermann funnel technique. From roots, the nematodes were recovered by placing chopped roots through blender over Baermann funnel.

RESULTS AND DISCUSSION

All the results obtained in 1979 have been analysed in Table I. The initial population of *H. gracilis* was counted 70/200 ml soil. It is evident from the results that *Hirschmanniella* population in soil becomes considerably low in treated subplots on 30th day after transplanting seedlings whereas it increases in untreated/inoculated subplots (12 against 94-158). It appears that the application of carbofuran granules in soil also checks the penetration of *Hirschmanniella* into the roots because 7 nematodes/5 gm roots were recovered against 34-86/5 gm roots from untreated or inoculated subplots. A marked improvement in shoot and root length, root weight and plant weight from treated subplots was noted over the untreated or inoculated subplots.

The sampling prior to second application of carbofuran granules revealed that the *Hirschmanniella* population has increased in the treated soil and the differences in the population among treated and untreated/ inoculated subplots did not remain significant except T_4 over T_1, T_2 and T_3 at 5% level. During this period the root population also increased in T_1 subplots and the differences among the different treatments did not remain significant. The length and weight of roots and shoots in the plants from treated subplots continued to be significant over the plants from T_2, T_3 and T_4 subplots.

The third or pre-harvesting sampling again confirmed the efficacy of carbofuran, since the soil and root population of *Hirschmanniella* declined after the second application of this pesticide in T_1 subplots. The soil and root population of *H. gracilis* became significantly low in T_1 subplots. The number of flowering tillers was significant in the treated subplots. In addition to this, shoot length, root weight and plant weight were also noted significant in T_1 subplots. Though at this stage the weight of roots and shoots do not remain of much importance because the plants have to prepare for the grain yield.

Finally, the following results of yield grain were recorded from the four treatments : $T_1 = 6{\cdot}575$ Kg., $T_2 = 5{\cdot}983$ Kg., $T_3 = 5{\cdot}683$ Kg., $T_4 = 5{\cdot}783$ Kg.

It is evident that the enhanced grain yield in T_1 subplots over T_2, T_3 and T_4 subplots is obtained due to the application of carbofuran granules which checks the population of *Hirschmanniella* at low level. Since the increase in yield is due to controlled population of *Hirschmanniella* sp. in T_1 subplots,

TABLE I. Losses in paddy yield due to *Hirschmanniella gracilis*

Time of sampling	Treatments	No. of non-* flowering tillers	No. of* flowering tillers	Shoot* height (cm)	Root* length (cm)	Plant Wt* (gm)	Root Wt.* (gm)	Population* of *H. gracilis* in root (5 gm)	Population* of *H. gracilis* in soil (200 ml)	Yield (Kg)
At the time of inoculation		—	—	—	—	—	—	—	78	—
30 days after transplanting seedlings	T_1	10.6	—	57	19	35	6	6.6	12	—
	T_2	10.8	—	50	16	23	2.5	34	94	—
	T_3	10	—	48	16	17	2.4	36	158	—
	T_4	12	—	51	16	22	2.3	86	158	—
C. D. at 1%		N.S.	—	5.92	2.3	10.97	0.83	49.27	71.46	—
C. D. at 5%		N.S.	—	—	1.66	—	—	—	51.67	—
Prior to second application of carbofuran	T_1	9	0.56	76	16	83	8.3	48	141	—
	T_2	6	0.48	71	14	56	5.9	56	155	—
	T_3	9	0.35	67	15	57	6.1	87	138	—
	T_4	10	0.21	73	13	75	7.0	79	255	—
C. D. at 1%		N.S.	N.S.	7.77	N.S.	19.23	2.07	N.S.	N.S.	—
C. D. at 5%		N.S.	N.S.	5.62	1.95	—	—	N.S.	92.08	—
Prior to harvesting	T_1	—	8.5	85	10	76	4.0	4	45	—
	T_2	—	9.0	80	10	68	2.9	7	69	—
	T_3	—	9.0	82	11	79	3.4	13	91	—
	T_4	—	8.5	82	11	76	3.6	18	214	—
C. D. at 1%		—	0.29	N.S.	N.S.	N.S.	0.83	N.S.	142.75	—
C. D. at 5%		—	—	3.37	N.S.	10.63	—	11.81	103.27	—
Post harvesting	T_1	—	—	—	—	—	—	—	—	6.575
	T_2	—	—	—	—	—	—	—	—	5.983
	T_3	—	—	—	—	—	—	—	—	5.683
	T_4	—	—	—	—	—	—	—	—	5.783
C. D. at 1%		—	—	—	—	—	—	—	—	N.S.
C. D. at 5%		—	—	—	—	—	—	—	—	0.34

Loss in yield (%) T_2=12.05 T_3=13.61 T_4=12.05

*Mean of six replications

TABLE II. Nematode population at the time of nursery sowing 353/200 ml of soil.

