Effects of crop rotations on *Pratylenchus zeae* and on yield of rice cultivar UPL Ri-5

Tin AUNG* and Jean-Claude PROT**

Plant Pathology Department, I.R.R.I., P.O. Box 933, 1099 Manila, Philippines.

SUMMARY

The effect of corn, cowpea, mungbean, rice, and sorghum on the population density of *Pratylenchus zeae* were tested in upland rice field conditions in the Philippines. The three cereal crops were very good host of the nematode. The two legumes crops were resistant to the parasite, but two successive croppings with these crops were necessary to reduce the nematode population density to a low level. The yield of rice grown after two crops of corn, cowpea, mungbean, or rice was correlated to the population densities of *P. zeae* detected at the end of the preceding crop. The yield of rice grown after cowpea and mungbean was significantly higher than that obtained after cereal crops. The yield of rice after rice was 37 % lower than the yield of rice after cowpea. Control of *P. zeae* by crop rotation using cowpea or mungbean is feasible. However, since the surviving nematodes multiply very rapidly on rice, rotating will protect only one rice crop in the case of a continuous cropping.

RÉSUMÉ

Effets de différentes rotations sur Pratylenchus zeae *et les rendements d'une culture de riz cv. UPL Ri-5*

Les effets de cultures de maïs, niébé, haricot mungo, riz et sorgho sur les densités de population de *Pratylenchus zeae* ont été testés au champ sur un site de culture de riz pluvial aux Philippines. Les trois céréales ont permis une importante multiplication de *P. zeae.* Les deux légumineuses sont apparues résistantes au nématode mais deux cultures successives de ces légumineuses ont été nécessaires pour réduire très fortement la densité de la population. Les rendements d'une culture de riz conduite après deux cultures de maïs, niébé, haricot mungo ou riz sont corrélés avec les densités de population de *P. zeae* détectées à la fin de la culture précédente. Les rendements en riz obtenus après niébé et haricot mungo sont significativement supérieurs à ceux obtenus après céréales. Le rendement en riz obtenu après un précédent riz est inférieur de 37 % à celui obtenu après un précédent niébé. Si le contrôle de *P. zeae* par culture de niébé et de haricot mungo est possible, il ne protège qu'une culture de riz car les nématodes survivants se reproduisent très rapidement sur riz.

Pratylenchus zeae Graham, 1951 is a pest of maize, tobacco, cotton, sweet corn, sugarcane, and rice (Fortuner, 1976). It is also a pest of rice in the USA, Brazil, Rhodesia, Ivory Coast, Cuba, Nigeria, India, and Panama (Ibañez, 1970; Reyes, 1970; Fortuner, 1976; Babatola, 1984). It is commonly associated with upland rice in the Philippines. Another member of the genus, *Pratylenchus indicus* Das, 1960, causes significant yield reductions (Prasad & Rao, 1978*b*; Prasad & Rao, 1983), and metabolic changes in rice (Prasad, Ramana & Rao, 1982). *P. indicus* can be controlled by crop rotations, with different crops such as barley, wheat and mung bean (Prasad & Rao 1978*a*). The primary objectives of this study was to determine, in field conditions, the effect of five crops, rice, corn, sorghum, mungbean, and cowpea, commonly associated to upland rice ecosystem in the Philippines, on a population of *P. zeae* and the effect of this nematode on the yield of a rice crop.

Materials and methods

The experiment was conducted on an upland rice field of the International Rice Research Institute (I.R.R.I.) experimental farm from April 25 1987 until December 5 1988. The field was naturally infested with *P. zeae.* Four other plant-parasitic nematodes, *Tylenchorhynchus annulatus Criconemella onoensis. Hemicycliophora penetrans, Helicotylenchus* sp., were occasionally detected on the field, but they were not taken into consideration in this study. Four different crop sequences were grown in 2 × 5 m plots, with five replications in a randomized complete-block design. The different crop sequences were : sorghum (*Sorghum vulgare* Pers.)-cowpea (*Vigna unguiculata* L., Walp.)-cowpea-rice (*Oryza sativa* L.), rice-mungbean (*Phaseolus mungo* L.)-mungbean-rice, corn (*Zea mays* L.)-corn-corn-rice, and rice-rice-rice-rice. The different varieties used were :

