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R Arulmozhi
Tamil Nadu Rice Research Institute, Aduthurai, Tamil Nadu, India

A Muthuswamy
Agriculture College and Research Institute, Karur, Tamil Nadu, India

R Pushpa
Tamil Nadu Rice Research Institute, Aduthurai, Tamil Nadu, India

Corresponding Author:
R Arulmozhi
Tamil Nadu Rice Research Institute, Aduthurai, Tamil Nadu, India

Phenotypic screening of rice leaf folder *Cnaphalocrocis medinalis*

R Arulmozhi, A Muthuswamy and R Pushpa

Abstract
Major rice insect pests that cause huge economic loss in Asia are stem borer, rice bug, leaf folder, leaf and plant hopper and gall midge (Sardesai *et al*., 2001). Among the eight leaf folder species recorded in India, *Cnaphalocrocis medinalis* was the most widely spread and the damage due to this species ranged from 18.3% to 58.4% depending on the stage of the crop at the time of infestation. In this study seventy four genotypes were screened for leaf folder damage following the procedure of IRRI (1964). The extent of leaf damage was recorded for plants in five hills selected randomly in all the three replications and were given grade from 0 to 3. Among the parents the female parent ACK 09009 was found to be highly resistant with mean scale of 1 with 6% leaf damage. The cultures ACK 09028 and ACK 09029 recorded highly susceptible with mean scale of 9 with 79 and 93% leaf damage respectively. Among the hybrids, the cross combinations involving ACK 09009, IR 8, IR 20 and CO 43 as female parent recorded moderately resistant with mean scale of 3 with range of 13 – 30% leaf damage. The expressions of resistance genes from parents to F1's were similar to the findings of Gallagher (1994) and Ramasamy (1996).

Keywords: Leaf folder, phenotyping, biotic stress

1. Introduction

Rice (*Oryza sativa* L.) is a predominant food crop of the world and staple food for about 2 billion people in the developing countries. Rice is grown in an area of 163.3 million hectares in the world with production of 749.7 million tonnes (Food and Agriculture Organisation, 2016). India is the world's second largest producer of rice cultivated in an area of 43.9 million hectares with an annual production of 104.3 million tonnes (Directorate of Economics and Statistics, Govt. of India, 2016) [15]. Rice is the principal food crop in southern and eastern part of India and is very important in terms of national food security. Biotic stresses caused by insect pests, diseases and weeds are the major constraints in rice production resulting in 37% yield losses (Krishnaiah and Varma, 2012) [5]. Major rice insect pests that cause huge economic loss in Asia are stem borer, rice bug, leaf folder, leaf and plant hopper and gall midge (Sardesai *et al*., 2001) [12]. Among these insect pests, the leaf folder emerged as a major pest in the tropical Asia during green revolution of the 1960's (Gallagher *et al*., 1994) [1]. Among the eight leaf folder species recorded in India, *Cnaphalocrocis medinalis* was the most widely spread and the damage due to this species ranged from 18.3 per cent to 58.4 per cent (Ramasamy and Jaliecksono, 1996) [13] depending on the stage of the crop at the time of infestation. About five per cent of total rice growing area of world was affected by rice leaf folder (RLF) and the loss in yield was estimated to be around 4.8 kg/ha, which in economic terms leads to a loss of $22.4 million (Herdt, 1991) [2]. The genetics of resistance to RLF in rice is very complex and not thoroughly explored.

Rice leaffolder, Cnaphalocrocis medinalis Guénee (Lepidoptera: Pyralidae) is a notable leaf feeding insect in all the major rice growing regions in Asia. Many Asian countries like China, India, Japan, Korea, Malaysia, Sri Lanka, and Vietnam reported frequent outbreaks of this pest and yield losses (Khan *et al*., 1988; Luo, 2010 and Li *et al*., 2012) [3, 7, 5]. Leaffolder infestation occurs right through the nursery stage to harvest stage, but incidences are high in the reproductive and ripening stages (Litsinger *et al*., 2006) [6]. Bentur (2011) [11] Murugesan and Chelliah (1983) [10] reported that a 10 per cent increase in flag leaf damage by the leaf folder reduces grain yield by 0.13 g per tiller and the number of filled grains by 4.5 per cent. Larva stitches the leaf edges and folds the leaves longitudinally. It feeds by scraping the green mesophyll tissue staying inside the folded leaves resulting in linear membranous damage. Due to this feeding, general vigor and photosynthetic efficiency of infested rice plant becomes drastically reduced resulting in poor grain filling causing significant yield loss.

