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Major root-parasitic nematodes associated with irrigated rice in the Philippines(1)

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Summary – Two surveys were conducted in five regions representative of most of the irrigated rice ecosystems in the Philippines. Six genera of plant parasitic nematodes were detected : *Criconemella, Helicotylenchus, Hemicriconemoides, Hirschmanniella, Meloidogyne,* and *Tylenchorhynchus.* The prevalent species was *Hirschmanniella oryzae,* observed in high population densities in 90 % of the fields. *Meloidogyne graminicola* was detected in 26 % of the fields surveyed and in more than 50 % of the fields in two regions including Central Luzon, the major rice producing area in the country. *M. graminicola* was mostly observed in non-permanently flooded fields, light soil areas and where farmers are practising intermittent irrigation. *Hirschmanniella mucronata* was observed in low population densities in 10 % of the fields. The other nematode genera were detected in a few fields with very low population densities.

Résumé – ***Principaux nématodes parasites des racines du riz irrigué aux Philippines*** – Deux enquêtes ont été conduites dans cinq régions représentatives de la plupart des écosystèmes dans lesquels le riz irrigué est cultivé aux Philippines. Six genres de nématodes parasites des racines ont été détectés : *Criconemella, Helicotylenchus, Hemicriconemoides, Hirschmanniella, Meloidogyne,* and *Tylenchorhynchus. Hirschmanniella oryzae* est l'espèce la plus fréquente dont de fortes densités ont été observées dans 90 % des champs prospectés. *Meloidogyne graminicola* est observé dans 26 % des champs, et en particulier dans la principale région productrice de riz des Philippines, Central Luzon, où ce nématode est présent dans plus de 50 % des champs. *Meloidogyne graminicola* est principalement présent dans les rizières de zones à sol léger non inondées en permanence, ou dans des zones où les riziculteurs pratiquent une irrigation intermittente. De faibles densités d'*Hirschmanniella mucronata* ont été observées dans 10 % des champs. Les autres genres n'étaient présents qu'en très faible nombre d'individus et dans quelques rizières seulement.

Key-words : *Hirschmanniella oryzae,* irrigated-rice, *Meloidogyne graminicola,* nematodes, Philippines.

More than 9 million tones of rice are produced each year in the Philippines where rice is grown on 3.5 million hectares in three production environments, irrigated, rainfed lowland and rainfed upland (Anon., 1991). The irrigated area represents 58 % of the total hectarage cultivated in rice and contributes more than 70 % of the national production. Root-parasitic nematodes, especially rice-root nematodes, *Hirschmanniella* spp., and the rice-root-knot nematode, *Meloidogyne graminicola* Golden & Birchfield, 1965, are suspected to cause important yield losses to rice (Bridge *et al.,* 1990; Jairajpuri & Baqri, 1991). However, information on root-parasitic nematodes associated with irrigated rice in the Philippines is limited. *Hirschmanniella mucronata* (Das, 1960) and *Hirschmanniella oryzae* (Van Breda de Haan, 1902) have been recorded associated with rice roots in the country (Thorne, 1961; Sher, 1968). A previous survey indicated that eleven genera of root-parasitic nematodes, with *H. mucronata* being the prevalent species, were found associated with rice (Madamba *et al.,* 1981). More recently, *M. graminicola* was also reported from the Philippines (Bridge *et al.,* 1990). However, none of these authors specify in what type of production environment these nematodes were observed.

Two surveys were conducted in major irrigated rice growing areas of the Philippines. The first survey was conducted in 1989 in the province of Laguna to determine the effect of the stage of the crop on the detection of the prevalent nematodes associated with irrigated rice in this area. The second survey was conducted in 1991-92 over five regions representative of most of the irrigated rice ecosystems of the Philippines to assess the presence and the distribution of the major root-parasitic nematodes associated with irrigated rice in this country. Root-parasitic nematodes associated with upland rice in the Philippines were reported earlier (Villanueva *et al.,* 1992).

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Materials and methods

During the first survey, soil and root samples were collected from 84 farmers' fields (ten samples/field) at different stage of the rice crop, maximum tillering (23 fields), flowering (17 fields), and harvest (44 fields). Each sample was made of one hill and 1 dm^3 of rhizosphere soil. Each soil and root sample was processed separately. Nematodes were extracted from 200 cm^3 of soil and 3 g of root subsamples. Nematodes were extracted from soil by a combination of sieving (using a 45 μm aperture size) and incubation in Baermann funnels (48 h extraction time). Root samples were shredded for 10 s in a blender and then extracted for 48 h in Baermann funnels. Numbers of nematodes per 200 cm^3 of soil and 1 g of roots observed at different stage of the crop were respectively compared by ANOVA after transformation using the factor b of the Taylor's power function to normalize their distribution, with b = 1.668 and b = 1.777 for roots and soil, respectively.

