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NECK ROT INFECTION OF RICE: VARIETAL RESISTANCE, PANICLE PHENOLOGY AND YIELD REDUCTION

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RINGKASAN

Tiga variti padi (Kadaria, Jaya dan Sekencang) telah diinokulasikan dengan spora *Pyricularia oryzae* apabila 75 peratus tanaman mengeluarkan tangkai padi. Kesan penyakit reput tangkai diawasi selepas inokulasi sehingga ke peringkat penuaian dan hasil padi bagi setiap variti ditentukan.

Kadaria didapati tahan terhadap jangkitan reput tangkai. Manakala untuk variti Jaya dan Sekencang pula, sejumlah 75 peratus tangkainya didapati telah dijangkiti penyakit. Bagi kedua-dua variti tersebut lebih dari 45 peratus tangkai yang keluar selepas inokulasi mendapat jangkitan sekunder.

Jangkitan reput tangkai menyebabkan pengurangan hasil padi. Hasil padi Jaya berkurangan sebanyak 41 peratus manakala hasil padi Sekencang pula berkurangan sebanyak 32 peratus. Penelitian lanjut ke atas variti Jaya menunjukkan jangkitan awal menyebabkan pengurangan hasil yang lebih besar, dan biji-biji padi di bahagian bawah tangkai adalah yang paling terjejas. Percubaan makmal menunjukkan bahawa jangkitan akan berkurangan apabila tangkai padi makin berumur.

INTRODUCTION

Neck rot, the symptom of the second phase of *Pyricularia oryzae* infection on rice is often observed in major rice growing areas in Malaysia. Besides being widely distributed it is also destructive especially under favourable conditions. However, there is little detailed and accurate information on the relationship between disease severity and yield loss.

Severity of infections on the neck node of the rice panicles vary with varieties and heavy infections are damaging to yield. Estimates of losses between 50% to 70% (VAN, 1967; SINGH, 1971; ANON, 1975) have been reported. GOTO (1965) pointed out that the amount of loss is also greatly influenced by the time of infection. To obtain further information regarding these cause-effect relationships, experiments were conducted at Bumbong Lima from 1980 to 1981 comparing the reactions of different varieties. In addition, in-vivo studies were also made to assess the resistance to infection of panicles of varying ages.

MATERIALS AND METHODS

1. Varietal Resistance under Natural and Artificial Environments

Three rice varieties (Kadaria, Jaya and Sekencang) were used in the experiment during the off season of 1980 at MARDI Rice Research Station, Bumbong Lima. Twenty-five days old seedlings of each variety were transplanted at a spacing of 25 x 25 cm apart in 5 x 5 m plots in a randomised complete block design. Each treatment plot was replicated four times. NPK fertilizers at the rate of 80:30:20 kg/ha respectively were applied and the plants were maintained till harvest.

When the crops had reached 75% heading, spore suspensions (5 x 10^4 spores/ml unless otherwise stated, in 1:2000 Tween 20) were prepared from 7–10 day old cultures of *Pyricularia oryzae* strain 293 grown on PDA medium. Before inoculation the panicles in each hill were tied together and spore suspension was sprayed to run off. Plants in the control plots were sprayed with sterile water. Inoculation was conducted in the evening.

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Disease assessment was made one week after inoculation and one week before harvest. The neck rot lesions were carefully examined on each panicle in twenty-five randomly selected hills to give an estimate of the percentage of panicles infected.

When the crops were fully matured the plants from (11 x 11) hills in each plot were harvested, thrashed and bagged accordingly. They were sun-dried to 14% moisture content, cleaned and weighed.

2. Susceptible Zone within Panicle

In another experiment which was carried out in the main season of 1981 a crop of Jaya in a 10 x 10 m plot was maintained under similar agronomic practices until harvest. At heading, a total of ten hills with uniform heading were selected for inoculation. In each hill, three panicles were inoculated with the spore suspension and three other panicles with sterile water.

At maturity the panicles were separately harvested. For yield comparisons, each panicle was divided into three equal lengths along its main axis viz. lower, middle and upper zones, and the grains from each zone were separately processed for their clean weights.

