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The Distribution, Incidence, Natural Reservoir Hosts and Insect Vectors of Rice Yellow Mottle Virus (RYMV), Genus Sobemovirus in Northern Nigeria

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Summary

Field visits and surveys were carried out in Niger, Kano, Bauchi and Gombe states of northern Nigeria at tillering and panicle initiation stages of rice in the years 2000 and 2001 to determine the distribution, host plants and occurrence of insect vectors of Rice Yellow Mottle Virus (RYMV). Farmers' cultural practices and field situations were also assessed. Visual inspection based on the Standard Evaluation Scale (SES) and enzyme linked immunosorbent assay (ELISA) methods were used in detecting RYMV infection. RYMV presence was established in all the four states surveyed. The virus was widely distributed in Kano state. The insect vectors of RYMV, such as Trichispa sericea *Guerin,* Chaetocnema pulla *Chapius,* Chnootriba similis *Thunberg and* Conocephalus longipennis *de Haan, were found in the 4 states. Outbreaks of* T. sericea *occurred in many farmers' fields in Kano state. RYMV was detected more frequently on* Oryza sativa *L. than on* O. longistaminata *Chev. & Roehr and* Echinochloa pyramidalis *Hitche and Chase. Virus infection was not established in any other grass species, sedges and broadleaf plants tested. It is evident therefore, that RYMV has a narrow host range and is found more frequently in the* Oryzeae*.*

Résumé

Distribution, incidence, hôtes des réservoirs naturels et insectes vecteurs du virus de la panachure jaune du riz (RYMV), genre sobemovirus dans le Nord du Nigeria

En 2000 et 2001, des visites de terrain et des enquêtes ont été réalisées dans les états du Niger, de Kano, de Bauchi et de Gombe dans le Nord du Nigeria pendant les stades du tallage et de l'initiation paniculaire du riz en vue de déterminer la distribution, les plantes hôtes et la fréquence des insectes vecteurs du virus de la panachure jaune du riz (RYMV). Les pratiques culturales et l'état des champs des paysans ont été également évalués. Une inspection visuelle basée sur l'échelle d'évaluation standard (SES) et les méthodes ELISA ont été utilisées pour détecter l'infection par le virus de la panachure jaune. La présence du RYMV *a été établie dans les quatre états étudiés, avec une plus large distribution dans l'état de Kano. Les insectes vecteurs du RYMV tels que* Trichispa sericea *Guerin,* Chaetocnema pulla *Chapius,* Chnootriba similis *Thunberg et* Conocephalus longipennis *de Haan étaient présents dans les 4 états. Des pullulations de* T. sericea *se sont produites dans beaucoup de champs paysans dans l'état de Kano. Il a été constaté que le* RYMV *était plus fréquent sur* Oryza sativa *L. que sur* O. longistaminata *Chev. & Roehr et* Echinochloa pyramidalis *Hitche et Chase. L'infection par le virus n'a été établie chez aucune autre espèce herbacée, de laîche et de plantes latifoliées testées. Il est donc évident que le RYMV possède une gamme d'hôtes étroite et se rencontre plus fréquemment chez* Oryzeae*.*

Introduction

Rice yellow mottle virus (RYMV) was first reported in West Africa in 1975 (16). It has been reported to occur in almost all the West African countries where rice is grown (3, 4). RYMV was first noticed in Nigeria over 20 years ago (10, 18, 19).

RYMV belongs to the sobemovirus group (9). It is transmitted through mechanical contacts and inoculations (1, 5). Chrysomelid and phytophagous coccinelid beetles and insects also transmit it as well as insects with chewing and biting mouthparts such as the long-horned grasshoppers (*Conocephalus* spp.) (1, 2, 5, 6).

The disease is characterized mostly by mottling and yellowing of the leaves of infected plants. Orange coloration is also noticed in some rice varieties. The

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intensity of symptom expression depends on the genotype (20). Infected plants also exhibit delayed flowering and poorly exerted panicles bearing sterile and discolored spikelets (20). Die off may occur in very susceptible rice varieties. Yield loss ranges from 25 to 100% depending on the date and time of infection as well as the genotype (18).