A total of 174 farmers' fields, scattered over five areas were sampled during the second survey. Ten samples, each made of one hill and 1 dm^3 of rhizosphere soil, were collected per field from 27 fields in Northern Luzon, 43 fields in the Highlands, 47 fields in Central Luzon, 32 fields in Southern Luzon, and 25 fields in Mindanao. The provinces where samples were collected from each of the five areas surveyed are indicated in Figure 1. All samples were collected between maximum tillering and booting stages. They were processed separately. Nematodes were extracted from 200 cm^3 of soil and 3 g of root subsamples. Soil samples were processed as for the first survey. Nematodes were extracted from the roots using a mistifier (Seinhorst, 1950) where roots were left for 7 days. For each nematode species, the absolute frequency or percentage of fields where the species was detected, and the average absolute population density or number of specimens of the species per dm^3 of soil and g of roots (fresh weight) in fields where the species was observed were calculated.

Results

H. oryzae was detected in all fields in Laguna province during the first survey and at all stages of the rice crop (Table 1). Numbers of *H. oryzae* recovered from roots at maximum tillering and flowering were higher ($p < 0.05$) than at maturity. On the other hand, numbers of *H. oryzae* recovered from soil were higher ($P < 0.05$) at maturity than at maximum tillering. Low numbers of *H. mucronata* ($n < 2/200$ cm^3 of soil) and *Helicotylenchus* sp. ($n < 5/200$ cm^3 of soil) were observed in 25 and 22 fields, respectively. No other plant-parasitic nematode was detected.

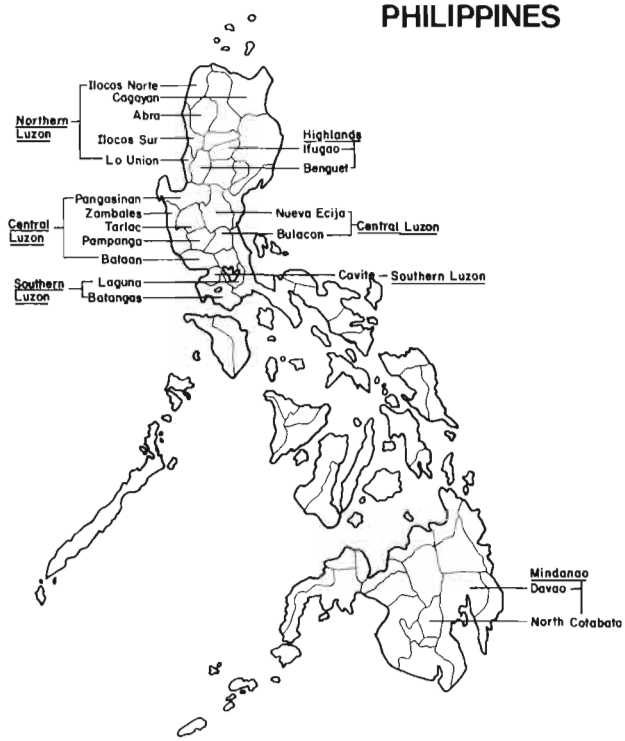

Fig. 1. *Regions and provinces surveyed.*

Table 1. *Average number of* Hirschmanniella oryzae *detected per g of root and 200 cm^3 of soil in 84 irrigated rice fields of the province of Laguna Philippines when samples were collected at different stages of the rice crop : maximum tillering (23 fields), flowering (17 fields) and maturity (44 fields).*

Stage of the rice crop	Number of fields	Average number of *Hirschmanniella oryzae* per	
		g of root	200 cm^3 of soil
Maximum tillering	23	57.7 a *	30 a
Flowering	17	34.3 a	61 ab
Maturity	44	14.5 b	158 b

* In a column, numbers followed by the same letter were not significantly different at 5 % level after an ANOVA.