3. Susceptibility of Different Age of Panicles

In a separate experiment the panicles of three different age groups of Jaya, between panicle emergence to grain filling, were collected and separately inoculated under controlled environments. The three age groups used were panicles before emergence (86 days after sowing [DAS]), panicles immediately after complete emergence (96 DAS) and panicles when the grains were at milky ripe stage (106 DAS). Before inoculation pieces of these panicles, 4 cm long and each carrying a neck-node at the centre, were surface sterilized in 10% chlorox solution for 10 min. cleaned in sterile water and allowed to dry. They were immediately placed on water agar which had been freshly incorporated with 150 ppm benzimidazole and drop inoculated (1 µl) at the neck-node region with spore suspension of *P. oryzae*. The pieces inoculated with sterile water acted as control. Immediately after inoculation they were incubated under continuous light at 24°C for 7–10 days for lesion development.

RESULTS & DISCUSSION

Different rice varities react differently to infection by *P. oryzae*. It is evident from *Table 1* that natural infection in the control plots was low and it largely varied according to the varieties planted. The degree of infection was found to be less than 3.5% in Jaya, less than 0.5% in Sekencang and none in Kadaria. As such, Jaya could be assumed to be more susceptible to neck rot than either Sekencang or Kadaria. The latter two varieties were equally resistant to neck rot.

To substantiate the above presumption, the varieties were inoculated with the spore suspension of *P. oryzae* strain 293, a rare but most virulent isolate (AKAMA, 1978). The reactions to the disease again differed with varieties. Both Jaya and Sekencang reacted almost similarly to the fungus. Both varieties had more than 75% of their panicles infected *(Table 2)*. Whereas, in Kadaria, the infection was less than 0.5%. Thus, Kadaria was resistant to strain 293 while both Jaya and Sekencang were susceptible.

The natural spread from its source of infection in the panicles was also studied. The panicles were tied together in each hill and immediately spray-inoculated. Those exserted later were not inoculated. Late infection was assumed to be caused by secondary inoculum. About 3% and 33% of the total panicles in Jaya and Sekencang respectively exserted after inoculation, and for these varieties more than 45% of these panicles were naturally infected *(Table 3)*. For Kadaria, even though 24% of the total panicles came out later, less than 0.5% was naturally infected. This showed that in a resistance variety like Kadaria, secondary infection is not a problem.

TABLE 1: NATURAL INFECTION OF PANICLE (%) IN THE FIELD BY *PYRICULARIA ORYZAE* (FROM 120 HILLS PER VARIETY SAMPLED AT RANDOM)

Variety	% of panicle infected
Jaya	3.45
Sekencang	0.37
Kadaria	0

TABLE 2: EFFECTS OF INFECTION BY *PYRICULARIA ORYZAE (STRAIN 293)* ON PANICLES AND LOSSES IN YIELD

Variety	Panicle infected (%)	Yield from (11 x 11) hills		
		Control yield (kg)	Diseased yield (kg)	% yield reduction
Jaya	87	2.20	1.30	40.95
Sekencang	75	2.29	1.56	31.98
Kadaria	0.23	2.42	2.39	1.31

TABLE 3: NATURAL SPREAD OF INFECTION ON PANICLES EXSERTED AFTER ARTIFICIAL INOCULATION

Variety	No. of panicles at time of inoc.	No. of panicles exserted after inoculation-(A)	(A)-expressed as % of total panicles	Secondary infection (%) on (A)
Jaya	1143	30	2.56	50.00
Sekencang	932	460	33.05	45.00
Kadaria	980	304	23.68	0.33

Yield reduction in a diseased plant largely depends on severity of the disease. As more panicles of a given variety are affected and the intensity of infection/panicle increases, there will be more reduction in yield. This evidence is clearly shown in the yield losses of the varieties tested *(Table 2)*. In both Jaya and Sekencang, the losses in yield amounted to between 32% to 41% compared to the control, whereas in Kadaria it was less than 2%.