Initial first and early second-instar larvae are found in groups and feeds on central furled leaf. Later, larva becomes solitary and folds the leaves for feeding. Each larva can destroy several leaves by its feeding during the development passing through five instars. Due to numerous folded and damaged leaves, heavily infested fields appear parched (Fraenkel G *et al*., 1981) [9].

At present, farmers are dependent on chemical control as feasible method to check leaffolder infestation during the crop growth period. Though, host plant resistance plays a major role in integrated pest management, rice cultivars resistant to leaffolder are not available. Hence, farmers mainly rely on toxic pesticides leading to higher cost of cultivation and pollution hazards. Though the yield has increased through several improved varieties and hybrids of rice, they are still vulnerable to the pests and diseases. Growing resistant variety plays a major role in the management of insects especially in low input farming situations of India and South Asia. It is also highly compatible with other methods of pest management. In any breeding programme, the breeder should have a thorough knowledge on the genetic architecture of the plant, the nature of gene action involved to introgress the resistant genes into high yielding varieties and hybrids. In this study seventy four genotypes were screened for leaf folder damage following the procedure of IRRI (1966).

2. Materials and Methods

The present study under investigation was carried out at AC& RI, Killikulam with eighteen genotypes of rice (*Oryza sativa* L.) which consisted of fourteen lines *viz*, ACK 09009, ACK 09024, ACK 09025, ACK 09028, ACK 09029, ACK 09030, ACK 10001, ASD 18, ASD 19, ADT 37, ADT 38, IR 8, IR 20 and CO 43 (seven cultures and seven varieties) and four testers *viz*., ADT 45, ADT 43, ADT 36 and ASD 16. These parents were crossed in a Line × Tester mating design.

Table 1: Details of the parents used

Sl. No.	Varieties	Pedigree	Code No.
		Lines	
1.	ACK 09009	IR 68890 x Norungan	L_1
2.	ACK 09024	ADT 47 x ADT 43	L_2
3.	ACK 09025	IR 68890 x VC	L_3
4.	ACK 09028	ADT 43 x ASD16	L_4
5.	ACK 09029	ADT 43 x ASD 16	L_5
6.	ACK 09030	ASD 19 x IR 8	L_6
7.	ACK 10001	ADT 43 x ADT 37	L_7
8.	ASD 18	ADT 31 x IR 50	L_8
9.	ASD 19	Lalnakanda x IR 30	L_9
10.	ADT 37	BG 280-1 2 x PTB 33	L_{10}
11.	ADT 38	IR 1529-680-3-2 x IR 4432-52-6-4 x IR 7963-30-2	L_{11}
12.	IR 8	Dee gee woo gen x Peta	L_{12}
13.	IR 20	IR 262 x TKM 6	L_{13}
14.	CO 43	Dasal x IR 20	L_{14}
15.	ADT 45	IR 50 x ADT 37	T_1
16.	ADT 43	IR 50 x White ponni	T_2
17.	ADT 36	Triveni x IR 20	T_3
18.	ASD 16	ADT 31 x CO 39	T_4

2. Methods

2.1 Mating design

Line x tester method of mating design was followed in which all the 14 lines were crossed with each of four testers resulting in 56 cross combinations.

2.2 Crossing programme

Fourteen lines and four testers were sown in the nursery during *kar*, 2011. In order to obtain synchronous flowering between the male and female parents of different durations, staggered sowings were taken. Twenty five days after sowing fourteen lines and four testers were transplanted in the main field.

Wet cloth method of hybridization suggested by Chaisang *et al*. (1967) [16] was followed for crossing. During early hours between 6.30 and 8.30 AM the spikelets likely to open on the same day were selected for emasculation in the female parent. All immature and already opened spikelets were removed. The panicle was wrapped fully with a wet cloth and hot air was blown by mouth. Due to the increase in temperature and humidity inside the wet cloth the anthers protruded out. All the six stamens were removed carefully using a pointed forceps. The unopened spikelets were clipped off. The ripe anthers from the selected spikelet of the male parent were collected at the time of anthesis and dusted on the stigma of the emasculated spikelets of the female parent. Then the crossed panicle was covered with a butter paper cover and labelled.