Plant growth and nematode population at the time of transplanting (Average of ten seedlings)								
Treatments	Shoot length (cm)	% increase untreated control.	Fresh root weight (gm)	% increase untreated control.	Nematode Population in soil/200 ml,	%de-crease.	Nematode population of root/5 gms.	%de-crease.
Untreated control.	24.35		0.18		170		27	
Carbofuran treated nursery @ 1 Kg/ha.	33.15	26.55%	0.24	25%	100	41.18	10	62.96

TABLE III. Losses in Paddy yield due to *Hirschmanniella gracilis*

Time of Sampling	Treatments	No. of non-* flowering tillers	No. of* flowering tillers	Shoot* height (cm)	Root* length (cm)	Plant Wt.* (gm)	Root Wt* (gm)	Population* of *H. gracilis* in root (5 gm)	Population* of *H. gracilis* in soil (200 ml)	Grain* yield (Kg.)
At the time of transplanting		—	—	—	—	—	—	—	280	—
30 days after transplanting seedlings	T_1	8.94	—	60.62	19.69	30.76	3.88	33.5	54.29	—
	T_2	8.75	—	59.3	18.02	27.35	2.76	40.13	77.14	—
	T_3	8.47	—	58.78	17.98	25.69	3.03	41.75	122.86	—
C.D. at 1%		N.S.	—	N.S.	N.S.	N.S.	N.S.	N.S.	39.44	—
C.D. at 5%		N.S.	—	N.S.	N.S.	N.S.	0.48	N.S.	28.28	—
Prior to second application of carbofuran	T_1	8.97	1.24	70.57	15.72	62.8	5.86	39.5	50.0	—
	T_2	9.2	1.45	66.91	13.5	58.74	3.65	43.87	63.75	—
	T_3	8.87	1.14	66.94	13.35	53.75	4.04	30.79	119.03	—
C.D. at 1%		N.S.	N.S.	N.S.	N.S.	N.S.	1.07	N.S.	45.33	—
C.D. at 5%		N.S.	N.S.	N.S.	N.S.	N.S.	—	N.S.	32.96	—
Prior to harvesting	T_1	1.46	8.55	79.37	—	55.5	2.56	11.87	121.25	—
	T_2	1.18	8.25	77.92	—	40.83	2.0	22.87	240.0	—
	T_3	0.88	8.91	78.46	—	41.15	1.95	18.0	215.0	—
C.D. at 1%		0.03	N.S.	N.S.	—	3.48	N.S.	N.S.	N.S.	—
C.D. at 5%		0.02	0.09	N.S.		2.51	N.S.	N.S.	53.19	—
Post harvesting	T_1	—	—	—	—	—	—	—	—	2.51
	T_2	—	—	—	—	—	—	—	—	2.01
	T_3	—	—	—	—	—	—	—	—	2.05
C.D. at 1%										N.S.
C.D. at 5%										N.S.

Loss in yield (%) T_2=19.22 T_3=18.33

*Mean of eight replications

the decline in the yield from T_2, T_3 and T_4 subplots has been considered as loss due to *H. gracilis*.

The loss has been assessed 12·05%, 13·61% and 12·05% in T_2, T_3 and T_4 subplots respectively.

The results of the second experiment conducted in 1981 have been analysed in Table II and III. The seed bed results have been furnished in Table II which show that the rice root nematode population in soil and root declined 41·18% and 62·96% respectively. In general, the seedlings from treated seed bed were healthier than the untreated seed bed.

Table III analyses the results from the main field. The results obtained from first sampling (30 days after transplanting), 2nd sampling (prior to second application of carbofuran granules) and 3rd sampling (prior to harvesting) are not discussed just to avoid the repeatition. Finally the grain yield was noted and it was found that T_1 subplots (main field treated with carbofuran granules, seedlings from treated seed bed) gave better yield than T_2 and T_3 subplots in which the loss has been calculated 19·22% and 18·33% respectively.

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