INCIDENCE AND SEVERITY OF RICE DISEASES IN SIX PROVINCES OF PAPUA NEW

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ABSTRACT

A survey was conducted in April 2005 in nine rice growing districts covering six provinces of Papua New Guinea to determine the prevalence and status of different diseases. Eleven diseases with varying severity levels were observed with highest number of diseases in the Morobe Province followed by Eastern Highlands and East Sepik. Brown spot and sheath rot, the two seed borne diseases were consistently present in all the rice growing areas with moderate to high level of severity. Tai Chung Sen 10 (TCS 10) was the predominant rice variety grown by the farmers.

Key words: Rice, survey, disease severity, brown spot, sheath rot

INTRODUCTION

In recent years, there has been an increasing interest throughout Papua New Guinea (PNG) in growing rice as a subsistence crop. Rice crop is susceptible to a number diseases and pests, and more than 80 rice diseases have been identified throughout the rice growing countries of the world (Ou 1985).

In PNG, several diseases associated with rice have been reported (Shaw 1985; Tomlinson 1984). More recently, a number of diseases were observed on upland rice at the Agriculture farm of the PNG University of Technology, Lae and the Clean Water area in the Markham district of Morobe Province (Akanda 2004) including sheath blotch which was not reported earlier (Akanda *et al.* 2003).

A number of major rice diseases are seed borne, and with the increase in rice cultivation, it is inevitable that these diseases are likely to spread across the country affecting rice yield and quality. To-date no systematic study has been conducted to establish the prevalence and severity of rice diseases in the major rice growing provinces of PNG. Therefore, a survey was undertaken to record the incidence and severity of various rice diseases in six rice growing provinces with the view to develop appropriate strategies for rice disease management in PNG.

MATERIALS AND METHODS

General

The survey was conducted in early April 2005 in six provinces, namely Central, Morobe, East New Britain (ENB) and East Sepik in the lowlands and Eastern Highland and Simbu in the highlands. The districts and the locations visited are presented in Table 1.

Table 1: Provinces, districts and locations of the survey

Province	District	Location
Central	National Capital	Pacific Adventist University
East New Britain	Kokopo	OISCA Institute
East Sepik	Angoram, Maprik Wewak	Gavian Villages 1 and 2 Bainik area, Kimbuga Village Nungunje Village, Brandi Secondary School
Eastern Highlands	Goroka	Sipiga and Fimito Villages, Bihute Corrective Institutes, Kabiufa Secondary School
Morobe	Markham Lae	Markham High School, Munum Farm NARI and ROC - Bubia
Simbu	Kerowagi	Kondiu Secondary School, Koronigle Area

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On-farm observations

The following observations were made during the surveys: (i) the rice farming systems i.e. upland rain-fed or irrigated paddy field, (ii) types of varieties cultivated (iii) the growth stage of rice plants, (iii) types of diseases present on rice, (iv) the incidence of these diseases, and (v) a general judgment on the soil type of rice gardens.

Assessment of disease type and incidence

Most rice diseases have characteristic symptoms (Ou 1985; Agarwal *et al.* 1989; Webster & Gunnell 1992) and the types of diseases present on rice were identified using these references. Plant samples for diseases with doubtful symptoms were collected and brought to the pathology laboratory of the PNG University of Technology for further investigation. In the laboratory, the samples were surface-sterilized with 0.5% sodium hypochlorite and sequentially purified on artificial growth media, including potato dextrose agar (PDA) and water agar (WA). Some of these samples were placed in humid chambers of petri dishes containing moist filter papers. Growth structures of pathogens from these treatments were then observed under a microscope to confirm the disease. The disease incidence and severity was recorded as low, moderate or severe using the Standard Evaluation Systems (SES) of International Rice research Institute (IRRI 2002) and judgment based on the extent of the crop area affected.

RESULTS

General on-farm observations

The sizes of rice farms visited averaged around 0.3 ha with an exception of rice fields at Pacific Adventist University (PAU), which were over 1 ha. Both upland rain-fed and irrigated paddy farming systems are practiced with the former being the most common. Most fields visited were with rice at reproductive stage (panicle initiation, heading, early or late ripening, maturing) with a few at vegetative stage (seedling or active tillering). The rice variety Tai Chung Sen -10 (TCS 10) was observed as dominant in the coastal provinces, while Gold Mountain, a variety brought in from China in 2000 was commonly grown in the two highlands provinces visited. Other varieties were also recorded in some farms and these include: IR 42, IR 64, IR 19, IR 68, MC Apo, PR 21, PR 21 (PAU, Kabiufa or Bainik); IR 10 and IR 15 (Koronigle); Finsch white (Kimbuga), and NR1, NR9, NR15, and NR16 (National Agricultural Research Institute- NARI, Bubia and Markham High School).

