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Quantification of yield loss caused by red stripe disease in rice

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ABSTRACT

Field studies on effect of red stripe disease severity on yield components of rice under natural incidence levels indicated there was an increase in the per cent chaffy grains and discoloured grains based on the mean of four rice varieties viz. MTU-2077 (Krishnaveni), MTU-1001 (Vijetha), MTU-1010 (Cottondora sannalu) and MTU-3626 (Prabhath). Number of grains panicle^{-1} decreased from 159.69 to 153.99, grain weight 30 panicles^{-1} from 109.27 to 101.88 g and healthy grains from 67.5 to 61.41 per cent. Chaffy grains increased from 28.91 to 33.48 per cent and discoloured grains from 3.59 to 5.12 per cent. Roving survey conducted during wet season 2008 and 2009 in East and West Godavari districts of Andhra Pradesh revealed very low incidence of red stripe on all the varieties grown. Similarly moderate to severe incidence of red stripe was observed in both the districts during dry season 2008 and 2009

Key words: *red stripe, rice, yield components*

Red stripe is an emerging disease of rice crop that has been observed in recent years in intensive rice production systems of Tropical Asia including India. It is also known in Vietnam as yellow leaf disease (Mai *et al*., 1997), yellow leaf syndrome (Vinh *et al*., 2001), leaf yellowing syndrome (Tuat, 2001) and in Indonesia as bacterial orange leaf blight (Suparyono, 2001). Red stripe was first reported in 1988 from Indonesia (Mogi *et al*., 1988). It also occurs in the Philippines (Barroga and Mew 1994), Malaysia (Yazid *et al*., 1996), Thailand (Dhitikiattipong *et al*., 1999) and Vietnam (Du *et al*., 1991b). It could cause yield loss up to 50% due to premature senescence and high ratios of unfilled grain (Du *et al*., 1991b). It has not yet been reported in temperate rice-growing countries.

In India, the disease was first observed during the year 2000 in a sporadic manner in East and West Godavari districts that are major rice growing tracts of Andhra Pradesh. Subsequently, during 2001 and 2002, the red stripe disease incidence was at a moderate level in these districts. Extensive survey on the red stripe disease from Andhra Pradesh revealed that all the promising rice cultures were mostly susceptible to the disease with mean disease severity ranging from 26.32 % to 57.83%. However, the varieties, MTU-1001 and PLA-1100 are highly susceptible with mean disease severity of 58.12% and 57.83%, respectively (Rajamannar *et al*., 2007). The disease is usually observed from flowering to ripening stage of the crop. Initial lesions are pin-sized spots, often light yellow green to light orange. An older lesion appears as an orange spot with a stripe that advances towards the leaf tip. Lesions may become necrotic and coalesce, ultimately blighting the leaves. Although more common on leaves, red stripe lesions are also found on sheaths. Typical symptoms are usually observed from flowering to ripening.

The fungus *Curvularia lunata* (Du *et al*., 1991) and bacteria such as *Acidovorax avenae* subsp. *avenae* (Tuat, 2001) and an unknown species of *Microbacterium* (Kaku *et al*., 2000) were reported to be associated with the disease. However, there has been no conclusive evidence that any of these organisms produce typical red stripe symptoms under natural or controlled conditions. Various studies have provided circumstantial evidence that red stripe may be caused by a fungus. Du *et al*. (1991) reported that red stripe intensity was lower in fields sprayed with benzimidazole fungicides, especially benomyl and carbendazim, compared with unsprayed fields.

Since red stripe symptoms do not resemble those caused by any known diseases of rice, various efforts have been exerted to understand its etiology. However, the causal organism is yet to be identified and its etiology remains obscure, and a reliable quantification of yield losses has not been done yet. Hence, an attempt was made to study the effect of red stripe disease on yield parameters of four commercially grown rice varieties.

Four rice cultivars viz. MTU-2077 (Krishnaveni), MTU-1001 (Vijetha), MTU-1010 (Cottondora sannalu) and MTU- 3626 (Prabhath) that are commercially grown in the state of Andhra Pradesh were chosen for assessment of yield losses due to red stripe disease. The rice varieties at panicle emergence to ripening stage were observed for disease incidence and the yield parameters under study were recorded at 50 per cent disease severity. A sample set consisting of 30 panicles were collected from naturally infected plants of four rice varieties. Simultaneously a set of 30 healthy panicles were also collected for comparison and these two sets of 30 panicles were used to record observations on various yield attributes viz. grain weight 30 panicles^{-1}, number of grains panicle^{-1}, chaffy grains, discoloured grains and 1000 grain weight.

