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Grain hardness and protein content of milled rice grains and their relationship with infestation of rice weevil *Sitophilus oryzae* L., (Coleoptera: Curculionidae)

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ABSTRACT

A study was carried out with eight varieties of milled rice of various sizes to find out the relationship between grain hardness, protein content and infestation of rice weevil Sitophilus oryzae L. Results indicated that Jyotirmayee was the susceptible variety having maxium adult population build-up of 445 numbers/ 50g rice, grain damage of 69.68 percent, protein content of 7.66 percent and least grain breaking force of 45.73 Newton. The experiment concluded that the infestation of rice weevil was significantly positively correlated with protein content and negatively with hardness. There was a positive correlation between weevil population build-up and percent grain damage and a negative correlation between grain hardness and protein content. The regression revealed that for each unit (Newton) increase in hardness, there was a 0.22% decrease in grain damage and for each unit (percent) increase in protein content, there was a 3.18 % increase in grain damage.

Key words: *grain hardness, grain damage, milled rice, protein content, Sitophilus oryzae L.*

Grain storage is a serious problem confronted by every farmer and householder in many developing countries by the insect pest attack where a considerable quantity of food grain is lost every year. It is reported that a loss of 9.33% occurs during storage of food grains and 6.55% of the food grains, seeds and different stored products are lost annually due to storage pests (Rajendran and Sriranjini 2008). Out of several insects attacking stored grains, *Sitophilus oryzae* L. is causing 65.6 to 98.5% infestation (Pathak and Jha 2003) with substantial losses to stored grain amounting 18.30 per cent (Adams 1976) and weight loss of 50% in storage. (Koura and El-Halfway 1967).

Rice hardness is important to many facets of rice industry and has been implicated as a factor in diverse areas like storage changes and ageing (Barber 1972); drying and handling, resistance to insects (Rout *et al.* 1976 Peng and Hsia 1984). The protein content of rice is very important in nutritional point of view and source of infestation. Hence, the present information is of paramount importance in studying the relationship between grain hardness, protein content of milled rice and its infestation by rice weevil *Sitophilus oryzae* L. under storage condition.

MATERIALS AND METHODS

The experiment was carried out during 2015-16 in the Dept of Entomology, Orissa University of Agriculture and Technology, Bhubaneswar with eight varieties of milled rice of various sizes (Table 1) in a completely randomized design (CRD) with four replications. The moisture content of the grains were standardised at 12.0 percent. Fifty grams of milled rice were taken in plastic jars of 150 gm capacity and then five pairs of newly emerged adults of *S. oryzae*. (Females: Rostrum relatively long and narrow, punctures along rostrum in regular rows and not touching each other; Males: Rostrum relatively short and wide, punctures along rostrum in large and irregular, not in rows and often touching each other) were released. The mouths of

Table 1. Different varieties of rice used in the study

Sl No.	Varieties	Grain characteristics	Source of collection
V1	Mandakini	Long bold	OUAT
V2	FV-30	Long slender	NRRI, Cuttack
V3	Satabdi	Long slender	NRRI, Cuttack
V4	KalingaIII	Medium slender	NRRI, Cuttack
V5	Jyotirmayee	Medium bold	OUAT
V6	Khandagiri	Medium slender	OUAT
V7	FV-25	Short bold	NRRI, Cuttack
V8	Sidhant	Short slender	OUAT

Note: NRRI - National Rice Research Institute, Cuttack; OUAT - Orissa University of Agriculture and Technology, Bhubaneswar

jars were closed with muslin cloth and tightened with the help of rubber band. The jars were kept at the room temperature of 30 ± 10^0 C with relative humudity of 75 ± 5% Observations were taken on population build-up of the *S. oryzae* and grain damage (%) at 15 days interval up to 60 days after release. The grain damage was calculated by taking 100 numbers of grains randomly out of the 50 gm of samples using the following formula;

$$\text{Grain damage (\%)} = \frac{\text{Total noumber of damaged grains}}{\text{Total number of grains}} \text{x100}$$

The grain hardness was measured mechanically by using the instrument "TA.XT Plus Texture Analyser" at 12.0 percent grain moisture content of the milled rice with the following specifications.

Mode: Measure force in compression
Option: Return to start
Pre-test speed: N/A
Test speed: 0.1 mm/s
Target mode: Strain
Strain: 40%
Distance: 4.8mm
Trigger type: Button
Data acquisition rate: 400pps

The protein content of the milled rice grains was determined by estimating the nitrogen content through the micro-kjeldahl method. To calculate the protein content (%) the following conversion formula was used:

Protein content (%) = Nitrogen content (%) X conversion factor (5.95)

The data obtained on weevil population and percent grain damage was subjected to ANOVA at 5% level of significance.

