STUDY ON RESISTANCE OF DIFFERENT RICE VARIETIES AGAINST RICE WEEVIL, *Sitophilus oryzae* (L.)

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ABSTRACT

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An experiment was conducted in the laboratory of Department of Entomology, Bangladesh Agricultural University, Mymensingh during June to October, 2004 to evaluate resistance, if any, of rice grains of 7 rice varieties viz, BR3, BR11, BR14, BR26, BRRI dhan28, BRRI dhan29 and Kalogira against rice weevil, *Sitophilus oryzae* (L). Resistance was tested against unhusked- unparboiled and husked- parboiled conditions of each of the varieties under controlled condition. Five pairs of adult rice weevil were confined on 50g of paddy or rice grains. Mortality of weevil populations within 10 days of confinement was observed. Mortality of initial weevil populations, new adult emergence, development and grain weight losses were considered as indicator of resistance. Among the grain conditions, unhusked- unparboiled paddy grains of all the varieties showed some degree of resistance against rice weevil. The variety Kalogira was consistently resistant against *S. oryzae* in all two conditions of rice grains, while resistance reaction of unhusked- unparboiled BR11 and BR3 paddy was not maintained after husking. The most resistant and susceptible variety suffered 3.34% (Kalogira) and 10.74% (BR26) loss in unhusked- unparboiled condition and 4.34% (Kalogira) and 14.60% (BR26) loss in husked-parboiled condition, respectively.

Keywords: Resistant rice variety, rice weevil (*Sitophilus oryzae)*, storage and weight loss

INTRODUCTION

Rice is grown in most of the countries of the world and also in Bangladesh as a staple food. It occupies about 10.26 million hectares, which is about 75 percent of total cultivable land of the country (BBS, 1997). The demand for rice is constantly rising in Bangladesh with nearly 2.3 million people being added each year to her population of about 120 million (BBS 2001). Storing grain in store house to keep them free from being damaged by insect pests is a problem which is confronted by every householder, whether he is a cultivator or not. According to Alam (1971), 5-8% of the food grains, seeds and different stored products are lost annually due to storage pests and if the losses incurred on farms were included, it would amount to 10%.

Insect pests cause considerable losses to stored rice, which may affect the food availability of a large number of people, particularly in the developing countries like Bangladesh. As many as 34 species of insects have been reported as pests of stored paddy and clean rice from different countries (Grist and lever, 1969). In Bangladesh 13 insect species have been recorded rice (Alam, 1971). Reliable estimates of over all losses during rice storage are difficult to obtain but these are much greater than generally appreciated. Khan (1991) reported loss of about 15 percent rice in storage in Bangladesh. Loss is usually lower in the unhusked-unparboiled rice than husked-parboiled rice (Bhuiyan, 1988). The rice weevil, *sitophilus oryzae* L. (Coleoptera; curculionidae), is one of the most important pests of the many common cereals and has a world wide distribution (Gomes *et al*., 1983). This insect occurs throughout the tropics and is also found in warm temperate regions, including Bangladesh. Rice weevils can cause losses to grain in storage, either directly through consumption of the grain or indirectly by producing ‘hot spots’ causing loss of moisture and thereby making grain more suitable for their consumption. This insect infests rice (both husked and unhusked), maize, wheat and sorghum particularly in monsoon. It also causes damage to oats barely, cotton seed, linseed and cocoa. The damage to the grain is caused by both larva and adult. In tropical countries, outbreak of this pest make the stored rice unfit for human consumption within eight months of storage (Prakash *et al*., 1987). In Bangladesh rice is mostly stored in farmhouse for several months or until the harvest of next crop; but stored for longer duration in pubic sector silos or large storages. *S. oryzae* is the most common pest in all types of rice stores in Bangladesh but loss estimates due to this pest are scanty. Bhuiyan *et al*., (1992) reported 11-16% weight loss of husked rice during 4 months of storage in the laboratory. The rice weevil is one of the most destructive inset pests of stored grain causing both vertical and horizontal infestation. This pest can infest the grains from top to bottom and vice versa, which is known as vertical infestation. Infestation that comes to storage via pest harvest operation is called horizontal infestation (Prakash *et al*., 1987). Although recognized as an important pest of stored rice, a limited research work has been reported in Bangladesh. Host resistance can play an important role in minimizing damage of stored rice by *S. oryzae*. So far, limited research has been conducted to identify resistance of rice grains against this insect pest in Bangladesh and other countries. The reported *S. oryzae* resistant or least preferred varieties include IR20 (Virmani *et al.,* 1980), IR5, khama, BR3, BR5 and BR11 (Anon, 1982) and Uijaya (Rout *et al.*, 1976). Among these varieties khama, BR3 and BR11 are widely grown, but the level and mechanism of resistance are not clear. The present study was undertaken to find out varietal resistance of seven rice verities to the rice weevil. Resistance was tested against unhusked-unparboiled and husked-parboiled conditions of each of the varieties.