The Republic of China Mission (ROC) distributes large quantities of TCS 10 seeds to the farmers in visited provinces and that might be the reason for its dominance. Recently released four NARI varieties are of good yielding and adaptability characteristics, but the seeds of these varieties are not yet produced and/or made available in large quantities to the farmers, except in the close proximity of NARI in the Morobe Province.

Assessment of disease type, distribution and severity

The survey revealed the occurrence of 11 different diseases in the survey areas. The type of diseases, their distributions, and the severity are presented in Table 2 and Figure 1. In three locations; PAU, Sipiga and Kondiu Secondary School gardens, either virus or blast-like symptoms were observed. The blast-like samples were cultured on artificial media and found containing isolates of a pathogen that causes the brown spot disease. The observed symptoms may have been severe cases of brown spot disease. Virus-like symptoms were observed in Kondiu Secondary School. Known viral insect vectors, such as green leafhoppers (*Nephotettix* spp.) and white-backed plant hoppers (*Sogatella* sp.) were seen on symptomatic plants. Leaf samples with virus-like symptoms were collected and are being maintained in silica gels for further test using molecular techniques.

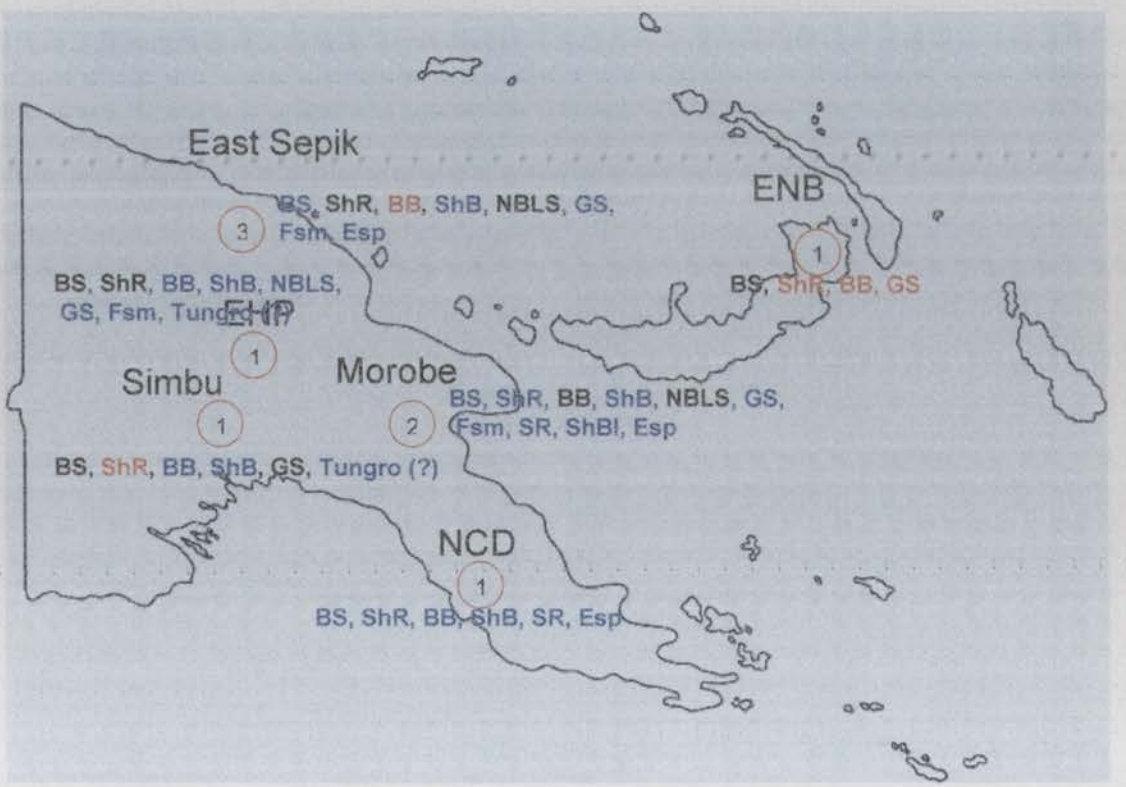
The number, incidence, and severity of the diseases also differ in different rice growing areas (Table 2, Fig 1). The maximum numbers of diseases (10) were observed in Morobe Province followed by Eastern Highlands and East Sepik provinces with eight diseases in each. Even though there was higher number of diseases in Morobe Province, most of the diseases were of low severity except for bacterial blight and narrow brown leaf spot with moderate severity. There were eight diseases in the Eastern Highlands Province; however, all of these were of low severity level. Similar severity level was also observed in case of Central Province with six diseases. In the Kerowagi district in Simbu Province, sheath rot was severe, brown spot and grain spot were moderate, whereas, bacterial blight, sheath blight, and tungro (?) were of low severity level. In East Sepik, bacterial blight was severe, and narrow brown leaf spot and grain spot were moderate;

