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INFESTATION RATE OF RICE WEEVIL ON SELECTED INDIGENOUS STORED GRAINS

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ABSTRACT

Rice weevil, *Sitophilus oryzae* Lin. (Coleoptera: Curculionidae) is economically significant and known as a ubiquitous pest in Bangladesh as well as throughout the world. In this study, the infestation rate by this pest was assessed throughout the year on twelve common indigenous cereal grains and pulses, namely boiled and nonboiled rice, wheat, barley, maize, felon, pea, grass pea, lentil, chickpea, black gram and mung bean. There were significant differences in the infestation rate among the months and in the susceptibility among grains over the year. The highest percentage of weight loss over the year was found in chickpea (84.56%) and the lowest percentage of weight loss was found in black gram (7.09%). The chronological position of the experimental grains according to their percentages of weight loss was chickpea > wheat > barley > maize > nonboiled rice > pea > boiled rice > grass pea > lentil ≥ mung bean > felon > black gram. The highest infestation occurs at the temperature range of 32-35°C and during the month of April-June.

Keywords: *Sitophilus oryzae*, infestation, stored grains, cereals, pulses

Introduction

Bangladesh is the fourth largest rice-producing country in the world. Besides rice, other cereals like wheat, maize, barley, etc. and different pulses are also cultivated here for domestic need and export as well. The harvested grains are the most fundamental foods for humans (Padin *et al.* 2002). Food grain loss due to insect infestation during storage is a major issue, especially in developing countries (Dubey *et al*. 2008, Talukder *et al*. 2004). This problem is a serious concern as the population is increasing rapidly (2.5%-3.0%) in comparison to the increase in food production (1.0%). A considerable loss of agricultural products in stored condition, add a serious burden to people's daily life. It has been reported that one-quarter and one-third of world grain crops are lost each year during storage (Emery and Cousins 2019) due to insect attacks. The quantitative and qualitative damage to stored grains and grain products from the insect pests may be 20-30% in the tropical zone and 5-10% in the temperate zone (Rajendran and Sriranjini 2008, Talukder 2006). Vinuela *et al.* (1993) reported that 75% of stored grain pests are coleopterans and the most damaging species are from the genera *Sitophilus* and *Tribolium.* Rice weevil is a ubiquitous and the primary pest of stored grains in the world particularly in warmer climates (Correa *et al.* 2013). In Bangladesh, the khapra beetle, rice weevil, and rust-red flour beetle were reported as more harmful for storage wheat grain (Arifuzzaman 2015). Pulse beetle, *Callosobruchus maculatus* Fab. is a major pest of stored green gram, *Vigna radiata* (Miah *et al*. 2013). Moreover, the Pulse beetle, *Callosobruchus chinensis* Lin. was reported as the major pest of stored Chickpea (Mala *et al*. 2010).

Rice weevil, a highly destructive insect pest of stored raw cereal grains (SAHOO and SAHOO 2017) leads to significant losses amounting to 18.30% (ADAMS 1976). Akbar *et al.* (2023) assessed quantitative losses in different wheat varieties due to rice weevil (Sitophilus oryzae L.) and revealed that among several wheat varieties RSP 561 was highly susceptible with 23.6% weight loss up to six months of storage period. In 2009, Subedi *et al.* tried to find out the host preference of rice weevil (Sitophilus oryzae L.) on selected stored grains in Chitwan, Nepal.

Based on the percentage of weight loss from that study, wheat (17.72%) appeared to be the most preferred host for S. oryzae L. followed by polished rice (11.57%), barley (9.18%) Maize (7.18%) and rough rice (3.40%) after 60 days of treatment. Batta (2004) showed that at 25 – 30 °C and low relative humidity, this pest causes the highest damage to grains at storage.

Therefore, the present study was under taken to find out the grains which are more susceptible to the infestation of *S. oryzae* and to find out the month that is more favorable to infest by this insect pest. This study may contribute to adopt strategy against the damage of rice weevil for specific stored grains.