MATERIALS AND METHODS

An experiment was conducted in the laboratory of Department of Entomology, Bangladesh Agricultural University, Mymensingh during June to October, 2004. Resistance status of 7 rice varieties viz. BR3, BR11, BR14, BR26, BRRI dhan28, BRRI dhan29 and Kalogira against rice weevil, *Sitophilus oryzae* (L) was evaluated. Resistance was tested against unhusked- unparboiled and husked- parboiled conditions of each of the varieties. The study was conducted in completely randomized design with three replications at room temperature. The weevil was mass reared in three plastic containers measuring 20x14cm. The containers were half filled with 500g of clean, freshly husked- parboiled rice grains of variety BR26 covered with a fine mesh nylon cloth for aeration. Male and female rice weevils were identification. Fifty gram of paddy or rice was placed in a plastic container and five pairs of adult *S. oryzae* were confined in each container. All the containers were closed with fine mesh nylon cloth. Mortality of initial weevil populations at 10 days after infestation was recorded. Dead and adult insects were separated from each sample and percentage mortality was calculated. After 22-25 days, new adults started emerging from these seeds .The number of emergent rice weevil at different days from each variety was recorded. When the emergences of the weevils were completed, the final weights of these seeds were taken to obtain grain weight loss for each variety. The weight losses of rice were found out by subtracting the final weight from the initial weight (50g). The weight losses were converted into percentage. Mortality of initial weevil populations, new adult emergence, development and grain weight losses were considered as indicator of resistance.

RESULTS AND DISCUSSION

Mortality of initial weevil population

Five pairs of adult rice weevil, *S.oryzae* released on paddy or rice grains in containers and mortalities of this rice weevil were counted after 10 days. The initial rice weevil populations in unhusked-unparboiled paddy grains suffered about 33.33% (average) mortality within first ten days of confinement (Table 1). Mortalities were about half in the case of husked-parboiled rice. In unhusked-unparboiled paddy grains mortality was highest in kalogira (66.67 %), closely followed by BR3 (63.33 %) and BR11 (60.00 %). Mortality in kalogira was significantly higher than all other varieties except BR3. In husked-parboiled rice, weevil mortality was significant highest in kalogira than other varieties. Weevils suffered least mortality in BR26 (3.33 %) in unhusked-unparboiled condition and no mortality in BR26 in husked-parboiled condition. Data indicated that rice husk provided some defense against rice weevil. Among the varieties kalogira, BR3 and BR11 probably possessed some degree of resistance against rice weevil. The resistance mechanism in kalogira seems to be associated with both the rice husk and kernel while in other two varieties probably only with the husk.

Table 1. Mortality of initial rice weevil population at 10-days after infestation in two different conditions of seven rice varieties

Variety	Mortality of initial weevil population (%)		Mean
	Unhusked-unparboiled paddy	Husked-parboiled rice	
BR3	63.33ab	16.67b	40.00
BR11	60.00b	16.67b	38.34
BR14	13.33d	6.67d	10.00
BR26	3.33e	0.00e	1.67
BRRI Dhan28	3.33e	13.33c	8.33
BRRI Dhan29	23.33c	16.67b	20.00
Kalogira	66.67a	30.00a	48.34
Mean	33.33	14.29	23.81
CV%	6.99	11.36	
LSD	4.08	2.84	