Since Jaya was highly susceptible, it was closely studied during the main season of 1980/81 particularly to find out which zone of of the panicle is most sensitive to yield reduction when the panicle was infected. As expected, there were differences in yield per panicle ($P < 0.001$) between those panicles infected with neck rot and those of control. However, when 't' tests were performed on the effects of inoculation on yield at each zone, it was found that only the difference between the lower zones of inoculated and control was significant ($P < 0.05$) *(Table 4)*.

This is explained by the fact that generally, anthesis starts earlier on the spikelets of the upper zones of the panicle. Grain filling therefore, would take place

TABLE 4: EFFECTS OF INFECTION ON PANICLE YIELD (GM) OF JAYA AT DIFFERENT PANICLE ZONES

Panicle zone	Non-inoculated (A)	Inoculated (B)	Difference between (A) and (B)
Lower	0.544(100.0)+	0.351(64.5)	0.193(35.5)*
Middle	0.500(100.0)	0.436(87.2)	0.064(12.8)NS
Uppermost	0.776(100.0)	0.665(85.7)	0.111(14.3)NS

( )+ in percentage
* significant at $P<0.05$
NS not significant

earlier in the spikelets situated higher up the panicle. Before infection could become severe and seriously damaged the vascular system at the neck-node of the panicle, the grains at the middle and upper zones would have almost been filled and, therefore, least affected. But those at the lower zone were greatly reduced.

The plant is particularly vulnerable to infection by *P. oryzae* during flowering and early grain filling. The panicles of a susceptible variety when young are highly susceptible. Consequently, an in-vivo study on Jaya was conducted in 1981, using panicles of three different age groups, namely panicles at 86 DAS, panicles at 96 DAS and panicles at 106 DAS. There was no symptom development on panicles inoculated with sterile water. However, a substantial number of young panicles were infected *(Table 5)* compared to older ones. Therefore, it is important to keep the crops free of disease at flowering and early grain filling stage. Once anthesis is completed and grain filling is reasonably well advanced, the situation is very different. The panicles become relatively resistant to infection. Consequently when the onset of the disease occurs relatively late in crop development the loss of grain yield is unlikely to be substantial.

The epidemiology of neck rot during early heading and subsequent development needs to be looked at in detail. In Kadaria, the yield is negligibly affected since the disease rarely develops. The situation with Jaya and Sekencang is different as *P. oryzae* can establish early and there is abundant inoculum available for secondary infection to take place on other newly exserted panicles. Given favourable conditions for infection, severe losses are thus likely to ensue.

The prospects for the development of rice varieties resistant to panicle blast are good as low disease incidence as shown by Kadaria appears to reduce the risk of secon-

TABLE 5: NUMBER OF PANICLES OF DIFFERENT AGE INFECTED WHEN INOCULATED WITH *P. ORYZAE* (STRAIN 293) – IN-VIVO TEST ON JAYA

	Panicles before exsertion (86 DAS)	Panicles immediately after exsertion (96 DAS)	Panicles at milky ripe stage (106 DAS)
No. of panicles+ infected	33	23	4

+ a total of 40 panicles per age class were inoculated.
* DAS, Days after sowing

dary infection. However, for variety Jaya it is worth nothing that if anthesis and grain filling within the same panicle can be completed in a short time, may be three to four days instead of seven to ten days (YOSHIDA, 1981) there will be a smaller risk of more grains at the lower region of the panicle being less filled. Even so, fungicides may offer effective control and these have to be applied at early heading stage.

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SUMMARY

Three rice varieties (Kadaria, Jaya and Sekencang) were inoculated with *Pyricularia oryzae* when 75% of the crops had headed. Disease severity was monitored from the time of inoculation until harvest, after which the grain yield was separately recorded for each variety.

Kadaria was found to be resistant to neck rot. However, about 75% of the panicles in Jaya and Sekencang were infected. In both varieties, it was also observed that more than 45% of the panicles which exserted after the time of inoculation had secondary infections.

Infection of neck node reduces grain yield. As much as 41% and 32% loss in yield was observed in Jaya and Sekencang respectively. Detailed observations on Jaya showed that early infections resulted in greater loss in yield. The grain yield of the lower zone of the panicle was most affected. Laboratory experiments indicated that panicles become less susceptible to infection as they mature.

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