Three nematodes, *H. mucronata, H. oryzae,* and *M. graminicola* were detected within the rice plant roots as well as within the rhizosphere soil. *H. oryzae* was the prevalent species (Table 2). It was observed in 90 % of all the fields surveyed and present in high population densities in 100 % of the fields of four regions surveyed : Northern Luzon, Central Luzon, Southern Luzon, and Mindanao. It was not detected in 16 fields all located in the province of Benguet in the Highlands. Low pop-

ulation densities of *H. mucronata* were observed in two regions, Central Luzon and Southern Luzon. This species was not detected in the other areas surveyed. *M. graminicola* was observed in 51 % of the fields in Central Luzon and 62 % of the fields in Southern Luzon provinces mostly in Batangas province. Very low populations of four other genera were detected in a few fields only. *Criconemella* was present in 12 fields in the province of Benguet. A few individuals of *Helicotylenchus* were observed in 18 % of the fields in three regions. Only three *Hemicriconemoides* were found in one field located in Northern Luzon. *Tylenchorhynchus* was present in 25 % of the fields but in populations that have never exceeded 10 per dm^3 of soil.

Table 2. *Average absolute population densities (D) per dm^3 of soil and g of root and absolute frequency (F) of occurence (% of fields where the nematode has been detected) of root-parasitic nematodes associated with irrigated rice in the Philippines.*

Nematode Species and genera	Area surveyed											
	Northern Luzon		Mountain Provinces		Central Luzon		Suthern Tagalog		Southern Mindanao		All Fields	
	D	F	D	F	D	F	D	F	D	F	D	F
Hirschmanniella oryzae												
Soil	65	100	3	34	20	96	–	–	25	96	30	78
Roots	74	100	104	63	45	100	75	100	39	100	65	90
Hirschmanniella mucronata												
Soil	0	0	0	0	50	34	–	–	0	0	50	11
Roots	0	0	0	0	0.2	15	4.5	31	0	0	2.7	10
Meloidogyne graminicola												
Soil	1	4	0	0	12	30	–	–	1	4	11	11
Roots	0	0	0	0	11	51	572	62	0.2	4	261	26
Criconemella												
Soil	0	0	13	28	0	0	–	–	0	0	13	8
Helicotylenchus												
Soil	1	15	2	7	4	40	–	–	0	0	3	18
Hemicriconemoides												
Soil	1	4	0	0	0	0	–	–	0	0	1	1
Tylenchorhynchus												
Soil	1	4	0	0	2	68	–	–	4	12	2	25

Discussion

The first survey indicated that *H. oryzae* was the major root-parasitic nematode associated with irrigated rice in Laguna province. It also indicated that the stage of the crop may significantly influence the distribution of *H. oryzae* between roots and soil and therefore evaluations of its soil and root population densities. The results obtained confirm previous observation that the nematode starts to exit the roots at flowering (Merny, 1972).

The nematode populations associated with irrigated rice in the Philippines appear to be similar to those observed in deep-water rice in Vietnam (Cuc & Prot, 1992) and, with the exception of the relatively high frequency of occurrence of *M. graminicola,* to nematode populations observed in other irrigated rice areas in the world (Bridge *et al.,* 1990). With six genera detected, it appeared to be less diversified than under upland rice conditions where eleven genera were observed (Villanueva *et al.,* 1993). Moreover, among the six genera observed four *(Criconemella, Helicotylenchus, Hemicriconemoides,* and *Tylenchorhynchus)* were present, in very low population densities, in a few fields only. These nematodes do not seem to be well adapted to the flooded environment. With the exception of the fields where *M. graminicola* was present the nematode population was almost a pure population of *H. oryzae.* This latter species is pathogenic to rice (Fortuner, 1974, 1977; Babatola & Bridge, 1979) and able to cause yield loss under field conditions (Khuong, 1987; Prot *et al.,* 1992). *M. graminicola* was observed mostly in irrigated rice fields which are not permanently flooded because of the light texture of the soil (Batangas province) or because farmers are applying intermittent irrigation (Central Luzon). *M. graminicola* can cause economic yield loss under rainfed conditions (Bridge *et al.,* 1990; Jairajpuri & Baq-

ri, 1991), but does not usually cause significant yield loss under permanent flooding (Bridge & Page, 1982; Kinh *et al.*, 1982). However in some areas, due to increasing scarcity and cost of water, rice farmers are progressively shifting from permanent flooding to intermittent irrigation. Under these conditions similar to those prevailing in rainfed rice ecosystems the rice root-knot nematode may cause severe damage.

These surveys have indicated that *H. oryzae* is the prevalent and almost certainly the most economically important plant-parasitic nematode associated with irrigated rice in the Philippines. *M. graminicola* is present in a large proportion of the irrigated rice fields in two major rice producing areas, Central Luzon and Southern Luzon, and is a potentially important pest for this crop especially if intermittent irrigation is developed to conserve water resources.

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