Adult Emergence from Different Varieties

There was variation with respect to the number of adults emerged from diferent varieties of rice. The adult emergence of *S. oryzae* commenced on the September 30. The highest emergence took place at different days on different varieties. In unhusked-unparboiled paddy BR26 initiated early emergence of adults reaching maximum on 10 October with 4.67 weevils per 50 g paddy. BR3, BR11, BR14, BRRI dhan 28, BRRI dhan 29 and kalogira had the maximum mean number 2.33, 2.00, 3.33, 3.00, 3.33 and 1.67 weevils on 10 October, 8 October, 10 October, 10 October, 10 October and 10 October, respectively (Table 2). In husked-parboiled rice BR26 initiated early emergence of adults reaching maximum on 9 October with 7.00 weevils per 50 g rice grain. BR3, BR11, BR14, BRRI dhan 28, BRRI dhan 29, and kalogira had the maximum mean number 4.67, 4.33, 5.67, 5.33, 4.67 and 2.00 weevils on 9 October, 9 October, 9 October, 10 October, 9 October and 11 October respectively (Table 3).

Overall mean emergent adults was least on unhusked-unparboiled paddy 22.05/50g and high on husked-parboiled rice 30.95/50g (Table 4). In unhusked-unparboiled paddy the lowest number of adults emerged from kalogira having mean of 4.67/50 g, followed by BR3 (12.33/50 g) and BR11 (15.67/50 g) while highest in BR26 (43.00/50 g) (Table 4). Adults emerged in kalogira was significantly lower than other six varieties. Similarly adults emerged in BR3 and BR11 was significantly lower than other four varieties. In husked-parboiled rice, the lower number of adults emerged from kalogira having mean of 10.67/50g, followed by BR3 (27.33/50g) while highest in BR26 (48.67/50g). Adults emerged in kalogira was significantly lower than other six varieties. Adults emerged was lowest in kalogira and second lowest in BR3 in all two conditions. Similarly highest adults emerged in BR26 in two conditions. Data clearly indicated that husking made the rice vulnerable to *S. oryzae*, thus population increased and parboiled rice seemed more suitable for population development. Among the tested 7 rice varieties kalogira consistently affected population development of rice weevil irrespective of grain conditions.

Table 2. Mean number of emergent adults of *S. oryzae* from different varieties of unhusked-unparboiled paddy from September 30 to October, 2004

Date	Grain weight (g)	Mean emergent adults(no.) on different varieties						
		BR3	BR11	BR14	BR26	BRRI Dhan28	BRRI Dhan29	Kalogira
Sep.30	50	0.00a	0.00a	0.00a	0.33a	0.00a	0.00a	0.00a
Oct.1	50	0.00a	0.00a	0.33a	0.33a	0.00a	0.00a	0.00a
Oct.2	50	0.00a	0.00a	0.67a	0.67a	0.33a	0.33a	0.00a
Oct.3	50	0.33b	0.33ab	1.00ab	1.67a	1.00ab	1.33ab	0.00b
Oct.4	50	1.00abc	1.33ab	2.00a	1.33ab	2.00a	0.67bc	0.00c
Oct.5	50	0.67cd	1.00c	2.33b	3.00a	0.67cd	1.33c	0.00d
Oct.6	50	1.00de	1.33cd	2.00bc	3.33a	2.33b	2.00bc	0.33f
Oct.7	50	1.33de	1.67d	3.00b	4.00a	2.67bc	2.00cd	0.67e
Oct.8	50	1.33a	2.00b	1.67b	4.00a	2.00b	2.00b	1.00b
Oct.9	50	2.00c	1.33c	3.00b	4.33a	2.00c	2.00c	1.00c
Oct.10	50	2.33cd	2.00d	3.33b	4.67a	3.00bc	3.33b	1.67d
Oct.11	50	1.00de	2.00cd	3.00b	4.33a	2.67bc	1.67cd	0.33e
Oct.12	50	1.00bc	1.33bc	3.00a	3.00a	1.67bc	2.67b	0.33c
Oct.13	50	0.33cd	1.00c	2.33b	4.00a	2.33b	2.33b	0.00d
Oct.14	50	0.00d	0.67c	2.33a	2.00b	0.67c	1.00bc	0.00d
Oct.15	50	0.00c	0.00c	0.67ab	1.33a	0.33b	0.67ab	0.00c
Oct.16	50	0.00a	0.00a	0.33a	0.67a	0.00a	0.00a	0.00a
Oct.17	50	0.00a	0.00a	0.00a	0.33a	0.00a	0.00a	0.00a