RESULTS AND DISCUSSION

Population build-up: The data on the adult population build-up of *S. oryzae* and the percent grain damage on different varieties were recorded in the Table 2.

Table 2. Population build-up of adult Sitophilus oryzae L. and grain damage

Varieties	Population count				Grain damage (%)			
	15 DAI	30DAI	45DAI	60DAI	15 DAI	30DAI	45DAI	60DAI
Mandakini	10.75^{ab}	72.75^{ab}	153.25^{b}	434.75^{ab}	3.19^{b}	13.67^{ab}	47.2^{b}	65.17^{b}
	(3.35)*	(8.53)*	(12.36)*	(20.86)*	(10.28)**	(21.68)**	(43.45)**	(53.84)**
FV-30	10.00^{d}	49.75^{bc}	145.00^{cd}	293.50^{cd}	2.42^{d}	12.64^{b}	45.02^{c}	61.24^{c}
	(3.24)	(7.06)	(11.98)	(17.15)	(8.93)	(20.81)	(42.25)	(51.50)
Satabdi	10.25^{c}	54.75^{b}	152.75^{bc}	329.50^{c}	2.70^{c}	13.21^{b}	46.55^{bc}	61.84^{c}
	(3.28)	(7.42)	(12.36)	(18.15)	(9.43)	(21.30)	(43.02)	(51.88)
Naveen	10.00^{d}	32.25^{f}	100.75^{f}	183.00^{f}	1.72^{e}	8.97^{e}	37.84^{e}	55.13^{f}
	(3.24)	(5.72)	(9.83)	(13.32)	(7.49)	(17.30)	(37.95)	(47.95)
Jyotirmayee	11.00^{a}	77.75^{a}	211.25^{a}	445.00^{a}	4.33^{a}	14.85^{a}	54.89^{a}	69.68^{a}
	(3.39)	(8.82)	(14.51)	(21.10)	(11.92)	(22.66)	(47.81)	(56.59)
Khandagiri	10.00^{d}	38.00^{de}	101.25^{ef}	194.25^{f}	2.00^{de}	12.55^{bc}	40.08^{d}	58.65^{e}
	(3.24)	(6.19)	(10.07)	(13.95)	(8.12)	(20.71)	(39.30)	(49.96)
FV-25	10.00^{d}	42.00^{d}	108.25^{de}	274.00^{e}	2.16^{d}	12.62^{b}	40.51^{d}	60.87^{cd}
	(3.24)	(6.50)	(10.42)	(16.56)	(8.42)	(20.78)	(39.52)	(51.28)
Sidhant	10.00^{d}	34.25^{f}	100.75^{f}	184.50^{f}	1.88^{e}	11.65^{cd}	38.21^{de}	56.27^{e}
	(3.24)	(5.88)	(9.83)	(13.57)	(7.85)	(19.91)	(38.17)	(48.61)
SE(m)+	0.001	0.13	0.61	0.35	0.23	0.55	0.70	0.58
CD 0.05	0.004	0.38	1.78	1.02	0.67	1.59	2.04	1.69

Note: DAI: Days after initiation. Values in the parenthesis are the square root (x+0.5) transformed (*) and angular transformed (**)

Table 3. Grain hardness and protein content of the milled rice varieties

Sl. No.	Variety	Grain hardness (Newton)	Protein content (%)
1	Mandakini	50.33	7.25
2	FV-30	55.78	6.99
3	Satabdi	54.09	7.08
4	KalingaIII	98.89	3.76
5	Jyotirmayee	45.73	7.66
6	Khandagiri	77.15	5.99
7	FV-25	58.08	6.65
8	Sidhant	77.23	5.17

The data revealed that there was a highest population build-up of 211.25 and 445.00 numbers per 50g rice in the Jyotirmayee variety along with 54.89 and 69.68% of grain damage at 45 and 60 days after initiation (DAI) of screening and it was followed by Mandakini variety having 434.75 weevil/ 50g rice and 65.17% grain damage at 60 DAI. The lowest number of 183 weevils per 50g rice was recorded in KalingaIII variety with 55.13% grain damage at 60 DAI.

Grain hardness: The grain hardness of the milled rice varieties (Table 3) indicated that a minimum of 45.73 Newton force was required to break down the grains of Jyotirmayee variety which was followed by 50.33 and 54.09 Newton for Mandakini and Satabdi varieties respectively. Highest force of 98.89 Newton was needed to break down the grains of KalingaIII variety. So it was concluded that KalingaIII variety is the hardest among all varieties and Jyotirmayee was the most fragile one.