* *Current address : Agriculture Corporation, Applied Research Division, Gyogon, Rangoon, Burma.*
** *ORSTOM nematologist.*

Table 1

Effect of different crops on a population of *Pratylenchus zeae.*

Initial population N/dm³ of soil	*Consecutive crops*							
	*Number of nematodes/1 dm³ of soil + 1 g of roots**							
44 *a***	sorghum	1 833 *a*	cowpea	694 *a*	cowpea	6 *a*	rice	477 *a*
73 *a*	rice	3 130 *a*	mungbean	1 000 *ab*	mungbean	28 *a*	rice	1 210 *b*
70 *a*	corn	6 266 *b*	corn	2 060 *b*	corn	6 283 *b*	rice	2 772 *c*
72 *a*	rice	2 994 *a*	rice	2 063 *b*	rice	4 404 *b*	rice	2 748 *bc*

* Average of five replications.

** In a column, means followed by a common letter are not significantly different at the 5 % level by Duncan's new multiple range test.

sorghum CS101, cowpea TV × 2724-01F, mungbean Pag-asa 5, corn Supersweet, and rice UPL Ri-5. The plants were grown with the following row spacing and spacing within the row : sorghum 50 cm-25 cm, cowpea 25 cm-15 cm, mungbean 25 cm-5 cm, corn 50 cm-25 cm, and rice with a row spacing of 25 cm at a seeding rate of 50 kg/ha. No fertilizer was applied. The field was irrigated as necessary and kept free of weeds by hand weeding. The successive crops were seeded and harvested at the following dates : 1st crop 25 April 87-29 August 87, 2nd crop 8 October 87-11 February 88, 3rd crop 22 march 88-25 July 88, and 4th crop 4 august 88-5 December 88. The first crop was planted after a 9 months fallow. The aerial parts of the crops were always removed from the plots to avoid a green manure effect.

Nematodes densities in each plot, were assessed at the beginning of the experiment, and at harvest. At each sampling time, five 200 cm^3 soil samples and five root systems were collected at random from each plot. The soil samples were analyzed for nematodes by sieving (using a 45 µm pore sive) and Baermann funnel (48 h extraction time). For each root sample a subsample of 3 g of roots was macerated for 10 s in an electric blender, and then placed on a Baermann funnel for 48 h. The yield of the final rice crop was measured on 3 m^2 in the centre of each plot.

Results and discussion

The cereal crops tested in this experiment : corn, rice, and sorghum were good hosts for *P. zeae* (Table 1). They allowed high multiplication rates of the parasite when its initial population densities were low, and they maintained the levels of infestation when the initial population densities were high. On the other hand, the two legume crops (cowpea and mungbean) caused a decrease of the number of nematodes present in the soil. In this experiment, two successive crops of cowpea or mungbean were necessary to reduce drastically the nematode population density. During the evaluation of the nematode population, in the plots where cowpea and mungbean were grown, *P. zeae* was found mostly in the soil, and only a few individuals were observed in the roots. These observations seem indicate that cowpea and mungbean were resistant to *P. zeae* but that the nematode was capable to survive, in the soil, the duration of a crop.

The yields of the rice crop following the two legume crops were significantly higher than those obtained after corn and rice (Table 2). A difference of 37 % in yield was observed between rice after rice and rice after cowpea. As in this experiment, the aerial parts of the plants were removed from the plots, the differences in yield can not be explained by a green manure effect of the legume crops.

At sowing of the last rice crop, the population densities of *P. zeae* were significantly lower after the legume crops than after the cereals (Table 1). Moreover, when all the plots were considered individually the yield of the last rice crop was correlated with the population density

Table 2

Effect of different crop rotations on the yield of a final rice crop

Crop rotations	*Last rice crop yield kg/ha**
sorghum-cowpea-cowpea-rice	1 126 *a***
rice-mungbean-mungbean-rice	868 *b*
corn-corn-corn-rice	741 *c*
rice-rice-rice-rice	710 *c*

* Average of five replications.