Table 2. Severity[a] of rice diseases in six provinces of PNG

Disease	Provinces					
	Central	East New Britain	East Sepik	Eastern Highland	Morobe	Simbu
Brown Spot	L	M-S	L-M	L-S	L-M	L
Sheath rot	L	S	L-S	L-S	L	S
Sheath blight	L	-	L	L	L-M	L
Bacterial blight	L	S	S	L	L-S	L
Stem rot	L	-	-	-	L	-
Eye spot	L	-	L	-	L	-
Grain spotting	-	S	L-S	L-M	L-M	M
Narrow brown leaf spot	-	-	L-S	L	L-S	-
False smut	-	-	L	L	L	-
Sheath blotch	-	-	-	-	L	-
Viral-like symptoms	-	-	-	L	-	L

Severity: L = Low, M = Moderate and S = Severe

Fig 1: Map showing the occurrence of different diseases and their severities in six provinces of Papua New Guinea



Number within the circle is the number of districts surveyed in the Province. Disease Severity: Blue= Low, Red= Severe and Black= Moderate. Abbreviations: BS- Brown spot, ShR- Sheath rot, ShB- Sheath blight, NBLS- Narrow brown leaf spot, GS- grain spot, Fsm- False smut, ShBl- Sheath blotch, BB- Bacterial blight, SR- Stem rot, Esp- Eye spot.

and the rest five diseases were of low severity. Only four different diseases were observed in rice fields at the Organization for Industrial, Spiritual and Cultural Advancement (OISCA) Institute in East New Britain; but, all of these diseases were severe except for brown spot that was moderate. The result also revealed that brown spot and sheath rot were consistently present in all the six rice-growing areas with low to high severity. The grain spot was present in all the provinces except in the Central Province.

DISCUSSIONS

Nine rice-growing districts across six different provinces were surveyed for the presence of different diseases. A total of 11 diseases with varying degrees of severity were observed. The number of diseases recorded in Morobe Province was higher than any other provinces. The areas surveyed in the Morobe Province included both upland rain-fed and irrigated (NARI and ROC) rice fields, and this might be a probable reason for the prevalence of higher number of diseases.

At OISCA in East New Britain, four diseases were found with high severity. Continuous cultivation of rice in this particular area over a long period mostly as upland rain-fed condition might have contributed to the build up of the inocula of these diseases resulting in severe infection. Akanda (2005) reported a similar finding in the Morobe Province.

Grain spotting caused by many pathogens, including brown spot and sheath rot fungi, is on the increase across all the locations and these seed borne pathogens can spread easily when the infected seeds are planted.

Brown spot caused by *Drechslera oryzae* and sheath rot caused by *Sarocladium oryzae* were consistently present at all the sites surveyed with low to high level of severity (Table 2). Brown spot is also called a 'poor man's disease' as the severity increases with low soil fertility level, especially the deficiency of potassium and nitrogen (Havlin *et al* 1999; Miah & Shahjahan 1987; Misawa 1955). In PNG, there is relatively little information available on nutrient deficiencies on food crops (Hartemink & Bourke 2000). Agricultural land-use is with varying intensities (Saunders 1993) and generally deficiencies in nitrogen (N) and potassium (K) are common in many parts of the country (Hartemink & Bourke 2000). Vance *et al.* (1983) reported a deficiency in sulfur (S) on rice grown on alluvial soils. A recent survey revealed low N, Phosphorus (P) and K in soils of some rice growing areas in PNG (Anon. 2002). Rice in PNG is mostly grown under upland rain-fed condition without any fertilizer application. Continuous rice cultivation without fertilizer replenishment accompanied by leaching of nitrogen due to high rainfall makes soil factors highly conducive for the severe brown spot development. The brown spot is further aggravated by the water stress at any growth stage of the rice plant, particularly during the flowering to ripening stage may lead to severe grain spotting. Brown spot infection reduces the photosynthetic area that in turn affects grain filling and grain discoloration. During milling, the infected grains are broken and produce black and discolored lower quality rice. Brown spot in severe cases could be extremely devastating as was responsible for Bengal famine in 1943 amounting to a loss of 90% (Ghose *et al.* 1960; Agrios 1997). Planting infected seeds often results in seedling blight diseases and/or germination failures.

