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ASSOCIATION OF *ROTYLENCHULUS RENIFORMIS* WITH PLANT GROWTH HETEROGENEITY OF PIGEONPEA[1]

by

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Summary. Pigeonpea (*Cajanus cajan*) plants were stunted in soils heavily infested with *Rotylenchulus reniformis* at Gwalior in Central India. Nematode densities in these soils at sowing ranged from 1.8 to 4.2 per cm^3 soil. Application of 6 kg a.i./ha carbofuran 3G significantly reduced nematode densities, and improved crop growth except at lower nematode densities (0.6 to 1.1 per cm^3 soil) where the treatment had little effect. In greenhouse trials, application of 20 l/ha of dibromo-chloropropane (DBCP) or 6 kg a.i./ha of carbofuran reduced nematode densities, and increased the plant growth, indicating that *R. reniformis* is a contributing factor in causing stunted and patchy growth of pigeonpea which is commonly known as the heterogeneity problem of pigeonpea.

Rotylenchulus reniformis Linford *et* Oliveira has a very wide host range and is an important pest of pigeonpea [*Cajanus cajan* (L.) Millsp]. The association of *R. reniformis* with pigeonpea crop growth variability has been observed in farmers fields in the Indian states of Madhya Pradesh, Andhra Pradesh, Karnataka and Gujarat. Damage thresholds of the nematode generally range from 1 to 4 *R. reniformis*/cm^3 soil depending on soil and climatic factors (Sharma and Nene, 1988; Sharma and McDonald, 1990). Patches of stunted plants in a crop of pigeonpea were observed at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) Cooperative Research Center at Gwalior in Central India (26" N, 78" E, 211.5 m alt.). The randomly distributed patches were not associated with any soil structure problem or micronutrient deficiencies and plant growth was vigorous in soil that was collected from these patches and autoclaved. Also, uniform irrigation and timely weeding reduced the variability in crop growth but did not alleviate it completely. In 1987, soil sampling indicated the presence of *R. reniformis* (6.4-14.4./cm^3) in patches of moderate to poor plant growth; and *R. reniformis* were also present (3.5/cm^3) in area where plants were healthy and of uniform growth. The involvement of *R. reniformis* with the plant growth heterogeneity problem of pigeonpea was investigated with the application of nematicides (Germani, 1979).

Materials and methods

Field trials were conducted at the ICRISAT Cooperative Research Center Farm, Gwalior from 1987-89. The soil (Inceptisol) consisted of 43% sand, 29% silt and 28% clay with pH between 7.2 and 7.8.

In pigeonpea fields with plant growth heterogeneity problem observed from 1985 to 1987 a 300 m^2 area was divided into 20 plots each of 12 m^2. Pigeonpea genotype ICPL 87 was sown in these plots on 8 July 1987. Each plot had eight rows spaced at 37.5 cm. Carbofuran 3G at 6 kg a.i./ha was applied to ten plots at sowing by manually incorporating the granules 5-6 cm deep in the rows which were then covered with a thin layer of soil. The carbofuran-treated plots and control (no carbofuran treatment) plots were arranged in a randomized block design. The trial was repeated at an adjacent location with pigeonpea genotype, ICPL 366 but the inter-row spacing was 75 cm and each plot had only 4 rows. In each trial ten plants were randomly selected at an early stage of growth and plant height was measured at regular intervals. ICPL 87 and ICPL 366 were harvested on 15 February 1988 and 6 April 1988, respectively.

In 1988 during the rainy season, the first field trial was repeated in another field with pigeonpea genotypes ICPL 87 and ICPL 151. Seeds were sown on 15 July 1988.

[1] Submitted as JA No. 1430 by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).

Genotypes were main plots and carbofuran treatments were sub plots in a split plot design with eight replications. Each 4 m long plot had four rows spaced at 60 cm with plants spaced at 5 cm in the row. The plots were irrigated three times at intervals of 30 days in September, October and November.

Soil samples were collected at sowing, within 40 days after sowing and at harvest. Population densities of *R. reniformis* were estimated in each plot in 1987/88 and 1988/89 by assaying a composite soil sample. Each sample consisted of six random cores of soil collected to 20 cm depth in each plot. Nematodes were extracted from 100 cm^3 soil samples by sieving soil suspension through 850 µm and 38 µm pore sieves, and placing the residue from 38 µm pore sieves on modified Baermann funnels (Schindler, 1961).