** The yields followed by a common letter are not significantly different at the 5 % level by Duncan's new multiple range test.

of *P. zeae* detected just before sowing notwithstanding the variability observed (Fig. 1). However, a significant difference in yield was observed between rice grown after cowpea and rice grown after mungbean (Tab. 2) when at the same time, the populations of *P. zeae* detected after the two legume crops were not significantly different. This could indicate a direct effect of the preceding crop on the rice crop, or that due to the

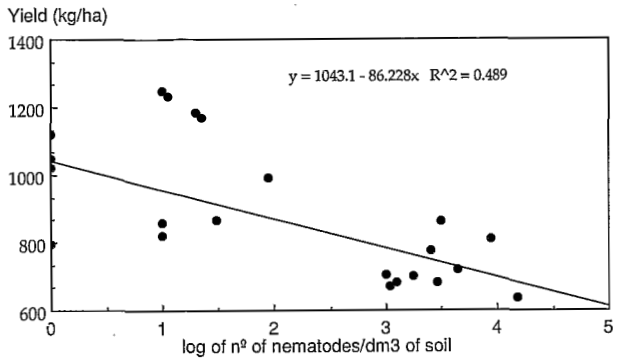

Fig. 1. Linear regression between the yield of an upland rice crop and the number of *Pratylenchus zeae* present a sowing time.

variability and the reduced number of replications the nematodes population densities detected after cowpea and after mungbean were not statistically different, while they may have had different effect on the rice crop. This last hypothesis is supported by the fact that inoculation with 30 *Pratylenchus indicus* per young seedling of the upland rice cultivar Bala, the yield was decreased by 34 % (Prasad & Rao, 1978*b*). The significant difference between the nematode population densities observed after rice following cowpea and after rice following mungbean could indicate that the population of *P. zeae* present after mungbean was able to reproduce more rapidly on rice and effect the yield more efficiently than the one left after cowpea.

Accepté pour publication le 9 janvier 1990.

This experiment indicates that :

— *P. zeae* may reduce the yield of an upland rice crop by 37 % in field conditions;

— corn, sorghum, and rice are good host plants for *P. zeae;*

— the nematode can be controlled by crop rotation with cowpea or mungbean. However in a continuous cropping, two crops of legumes are necessary to decrease the infestation to a low level. Moreover, this practice will most certainly protect only one rice crop as the multiplication rate of the nematode is very high on rice.

Références

Babatola, J. O. (1984). Rice nematode problems in Nigeria : their occurrence, distribution and pathogenesis. *Trop. Pest Manag.*, 30 : 256-265.

Fortuner, R. (1976). *Pratylenchus zeae.* C.I.H. Descr. Pl.-parasit. Nematodes, Set 6, No.77.

Ibañez, A. R. (1970). *Determinación de plantas hospederas del nemátodo* Pratylenchus zeae *Graham 1951, bajo condiciones de invernadero.* Thesis, Panamá Universidad, 33 p.

Prasad, J. S., Ramana, K. V., & Rao, Y. S. (1982). Metabolic changes in rice due to migratory endoparasitic root nematodes. *J. Res. Assam agric. Univ.*, 3 : 72-75.

Prasad, J. S. & Rao, Y. S. (1978*a*). Influence of crop rotations on the population densities of the root lesion nematode, *Pratylenchus indicus* in rice and rice soils. *Annals Zool. Écol. anim.*, 10 : 627-633.

Prasad, J. S. & Rao Y. S. (1978*b*). Potentiality of *Pratylenchus indicus* Das 1960, the root-lesion nematode as a new pest of upland rice. *Annals Zool. Écol. anim.*, 10 : 635-640.

Prasad, J. S. & Rao, Y. S. (1983). Influence of age of rice plant at the time of inoculation of *Pratylenchus indicus* Das on the multiplication of the nematode and yield of the host plant. *Acta œcol.*, 4 : 309-312.

Reyes, R. D. (1970). Determinación de la eficiencia de diferentes variedades de arroz de maiz, como hospederas de *Pratylenchus zeae.* In : *Progresso de Labores de Investigaciones Agropecuarias. Panama; Facultad de Agronomia, Panama Universidad :* 159-166.