Sheath rot is also a seed borne disease caused by *Sarocladium oryzae*, which is a weak pathogen. The disease is aggravated when plants are infected and weakened by insects, like stem borer attack and infections by diseases, like tungro virus and stem rot, and water stress, particularly at the ripening stage (Miah & Shahjahan 1987; Ou 1985). Rain-fed upland rice production systems in most regions of PNG, water stress at the ripening stage is more of a common phenomenon predisposing the plants to severe sheath rot infection. Milling of infected rice produces broken and black lower quality rice similar to brown spot infection. In case of severe infection, the panicle may fail to emerge causing total crop loss (Ou 1985).

There might be several reasons for the consistent presence of brown spot and sheath rot in most of the areas surveyed including the prior presence of the fungi on alternative hosts (Akanda 2004; Miah & Shahjahan 1987; Ou 1985). However, distribution and/or use of infected seeds for planting might be one of the most probable causes (Ou 1985). Sometimes, farmers use their own seeds they collected from previous crop without realizing the presence of the diseases or the consequences that the infected seeds might have in the next crop.

There are many ways to reduce the severity of brown spot and sheath rot including hot water treatment and chemical treatment of seeds, fungicidal sprays in the field and cultural practices (Akanda 2004; Miah & Shahjahan 1987; Ou 1985). As the rice yield in the farmers field are quite low, the application of chemicals in the field may not

be an attractive proposition as well as the pesticides also have many detrimental environmental consequences. As the occurrence of brown spot is associated with infertile soil and water stress, strategies like field sanitation, balanced fertilizer application, crop rotation, adjusting planting dates to avoid water stress during the ripening stage of the crop, and good water management are effective in reducing brown spot (Havlin *et al.* 1999; Miah & Shahjahan 1987; Ou 1985). The chemical treatment of seeds may also be tried to reduce/destroy initial inoculum before the seeds are distributed and planted. Economically, it will be a better option than the field application of fungicides. Furthermore, seed producers should be very careful during the production process, including testing the seeds before distribution there by making sure that the seeds are free from any seed borne pathogens. Farmers also need to be informed and trained about the techniques of seed production and the consequences of using infected seeds for planting. If the farmers do not have access to pure disease free seeds, they can collect the seeds from their own field from areas where the plants do not have any infection and/or the level of infection is very low.

CONCLUSIONS

Based on the above survey, the following recommendations/suggestions could be made.

- Regular surveys should be conducted to various rice-growing regions to monitor the presence of diseases and the change in their status.
- At least two visits should be made to each of the region, as some of the diseases are quite specific to the growth stages.
- During the present survey, some of the major rice growing areas, namely Madang, Oro, Bereina of Central province, and Finschafen of Morobe Province could not be visited due to time constraints and funds. These areas should be visited to determine whether the occurrence of the diseases is any different from other areas.
- An awareness campaign should be initiated to educate the farmers about the dangers of seed borne diseases.
- Farmers should be trained on the techniques of production of pure and disease free seeds.
- Organizations, institutes, NGOs involved in the production of seeds need to be more careful in the seed production process. The seeds should be tested for the presence of seed borne pathogens and the infected seeds be chemically treated before distribution.
- The Department of Agriculture and Livestock (DAL) might introduce inspection and seed certification scheme as a way of ensuring the production and distribution of pure and healthy seeds to the growers.
- Production of rice seed should be concentrated only under irrigated condition as this would greatly minimize the occurrence of brown spot disease.
- ROC, NARI, Trukai Industries, NGOs and progressive farmers involved in seed production be encouraged to produce seeds of all recognized HYVs and distributed to the growers. This would give the growers more choice and flexibility of growing different varieties rather than concentrating on a particular variety and in such case the consequence could be disastrous as cultivation of a single variety for long period make it prone to resistance break down.

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