In 1990, a pot experiment was conducted to study the effect of population densities of *R. reniformis* and soil moisture levels on pigeonpea growth. Two sets of 30 pots each were filled with soil collected from the top 20 cm profile from an area having apparently healthy plants and from patches with plant growth heterogeneity problem. Average soil weight of the 19-cm diameter pot was 4.6 kg. Five 100 cm^3 soil samples were collected from the two soils to assess initial population densities of *R. reniformis.* Two soil moisture regimes 19% and 10% (w/w) were maintained with deionized water. Three treatments, 1) 6 kg a.i./ha of carbofuran 3G, 2) 20 l/ha of dibromo-chloropropane (DBCP) and 3) untreated control (no chemical treatment) were tested in a factorial design. The chemicals were applied 5 cm deep with a thin layer of soil separating the chemicals and seed at sowing. Eight seeds of pigeonpea genotype ICPL 87 were sown in the pots on 29 June 1990, one day after the application of the chemicals. The pots were irrigated with deionized water on alternate days to maintain a predetermined weight.

Days to flowering, podding, maturity and plant height at several intervals were measured. Dry shoot, root and pod, and grain mass was assessed at final harvest. Population densities of *R. reniformis* in soil were estimated in 100 cm^3 soil samples collected at harvest.

Results and conclusions

In 1987, population densities of *R. reniformis* ranged from 1.8 to 4.2/cm^3 soil at sowing and comprised approximately 75% of the total number of plant parasitic nematodes. Other parasitic nematodes in the samples included *Tylenchorhynchus vulgaris* Upadhyay Swarup *et* Sethi, *Hoplolaimus indicus* Sher, *Helicotylenchus indicus* Siddiqi, *Tylenchus* sp., and *Aphelenchoides* sp. Average population densities of *R. reniformis* in untreated plots at 35 days after sowing were twice (P=0.05) the *R. reniformis* density in plots treated with carbofuran. At sowing, the average nematode density was 61% greater (P=0.05) in ICPL 366 plots treated with carbofuran 3G than in ICPL 366 control plots; however, at 90 days after sowing the nematode density was 38% lower (P=0.05) in the plots treated with carbofuran than in the untreated plots (Table I).

In the second field trials with ICPL 87 and ICPL 151, the population density of *R. reniformis* ranged from 0.6 to 1.1/cm^3 of soil and was 38% of the total density of plant-parasitic nematodes. Average density of *R. reniformis* was 0.9/cm^3 of soil in untreated plots and 1.1/cm^3 of soil from plots to be treated with carbofuran.

TABLE I - *Population densities of* Rotylenchulus reniformis *in carbofuran-treated and control plots.*

Pigeonpea genotype	Treatment	*R. reniformis* densities/100 cm^3 soil			
		O	35	90	210
		days after sowing			
ICPL 87	Control	250	325	1508	1705
	Carbofuran 3G 6 kg a.i./ha	298	158	1243	1620
LSD (P=0.05)		NS	103.8	NS	NS
ICPL 366	Control	183	400	967	1648
	Carbofuran 3G 6 kg a.i./ha	295	295	700	2086
LSD (P = 0.05)		111.8	NS	258.4	NS

Treatment differences in plant height in 1987/88 season were observed 45 days after sowing. The height of ICPL 87 in carbofuran treated plots was 33% greater than in the untreated plots at 58 days after sowing whereas the height of ICPL 366 in carbofuran treated plots was 50% greater than plant height in the untreated plots. These differences continued throughout the growing period but the differences decreased with time (Table II). The number of branches at harvest was 33% greater in carbofuran treated plots than in untreated plots (Table III). Dry biomass of ICPL 87 was 21% higher and pod yield was 22% higher in carbofuran treated plots than in the control plots. Pod yield was 1530 kg/ha in control plot and 1860 kg/ha in carbofuran treated plots. The effect of carbofuran on growth of ICPL 366 was similar. In the 1988/89 season, visual ratings of plant growth 45 days after sowing on a 1 to 5 scale (1=excellent growth; 5=poor growth) was 1.8 in carbofuran treated plots and 2.5 in untreated plots. Plant height of ICPL 87 in carbofuran treated plots was 11% and of ICPL 151 was 5% greater than plant height in the untreated plots. Grain yield for ICPL 87 was 1550 kg/ha and 1620 kg/ha for ICPL 151. Biomass and yield differences were not statistically significant.