RYMV is indigenous to Africa (3) and came to limelight with the introduction of exotic rice varieties from south-east Asia coupled with the intensification of cropping practices without dry season gaps (21). This situation as well as inadequate testing of exotic rice varieties before introduction led to the disruption of the apparent equilibrium established between the local rice host and RYMV (3, 4).

There have been reports of weeds serving as reservoir hosts of RYMV in some countries in Africa (4, 5, 8, 13, 15). Similar studies have not previously been carried out in Nigeria. However, there is ample evidence that the incidence of the disease is increasing in the country. Thus, it is suspected that there might be some natural reservoir hosts and insect vectors of the virus in the rice ecological system in Nigeria.

In view of the importance and increasing incidence of RYMV in Nigeria (3), it has become necessary to establish the status of RYMV and the occurrence of its insect vectors on farmers' fields in the country. Additional goals of this study were to detect the natural reservoir hosts on which the virus subsists. Furthermore, some of the cultural practices of the farmers, which are likely to predispose rice to RYMV infection and insect infestation, were assessed.

Materials and methods

Field visits, surveys and samplings

Four states (Niger, Kano, Bauchi and Gombe) in northern Nigeria were surveyed in the years 2000 and 2001 for the distribution of RYMV and its reservoir hosts. The occurrence of the insect vectors of the virus was also investigated. The visits and surveys were carried out at tillering and panicle initiation stages between August and November each year.

In each state 10 farmers' fields were examined for the presence of RYMV. Rice and weed species with and without RYMV-like symptoms were randomly sampled on the bunds, edges of the fields, within the rice fields and in the vicinity of the RYMV-infected plants. The visual diagnostic symptoms of RYMV are yellowing and mottling of leaves as well as severe stunting in some rice genotypes. In other genotypes orange coloration is noticed. The sampling of the insect vectors of RYMV was carried out with a sweep net and aspirators on the fields surveyed. Ten sweeps were made diagonally across each field. The insects caught in the net were collected in sample bottles closed by a perforated cover with a closable opening. Thereafter, the insects known to be vectors of RYMV (1, 5) were identified and recorded. The non-vectors of RYMV were discarded. In each state surveyed, the types of rice varieties commonly cultivated and farmers cultural practices were noted.

Visual assessment method

The Standard Evaluation System (SES) (11) on a scale of 1-9 was used. Scale 1 means no visible symptoms while scale 9 denotes leaves turn yellow or orange, stunted and death of plants. The presence of RYMV in the plants was confirmed by Enzyme Linked Immunosorbent Assay (ELISA) method (7, 14).

Serological method

Antigen Coated Plate (ACP)-ELISA (14) was performed as followed: ELISA plates were coated with 1:10 (W/V) of rice samples previously ground in phosphate buffered saline (PBS)-Tween (T) containing 2% polyvinyl pyrollidone (PVP) and kept overnight in the refrigerator at 4 °C. The plates were washed with PBS-T. Blocking was done with 5% skimmed milk solution dissolved in PBS-T for 30 minutes at 37 °C. The excess milk was discarded without washing with PBS-T and 100 µl/well of homologous antisera (dilution 1:1000) in PBS-T was applied. The plates were incubated for 2 hr at 37 °C. After washing with PBS-T, 100 µl/well of goat-anti rabbit alkaline phosphatase conjugate (dilution 1:10,000) in PBS-T-PVP containing 0.2% BSA was applied and the plate incubated for 2 hr at 37 °C. After another round of washing, 100 µl/well of 1 mg/ml (p-Nitrophenyl phosphate) substrate diluted in 10% diethanolamine, pH 9.8 was applied and the plate was incubated for 1 hr at 37 °C. The absorbance at 405 nm was read using an automated Dynex MRX ELISA reader after 1 hr. Values were considered as positive when the reading was equal to or greater than twice the mean absorbance of the virus-free control sample.

Results and discussion

The results of the distribution of RYMV in four states of northern Nigeria are presented in Table 1.