Several inoculation methods like mechanical transmission using crude sap, cotton swabbing and cut bits placed on leaf lamina were tried to study the transmission mechanism of red stripe disease in rice. Young leaves showing typical red stripe lesions from the infected rice plants were collected and inoculums were prepared by macerating these leaves in pre-chilled sterile mortar and pestle. Pre-chilled 0.05 M potassium phosphate buffer (pH 7.0) containing 2-mercaptoethanol was added @ one ml g^{-1} of infected leaf tissue while macerating. The resultant pulp was squeezed through two folds of sterile muslin cloth. Plants were kept in darkness for 24 h prior to inoculation. Such plants were inoculated with the help of a sterilized cotton wool soaked in inoculum by gently rubbing uni-directionally on the upper surface of the rice leaves. Cotton swabs dipped in the red stripe inoculum as well as, leaf pieces of infected red stripe leaves were fixed over the leaf lamina of healthy leaves with cello tape. Roving survey was carried out along with transect of East and West Godavari districts of Andhra Pradesh during the years 2008 and 2009 to monitor the incidence of the disease.

Significant reduction in grain weight 30 panicles^{-1}, number of grains panicle^{-1} and test weight was recorded at 50 per cent disease severity of red stripe in four different rice varieties (Table 1). On the basis of mean yield data, all the four varieties recorded significantly higher grain yield per 30 panicles under healthy (109.27 g) as compared to the yield obtained

Table 1. Effect of red stripe severity on grain yield and yield components of four rice varieties

Components	Severity (%)	MTU-2077 (Krishnaveni)	MTU-3626 (Prabath)	MTU-1001 (Vijetha)	MTU-1010 (Cottandora sannalu)	Mean
Grain weight 30 panicles^{-1} (g)	0	139.59	104.89	118.46	74.13	109.27
	50	127.82	100.76	111.28	67.66	101.88
% decrease over healthy		8.43	3.94	6.06	8.73	
Chaffy grains (%)	0	56.87	20.43	19.60	18.74	28.91
	50	56.99	29.88	30.36	16.67	33.48
% increase over healthy		0.21	31.63	35.44	-12.42	
Discoloured grains (%)	0	0.012	6.18	5.21	2.96	3.59
	50	2.15	4.78	8.30	5.26	5.12
% increase over healthy		99.44	-29.29	37.23	43.73	
Number of grains panicle^{-1}	0	276.37	107.37	153.60	101.40	159.69
	50	262.27	108.9	150.97	93.8	153.99
% decrease over healthy		5.10	-1.43	1.71	7.50	
Healthy grains (%)	0	43.12	73.39	75.19	78.30	67.5
	50	40.86	65.35	61.34	78.07	61.41
% decrease over healthy		5.24	10.96	18.42	0.29	
1000 Grain weight	0	16.672	31.706	25.776	24.370	24.63
	50	16.315	30.794	24.956	24.044	24.03
% decrease over healthy		2.14	2.88	3.18	1.35	

from plants showing red stripe symptoms (101.88 g). Chaffy grains increased from 28.91 to 33.48 per cent and discoloured grains from 3.59 to 5.12 per cent on mean basis of four varieties.

Number of grains panicle^{-1} were significantly more in healthy plants (159.69), which decreased (153.99) in diseased plants. Healthy grains panicle^{-1} decreased from 67.5 to 61.41 on mean basis of four varieties. Similarly, there was a significant difference in test weight which decreased from 24.63 to 24.03 g on overall basis of four rice varieties.

There was negative correlation between red stripe severity and the yield parameters except chaffy grains and discoloured grains which increased with an increase in disease severity. The reduction in grain yield was found to be maximum in MTU-1010 followed by MTU-2077, MTU-1001 and minimum in MTU-3626. There were as high as 35.44 per cent more chaffy grains in infected plants over healthy in variety MTU-1001 followed by MTU-3626 while, minimum increase in chaffy grains was observed in variety MTU-2077. Similarly, There were as high as 99.44 per cent more discoloured grains in plants exhibiting disease severity over healthy in variety MTU-2007 followed by MTU-1010 and minimum increase in chaffy grains was observed in variety MTU-1001.

Proportionate decrease in number of grains per panicle was more in the variety MTU-1010 over healthy while it was minimum in MTU-1001. The reduction in per cent healthy grains was found to be maximum in MTU-1001 followed by MTU-3626 and MTU-2077 while, minimum in MTU-1010. Per cent reduction in test weight was more in MTU-1001 (3.18) as compared to 2.88 to 2.14 in varieties, MTU-3626 and MTU-2077 and minimum in MTU-1010 indicating same pattern of quantitative reduction in yield and yield components.

None of the inoculation methods exhibit any of the red stripe symptoms after inoculation. Moderate to severe incidence of red stripe was observed in both the districts surveyed during dry season 2008 and 2009.

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