Means having same letters in row did not differ significantly

Table 3. Mean number of emergent adults of *S. oryzae* from different varieties of husked- parboiled paddy from September 30 to October, 2004

Date	Grain weight (g)	Mean emergent adults (no.) on different varieties						
		BR3	BR11	BR14	BR26	BRRI Dhan28	BRRI Dhan29	Kalogira
Sep.30	50	0.00a	0.00a	0.00a	0.33a	0.00a	0.00a	0.00a
Oct.1	50	0.00a	0.00a	0.00a	0.67a	0.00a	0.00a	0.00a
Oct.2	50	0.33ab	0.67ab	0.33ab	1.33ab	0.33ab	0.67ab	0.00b
Oct.3	50	1.00b	1.33b	1.67ab	2.33a	1.00b	1.33b	0.00c
Oct.4	50	1.33bc	1.67ab	2.33ab	2.67a	1.33bc	1.33bc	0.33c
Oct.5	50	2.00b	2.33b	2.67ab	3.33a	2.33ab	2.33ab	0.33c
Oct.6	50	3.00ab	3.00ab	3.00ab	3.33a	2.67b	3.00ab	0.67c
Oct.7	50	2.33c	3.00ab	3.33ab	3.67a	2.33c	2.67bc	0.67d
Oct.8	50	2.67c	3.33abc	4.00ab	4.33a	2.67c	3.00bc	1.33d
Oct.9	50	4.67bc	4.33c	5.67b	7.00a	4.00c	4.67bc	2.00d
Oct.10	50	3.00bc	3.00bc	5.33a	5.00a	5.33a	3.33b	1.67c
Oct.11	50	3.33a	3.00a	3.33a	3.67a	3.33a	2.67a	2.00a
Oct.12	50	1.33b	1.67ab	3.00ab	3.67a	2.67ab	1.33b	1.33b
Oct.13	50	1.33abc	1.00bc	3.00a	2.67ab	2.00abc	1.67abc	0.33c
Oct.14	50	0.67b	1.33a	1.33a	1.33a	1.33a	0.67b	0.67b
Oct.15	50	0.00b	0.67ab	0.33ab	1.33a	0.67ab	0.00b	0.00b
Oct.16	50	0.00a	0.00a	0.33a	0.00a	0.00a	0.00a	0.00a
Oct.17	50	0.00a	0.00a	0.00a	0.33a	0.00a	0.00a	0.00a

Means having same letters in row did not differ significantly

Table 4. Mean number of emergent adults of *S. oryzae* from two different conditions of seven rice varieties

Variety	Grain weight (g)	Mean emergent adults (no.) on different rice varieties	
		Unhusked-unparboiled paddy	Husked-parboiled rice
BR3	50	12.33d	27.33c
BR11	50	15.67d	30.33c
BR14	50	31.33b	39.67b
BR26	50	43.00a	48.67a
BRRI Dhan28	50	23.33c	32.00c
BRRI Dhan29	50	24.00c	28.00c
Kalogira	50	4.67e	10.67d
Mean	50	22.05	30.95
CV (%)		11.20	8.25
LSD		4.32	4.47