The set seeds were collected at physiological maturity and utilized for raising the F_1's. Selfing of parents was also done by covering the panicles before anthesis with butter paper cover and the selfed seeds were collected at maturity.

2.3 Experimental design and layout

All the 56 hybrids, along with 14 lines and four testers were raised in randomized block design with three replication in *Pishanam*, 2011. Twenty-five days old seedlings were transplanted in the main field in three -meter row length with spacing of 20 x 20 cm with single seedling per hill. The recommended agronomic practices were followed.

Seventy four genotypes (18 parents and 56 F_1's) were screened for leaf folder damage following the procedure of IRRI. The extent of leaf damage was recorded for the plants in five hills selected randomly in all the three replications and they were given grade from 0 to 3.

Grade	Damage
0	No damage
1	Up to 1/3 of leaf area scraped
2	1/3 to 1/2 of leaf area scraped
3	More than 1/2 of leaf area scraped

Based on the above grading, damage rating was computed as follows:

$$\text{Percentage Rating (R)} = \frac{(\text{No of leaves with damage grade of } 1\text{x } 100)\ 1}{\text{Total no of leaves observed}} + \frac{(\text{No of leaves with damage grade of } 2 \text{ x } 100)\ 2}{\text{Total no of leaves observed}} + \frac{(\text{No of leaves with damage grade of } 3 \text{ x } 100)\ 3}{\text{Total no of leaves observed}} \div 6$$

The overall damage rating (D) is converted to a 0-9 scale

Scale	% Damage Rating (D)
0	No damage
1	1-10
3	11-30
5	31-50
7	51-75
9	More than 75

3. Results and Discussion

Success of any breeding programme solely depends on the extent of combining ability of parents. Crop improvement for grain yield and quality traits can be improved by combining desirable traits of parents. While selection for yield, the nature of relationship between yield and component traits and their direct and indirect effects on yield are of great value for crop improvement.

The data recorded in eighteen parents and fifty six hybrids were statistically analysed and the results are presented below.

Resistance to rice leaf folder in 74 genotypes (18 parents and 56 hybrids) in 0-9 scale was represented in Table 16. Among the parents the female parent ACK 09009 was found to be highly resistant with mean scale of 1 with 6% leaf damage. The cultures ACK 09028 and ACK 09029 recorded highly susceptible with mean scale of 9 with 79% and 93% leaf damage respectively. Six parents (4 lines and 2 testers)/ registered moderately resistant for rice leaf folder with mean scale of 3. Nine parents (7 lines and 2 testers) were found to be moderately susceptible with mean scale of 5.

Among the hybrids, the cross combinations involving ACK 09009, IR 8, IR 20 and CO 43 as female parent recorded moderately resistant with mean scale of 3 with range of 13 – 30% leaf damage. Except the hybrids ACK 09030 × ADT 45, ACK 09030 × ASD 16, ADT37 × ADT 45, ADT 38 × ADT 45 and ADT 38 × ADT 36 other F_1' s involving ACK09030, ADT 37 and ADT 38 as female parent showed moderately resistance with mean scale of 3. The former hybrids recorded moderately susceptible damage with the mean scale of 5. Except the hybrids ACK09024 × ADT 45, ACK 09024 × ADT 36, ACK 09025 × ADT 43, ASD 18 × ADT 36 and ASD 18 × ASD 16 other cross combinations involving ACK 09024, ACK 09025, ASD 18 as female parent recorded moderately susceptible for leaf folder with 31 – 50% leaf damage with mean scale of 5. The former hybrids showed highly susceptible for leaf folder with 51 – 75% leaf damage.

The F_1's with ACK 09028, ACK 09029, ACK 10001 and ASD 19 as female parent recorded moderately susceptible for leaf folder with 31 – 51% leaf damage with mean scale of 5.

4. Conclusion

The parent ACK 09009 was found to be highly resistant to rice leaf folder. All the hybrids involving ACK 09009 as female parent were found to be resistant with a damage scale of 3 to rice leaf folder confirming the genetic basis of resistance. The hybrids with ACK 09028 and ACK 09029 as female parent showed a resistant score of 5.

5. References

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