Kano State had the highest incidence of RYMV. The disease was detected in six locations in Kano state, three in Niger state and one each in Bauchi and Gombe states. Some farms in Kano and Gombe states were destroyed by RYMV. The commonly cultivated rice varieties in these states included FARO 44 (Sipi), FARO 29 (BG90-2), FARO 35 (ITA 212), WITA 4, which are known to be highly susceptible to RYMV (Table 1). It is estimated that 80% of the 160 ha of land at Kadawa irrigation scheme in Kano state is set aside for rice cultivation alone. FARO 44 (Sipi), FARO 35 and WITA 4 are grown on a large scale at this irrigation scheme where RYMV incidence was found to be high.

In Kano state farmers grow rice during the rainy season and wheat under irrigation during the dry season between November and January. In Niger state, rainfed and dry season rice cropping is practiced in some areas. At Dadin Kowa in Gombe state, the irrigation channel had broken down during the survey period and farmers had to rely mainly on rainfall for rice cultivation. This situation caused some farmers, particularly those that planted rice late after the onsets of rains, to loose their rice crop to drought. Here, RYMV

Table 1

Incidence of Rice Yellow Mottle Virus (RYMV) and rice varieties commonly grown by farmers in some northern states of Nigeria

Rice varieties	[a]RYMV Susceptibility level	States	Locations	% RYMV Incidence in the field
Sipi (FARO 44), Ex-china, FARO 29 (BG90-2)	S	Bauchi	-Bauchi town peri-urban, Gombe road, Bauchi	25
FARO 29 (BG90-2), FARO 44 (Sipi), FARO 35 (ITA 212), ITA 306, WITA4	S	Kano	-Kadawa irrigation scheme, Hadejia-Ja'amare River Basin Development Authority, Garun Malan	>75
FARO 44 (Sipi), FARO 35 (ITA 212), FARO 29 (BG90-2), WITA 4	S	Kano	-Kura irrigation scheme, Hadejia Jama'are River Basin Development Authority, Garun Malan	>75
FARO 29 (BA90-2), FARO 35 (ITA 212), FARO 44 (Sipi), WITA 4	S	Kano	-Watari irrigation scheme, Bichi Road, Bagwai	>75
FARO 44 (Sipi), FARO 35 (ITA 212)	S	Kano	-Rano Road, Bunkure	50
FARO 44 (Sipi), FARO 29 (BG90-2)	S	Kano	-Zawaciki Village, Kumbosto	25
FARO 44 (Sipi)	S	Kano	-Koya, Madobi	25
FARO 29 (BG90-2), FARO 44 (Sipi), ITA 306,	S	Gombe	-Upper Benue River Basin Development Authority irrigation rice fields, Dadin Kowa	>75
FARO 29 (BG90-2), BOUAKE 189, WITA 4, WITA 8, WITA 9, FARO 29 (BG 90-2), FARO 35 (ITA 212)	S	Niger	-Edozhigi	50
FARO 29 (BG90-2), BOUAKE 189, WITA 4, WITA 8, WITA 9, FARO 35 (ITA 212)	S	Niger	-Wuya	25
FARO 29 (BG90-2), FARO 35 (ITA 212)	S	Niger	-Doko	25

[a]S = Susceptible on a scale of 9 (IRRI 1996)

and its insect vectors were found in abundance in the drought stricken fields. In all the states cattle grazed on the stumps, ratoons and volunteer rice after the rice harvest. While the cows were feeding they dropped dung in the fields. Cow dung has been implicated in the transmission of RYMV in Madagascar (17). Some farmers abandoned the RYMV-infected portions of their rice fields and did not always destroy rice plants. These practices contribute to additional sources of RYMV inoculum in the field. Farmers in these states are known to apply fertilizers in their farms. In most cases however, they do not follow the recommended dosage. The sickle used by these farmers to harvest rice is another source of contamination. This source of infection by sickle has been established (22). RYMV-infected seedlings from the nursery are another potential source of inoculum from which RYMV is introduced into the field (17).

These observations are in line with the earlier report by Thresh (21) that the introduction of exotic rice varieties from Southeast Asia coupled with intensification of cropping practices through irrigation facilities has brought RYMV to the limelight in Africa. In this study RYMV infection was detected where exotic rice varieties were grown on a large scale under irrigation. Due to the high incidence of RYMV on FARO 35 (ITA 212) at the Kadawa irrigation scheme, farmers were advised to replace this variety with RYMV-tolerant ones. However, it was found that where the RYMV incidence was low the susceptibility of the varieties to RYMV was moderate. On the other hand where the incidence of RYMV was rated as high the susceptibility of the varieties to the virus disease was also high. This suggests that these susceptible varieties should be withdrawn and replaced with tolerant varieties in areas where RYMV incidence is rated as very high.