Grain weight loss

The weight losses were found out by subtracting the final weight from initial weight (50g) and were calculated into percentage of the weight losses of rice seeds. Overall weight losses due to five pairs of initial rice weevil population of storage period varied between grain conditions (Table 5). Overall loss was minimum in the case of unhusked-unparboiled paddy (6.06%) and maximum in husked-parboiled rice (8.74%). In unhusked-unparboiled condition lowest weight loss suffered by three varieties were BR11 (2.66 %), kalogira (3.34%), and BR3 (4.34%) and highest loss suffered by BR26 (10.74%). Weight loss in BR11 and Kalogira was significantly less than other five varieties and losses in BR3 were significantly less than four other varieties. In husked-parboiled condition lowest weight loss suffered by one variety was kalogira (4.34%) and the highest loss suffered by BR26 (14.60%). Weight loss in kalogira was significantly less than all other six varieties. Kalogira consistently suffered least grain weight loss irrespective of rice grain conditions mainly due to high mortality of initial rice weevil and reduced adults emerged compared to other varieties. Bhuiyan *et al.* (1992) reported similar trend of weight loss in different qualities of stored rice grains due to weevil infestation. These results supported the findings of the present research work. However, rice weevil caused more damage to husked-parboiled rice than to unhusked-unparboiled rice. Rice with compact husk could be the explanation of least damage as husk acted as a barrier to *S. oryzae*.

Table 5. Grain weight losses due to rice weevil in two conditions of seven rice varieties during 45 days of storage, laboratory test

Variety	Grain weight loss during of storage infested by 5 pairs of rice weevil (%)		Mean
	Unhusked-unparboiled paddy	Husked-parboiled rice	
BR3	4.34d	7.46c	5.9
BR11	2.66e	7.46c	5.06
BR14	8.20b	10.74b	9.48
BR26	10.74a	14.60a	12.67
BRRI Dhan28	6.66c	9.06bc	7.86
BRRI Dhan29	6.46c	7.46c	6.96
Kalogira	3.34e	4.34d	3.84
Mean	6.06	8.74	7.40
CV%	9.04	11.67	
LSD	0.9592	1.785	

As rice is usually stored as unhusked-unparboiled conditions in farm houses, the loss due to rice weevil infestation is expected to be minimal. On the other hand traders and food department of government usually store husked rice, mostly parboiled condition. Such grains are likely to suffer 2-3 times grater loss due to rice weevil infestation than unhusked-unparboiled rice. Therefore, if rice weevil is a serious problem in Govt. soils and godown, storage of unhusked-unparboiled rice may be considered instead of husked-parboiled rice. However, a survey is needed before such recommendations.

Summary and conclusion

The nature and intensity of damage caused by the rice weevil were different among rice qualities viz. unhusked-unparboiled and husked-parboiled rice. Husked-parboiled rice was most preferred and unhusked-unparbioled rice was least preferred. The infestability success of *S. oryzae* in different rice qualities was more in unhusked-unparboiled than husked-parboiled. The highest mean number of adult mortality in unhusked-unparboiled rice (33.33%) and lowest in husked-parboiled rice (14.29%). So unhusked-unparboiled rice was least suitable or unsuitable for rice weevil population growth. The emergence of new adults from the seeds infested by those adults was significantly different among the rice varieties. In unhusked-unparbioled paddy the highest number of 43.00 adults per container emerged from BR26. The lowest number of 4.67 adults emerged from the paddy of kalogira. In husked-parboiled rice the highest number of 48.67 adults per container emerged from BR26. The lowest number of 10.67 adult emerged from the rice of kalogira. In the comparative infestability study of different rice qualities, husked-parboiled rice suffered highest loss followed by unhusked-unparboiled rice. Weight loss was significantly higher in husked-parboiled rice compared to unhusked-unparboiled rice. Among seven varieties tested in unhusked-unparboiled condition, kalogira, BR3 and BR11 showed high resistance to rice weevil and BR14, BRRI dhan 28 and BRRI dhan29 exhibited moderate resistance and BR26 were most susceptible to rice weevil. The trend was changed in case of husked-parboiled condition where almost all varieties were preferred by rice weevil except kalogira. Resistance in BR3 and BR11 appeared to be associated with rice husk. Husking did not cause resistance to kalogira indicating cause of resistance in this variety probably due to antibiosis. Rice varieties with resistance against major stored grain pests could play significant role in minimizing losses during storage. Therefore, stored grain pest resistant varieties could be developed. Resistance source of different stored grain pests need to be identified and advance breeding lines may also be screened against major stored grain pests.

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