Protein content: The protein content of the grains was analysed and resulted that Jyotirmayee variety had 7.66% protein which was highest followed by Khandagiri variety (7.25%). KalingaIII variety grains had least amount of protein of 3.76% (Table 3).

Correlation analysis: Weevil population was positively correlated with percent grain damage (0.953) and

Table 4. Correlation between the adult S. oryzae population with the grain hardness and protein content of milled rice

Variable	Population build-up	Grain damage	Hardness	Protein content
Population build-up	1			
Grain damage	0.953*	1		
Hardness	-0.861*	-0.875*	1	
Protein content	0.872*	0.878*	-0.981*	1

*significant at 5% level

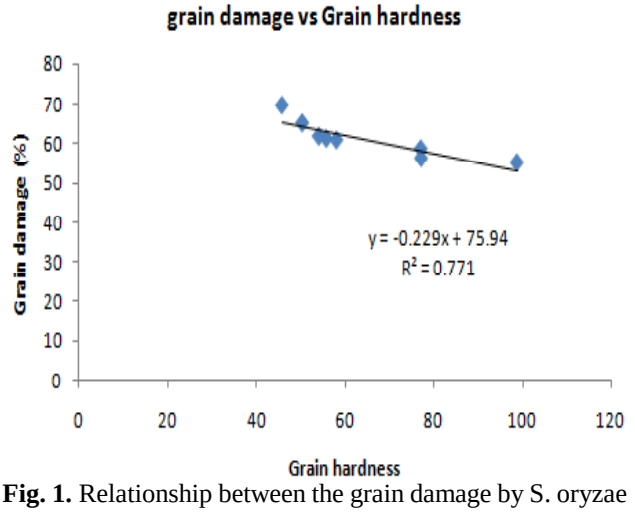

Fig. 1. Relationship between the grain damage by S. oryzae and the grain hardness.

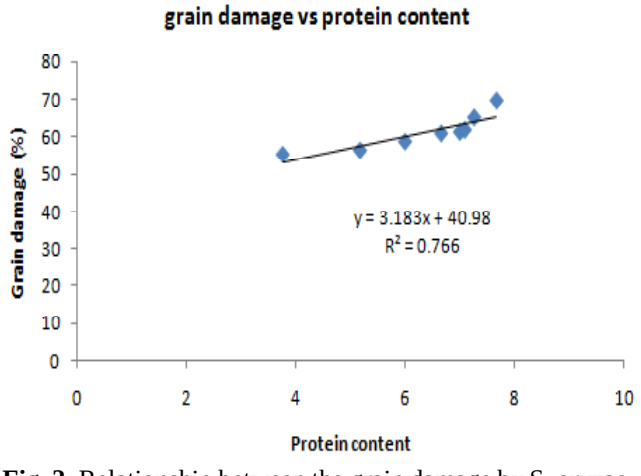

Fig. 2. Relationship between the grain damage by S. oryzae and the grain protein content.

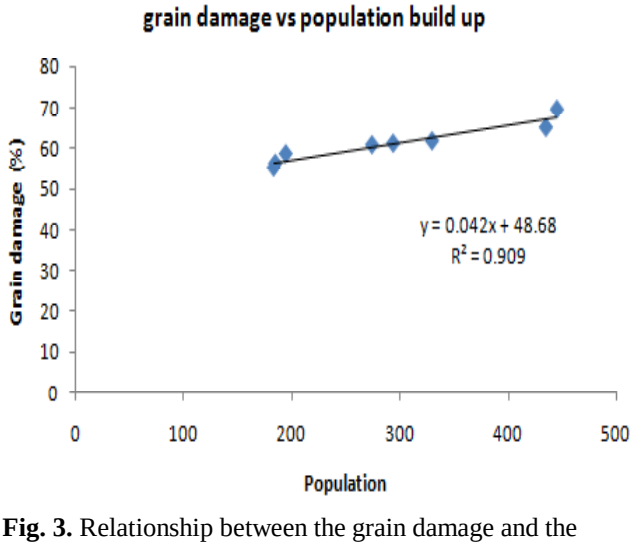

Fig. 3. Relationship between the grain damage and the population build-up by *S. oryzae*