The insect vectors of RYMV identified in the states during the survey are presented in table 2.

Trichispa sericea Guerin, *Chaetocnema pulla* Chapius, *Chnootriba similis* Thunberg and *Conocephalus longipennis* de Haan, which are vectors of RYMV (1, 5) were found in the four states. However, serious outbreaks of *T. sericea* accompanied by rice damage were found only in Kano state, and particularly in Wasai, Minjibir, Koya and Dawakin Tofa areas. *C. pulla* was found in large numbers at Dadin Kowa in Gombe state.

The rice and weed species sampled are presented in table 3.

The ELISA tests showed that samples collected on rice and *Echinochloa pyramidalis* Lam. Hitche and

Table 2

The occurrence of insect vectors of Rice Yellow Mottle Virus (RYMV) in four northern states of Nigeria

States	Caught insect vectors of RYMV in each state
Bauchi	*Conocephalus longipennis* de Haan, *Chaetocnema pulla* Chapius.
Gombe	*Chaetocnema pulla* Chapius, *Conocephalus longipennis* de Haan, *Chnootriba similis* Thunberg.
Kano	*Trichispa sericea* Guerin, *Chaetocnema pulla* Chapius, *Conocephalus longipennis* de Haan, *Chnootriba similis* Thunberg.
Niger	*Chaetocnema pulla* Chapius, *Conocephalus longipennis* de Haan, *Chnootriba similis* Thunberg, *Trichispa sericea* Guerin.

Chase were infected naturally in the field. However, RYMV was detected more frequently in *Oryza sativa* L. (rice) than in *O. longistaminata* Hitche and Roehr and *E. pyramidalis* (weed). RYMV was not detected in any other plant species sampled.

The results from this investigation have established that RYMV is present in northern Nigeria and is widely distributed in Kano state. Its incidence is also increasing due to intensification of rice cropping and with the introduction of exotic rice varieties. The principal insect vectors of RYMV are found in these states where RYMV infection has been detected. It is possible that the cropping practices, the presence of mobile insect vectors and other factors enumerated above have brought the RYMV to the limelight in northern Nigeria. This study confirms that the host range of RYMV is narrow and restricted mostly in the family graminae.

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Table 3

Field-collected rice and weed species and their RYMV status as determined by enzyme-linked immunosorbent assay (ELISA)

Plant samples	Detection of RYMV infection by ELISA (A405 nm)
Grases	
Oryza sativa L.	0.4 (++)
O. longistaminata Chev et Roehr	0.2 (+)
Leersia hexandra Sw.	0.1 (-)
Imperata cylindrical L.	0.1 (-)
Echinochloa pyramidalis L.	0.2 (+)
Panicum maximum L.	0.1 (-)
Panicum spp	0.1 (-)
Digitaria debilis Desf. Wild.	0.1 (-)
D. horizontalis L.	0.1 (-)
Eleusine indica L.	0.1 (-)
Leptochloa caerulensens Steud	0.1 (-)
Sacciolepsis africana C. E. Hubbard	0.1 (-)
Zea mays L.	0.1 (-)
Saccharum officianarum L.	0.1 (-)
Triticum aestivum L.	0.1 (-)
Sedges	
Cyperus difformis L.	0.1 (-)
C. esculentus L.	0.1 (-)
C. incompressus C-B.	0.1 (-)
Scripus jacobi C.E.C. Fischer	0.1 (-)
Fimbrystilus spp	0.1 (-)
Broad leaves	
Ludwigia spp	0.1 (-)
Sphenoclea zeylanica Gaert.	0.1 (-)
Nymphaea lotus L.	0.1 (-)
Lindernia diffussa (L.) Wett	0.1 (-)
Ipomoea aquatica Forsk	0.1 (-)
Marsilea crenata (L.)	0.1 (-)

++ = Frequent detection of RYMV
\+ = Occasional detection of RYMV
\- = Negative detection of RYMV

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