In the greenhouse experiment, soil samples collected from areas with good plant growth and from plant growth heterogeneity patches initially had 1.6 and 8.5 *R. renifor-*

TABLE II - *Plant height of ICPL 87 and ICPL 366 in carbofuran treated and control plots (rainy season) 1987-88.*

Treatment	Plant height (cm) at			
	58	85	105	210
	days after sowing			
ICPL 87				
Control	51	94	109	111
Carbofuran 3G (6 kg a.i./ha)	68	108	119	120
LSD (P=0.05)	7.5	9.2	5.8	5.7
CV %	12.5	9.0	5.0	4.9
ICPL 366				
Control	44	91	127	155
Carbofuran 3G (6 kg a.i./ha)	66	113	142	162
LSD (P=0.05)	8.0	11.0	9.1	7.0
CV %	14.4	10.7	6.7	4.4

TABLE III - *Biomass of pigeonpea genotype ICPL 87 in carbofuran 3G treated and control plots 1987-88.*

Treatment	No. of primary branches	Fresh shoot mass (kg/ha)	Dry shoot mass (kg/ha)
Control	9	7987	3403
Carbofuran 3G (6 kg a.i./ha)	12	10897	4124
LSD (P=0.05)	0.9	1896.0	720.0
CV %	15.1	19.9	19.0

TABLE IV - *Effect of nematicides and soil moisture on population density of* Rotylenchulus reniformis [1].

Soil source	Carbofuran 3G		DBCP		Control		Mean
	19% soil moisture	10% soil moisture	19% soil moisture	10% soil moisture	19% soil moisture	10% soil moisture	
Good soil[2]	4735	9780	3263	539	8805	9915	6173
PGH soil[3]	11390	12974	3544	2190	9520	15280	9150
LSD (P=0.05)						1294.3	731.0
Mean	8063	11377	3404	1364	9163	12598	
LSD (P=0.05) (moisture level x nematicide)						1962.1	

[1] Carbofuran was applied at the rate of 6 kg a.i./ha and DBCP 20 l/ha; population density of *R. reniformis*/100 cm^3 soil was estimated.
[2] Good soil = soils collected from areas with apparently healthy plants.
[3] PGH soil = soils collected from patches of variable plant growth (plant growth heterogeneity problem).

mis/cm^3 of soil, respectively. At final harvest the nematode density was 48% greater in the soil from plant growth heterogeneity patches than that from good plant growth areas (Table IV). Carbofuran and DBCP treated soils had 11% and 78% lower densities (P=0.05) of *R. reniformis* than in the untreated soil. Soils with 10% moisture had a 23% greater nematode density (P=0.05) than in soil with 19% moisture probably due to reduced infectivity at higher moisture levels (Rebois, 1973). Interactions between soil type, nematicide and moisture levels were significant. Pots with 19% moisture had significantly lower densities of *R. reniformis* in carbofuran and control treatments. In DBCP treated soils, the nematode density was 2.5 times greater in pots with 19% moisture than in those with 10% moisture, particularly in soil from good plant growth areas.

Dry biomass, pod mass, and pod number were 10-28% greater in soil collected from good plant growth areas than in soil collected from patches with plant growth heterogeneity problem. DBCP and carbofuran applications resulted in significantly greater biomass production. Interactions between nematicide and moisture levels on plant biomass were significant. Dry shoot mass was 42% greater in soils with 19% moisture than with 10% moisture. DBCP inhibited seed germination and only 12 of 48 seedlings emerged. In plant growth heterogeneity problem soil, seedling emergence in DBCP-treated soil was twice that in soil from good growth areas. Plant growth in DBCP treated soils were much improved compared with that in nontreated soils.

The results indicate that *R. reniformis* is an important contributory factor in plant growth heterogeneity of pigeonpea. Nematicides provided protection to roots from nematode-caused damage and improved pigeonpea biomass. Healthy and plant growth heterogeneity patches are probable indicators of *R. reniformis* population densities. The population densities of *R. reniformis* at harvest were more than 10 nematodes/cm^3 of soil in all treatments and it is assumed that if the summer fallow (April-July) does not reduce the nematode population density below the threshold levels, the nematode infestation in the subsequent crop may result in extensive crop damage.

Further studies on the interaction between *R. reniformis* densities, soil moisture, and micronutrients are suggested. Application of nematicides at the time of sowing, crop rotations with rice and groundnut and soil solarization during the summer months in the soils with growth heterogeneity problem may be useful for crop improvement (Sharma and Nene, 1990).

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Accepted for publication on 16 March 1993.