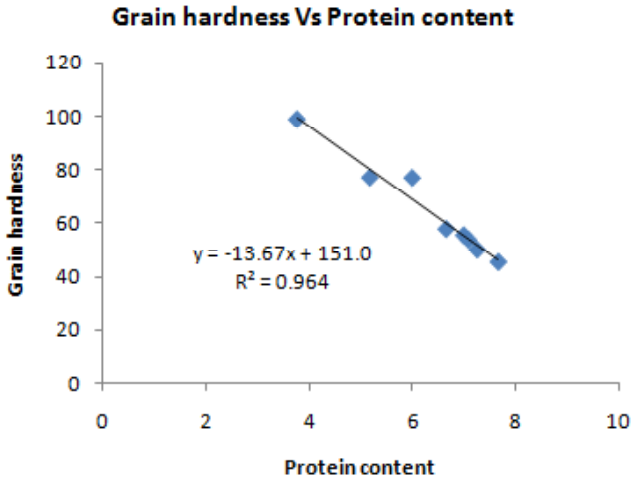

Fig. 4. Relationship between the grain hardness and the grain protein content

negatively correlated with grain hardness (-0.861) (Table 4) Dobie (1974) and Rout *et al.* (1976) established a positive relation between the grain hardness and their resistance towards insect pest attack and also Silverio *et al.* (2003) reported that grain susceptibility is negatively correlated with the grain hardness (r = -0.87) which corroborates our findings. The population build-up and the percent grain damage by the *S. oryzae* is significantly positively correlated with the grain protein content with the correlation coefficient of 0.827 and 0.878, respectively. Sahoo (1998) established a positive relation between the grain protein content and the pod borer infestation in pigeon pea which supports the present findings where as Silverio *et al.* (2003) reported that maize grain susceptibility is negatively correlated with protein content (r = -0.82) which contradicts our result. The grain protein content is significantly negatively corelated to the grain hardness (-0.981). However Webb *et al* (1986) reported the correlation coefficient between grain hardness and protein content is of a lower order of magnitude and inconclusive.

Regression analysis: The result of regression analysis of grain damage with the grain hardness and protein content revealed that for each unit (Newton) increase in hardness, there was a 0.22% decrease in grain damage (Fig.1) and similarly for each unit (percent) increase in protein content, there was 3.18% increase in grain damage (Fig. 2). The regression equation of grain damage with population build-up (Fig.3) also revealed that for each unit increase in population, there was 0.04% increase in grain damage and the regression equation of grain damage with protein content (Fig. 4) indicated that for each unit (percent) increase in protein content there was 13.67% decrease in grain hardness.

It is reported that Jyotirmayee variety was the most susceptible variety among the eight varieties with maximum *Sitophilus oryzae* L. population build-up (445.00 per 50 g rice) and maximum grain damage of 69.68 percent due to highest protein content and least grain hardness. So it was concluded that the infestation of *Sitophilus oryzae* L. is positively correlated with grain protein content and negatively with grain hardness i.e more fragileness in grains, leads to more attack by the rice weevil.

REFERENCES:

Adams JM 1976. Weight loss caused by development of S. oryzae. Journal of Stored Product Research 12 : 269-272

Barber S 1972. Milled rice and changes during ageing. Rice-Chemistry and Technology, pp. 215-263

Dobie P 1974. The laboratory assessment of the inherent susceptibility of maize varieties to postharvest infestation by Sitophilus zeamais Motsch. (Coleoptera: Curculionidae). Journal of Stored Products Research 10:183-197

Koura A and El-Halfway M 1967. Studies on the susceptibility of certain Ezyptian varieties of maize Zea mays to infestation with rice weevil and lesser grain borer and the host preferences of these insects. Agricultural Research Review Cario 45: 490-495

Pathak KA and Jha AN 2003. Incidence of insect pests of storage maize and paddy in different storage structures/ practices of north east region. Indian Journal of Entomology 65:143-145

Peng WK and Hsia WT 1984. Hardness of rice kernel and its relevance to resistance to maize weevil. Plant protection bulletin (Japan). 26:231-235

Rajendran S and Sriranjini V 2008. Plant products as fumigants for stored-product insect control. Journal of Stored Product Research 44: 126-135

Rout B, Senapati G and Ahmed T 1976. Studies on the relative susceptibility of some high yielding varieties of rice to the rice weevil (Sitophilus oryzae L.) (Curculionidae: Coleoptera) Bulletin of Grain Technology 14:34-36

Sahoo BK 1998. Bioecology of pod borers of pigeon pea (*Cajanus cajan* L. Millsp) in coastal district of Orissa and their managements. A Ph.D thesis submitted to Orissa University of Agriculture and Technology,Bhubaneswar(Orissa)

Silverio GL, David JB, Andrew JB, Al I R, David MDP and John TA 2003. The Role of Pericarp Cell Wall Components in Maize Weevil Resistance, Crop Science Society of America 44(5): 1546-1552

Webb WD, Pomeranz Y, Afework S, Lai FS and Bollich CN 1986. Rice grain hardness and its relationship to some milling, cooking and processing characteristics. Cereal Chemistry 63(1): 27-30