Materials and Methods

Collection of rice weevil: Infested rice grains were collected from the local market of Hathazari, Chattogram. *S. oryzae* were sorted from infested grains observing under a simple microscope and kept in a jar containing fresh rice grains as culture medium. For proper aeration, the lids of the jar were pierced with a heated slender pin**.**

Collection of grains; Non-boiled and boiled rice (*Oryza sativa* L.), wheat *(Triticum aestivum* L.*),* barley *(Hordeum vulgare* L.*)*, maize *(Zea mays* L.*)*, felon (*Phaseolus densiflorus* L.*),* pea *(Pisum sativum* L.*),* grass pea *(Lathyrus sativus* L.*)*, lentil *(Lens culinaris* L.*)*, chickpea (*Cicer arietinum* L.*)*, black gram *(Vigna mungo* L.*)* and mung bean *(Vigna radiata* L.*)* were selected for this study. Grain samples were collected in December 2017 from Salam store, Horogram bazar, Court Station Road, Rajshahi, and local market of Hathazari, Chattogram.

After collection, all fresh grains were properly sun dried and all the foreign particles were removed from the grains. The study was conducted in the small plastic jar with three replicates for each grain. A heated slender pin was used to get several minute punctures on the lid of each jar which help in aeration as well as in preventing escape of the insects. All jars were labeled carefully with replicate numbers.

Weight of all empty jars with lids were taken and noted down first. Then, 200g of each grain was taken in each of the small plastic jars following the label that was previously prepared. Ten *S. oryzae* were taken from the pure culture and released in each replicate of experimental grains. Then weight of fresh grain with insect was measured and noted down for each replicate of each grain. Finally, all jars of the experimented grains were kept in a cartoon paper box and reared for one month in a safe and dark chamber in the laboratory of Entomology, Department of Zoology, University of Chittagong. On last day of the month, fluctuations of the weight were taken through an electric balance (Model- Shinko KS-300A, 300g/0.01g). Then, the weight of the jars with grains was subtracted from the previous weight of jars and noted down.

After that, all jars were cleaned off and decontaminated to add 200g of fresh grain as previous and ten *S. oryzae* was released in each jar and kept for one month in a dark place as like as before. This process was continued in each months from January 2018 to December 2018. The prevailing temperature during the study period was also noted (Table 3).

Statistical analysis: Data were analyzed by one-way analysis of variance (ANOVA) test using the IBM statistical analyzing program, SPSS. Differences among the treatments were determined by Tukey HSD test at $p \leq 0.05$. Percentages of weight loss of the grains over the year were also calculated.

Results and Discussion

Selected experimental grains showed varied weight loss pattern over the year. For boiled rice, highest percentage of weight loss was found during May-June and lowest was found in January whereas, in the case of nonboiled rice, the highest percentage of weight loss was found in May and the lowest was found during December-January. Wheat and pea also showed the same weight loss pattern as nonboiled rice. In May, highest percentages of weight loss were also found in barley, maize, felon, grass pea, and black gram just like other three grains i.e. nonboiled rice, pea, and wheat but in case of lowest percentages those were similar to the boiled rice (in January) (Table 1). May was found to be more favorable for lentil and December seemed less favorable. May was also found as the most favorable in case of mung bean and January was found as less favorable though the value was statistically same as March. Chickpea showed lowest weight loss in January whereas it showed highest weight loss in May in

Table 1: Comparison of the infestation rate (%) of *Sitophilus oryzae* on different grain species among the months of a year

Cereal grain	Infestation rate (%) in different months												F statistic	
	January	February	March	April	May	June	July	August	September	October	November	December	F_{df}	P
Boiled rice	0.4 ±0.2 f	0.4±0.1 ef	0.8±0.1 df	2.0±0.3 bc	4.2±0.4 a	4.1±0.7 a	2.9±0.2 b	2.2±0.3 bc	1.5±0.2 cd	1.7±0.4 cd	1.4±0.3 ce	0.9±0.1 df	$F_{11,24}$= 53.2	< 0.001
Nonboiled rice	0.4±0.2 f	1.4±0.3 ef	2.0±0.6 e	2.7±0.1 de	13.9±0.8 a	11.9±0.7 b	9.9±0.5 c	3.8±0.7 d	2.7±0.4 de	2.0±0.4 e	1.6±0.2 ef	0.5±0.3 f	$F_{11,24}$= 277.5	< 0.001
Wheat	0.3±0.2 f	1.4±0.3 ef	2.1±0.6 e	2.7±0.1 de	13.9±0.8 a	11.9±0.7 b	9.9±0.5 c	3.8±0.7 d	2.7±0.4 de	2.0±0.4 e	1.8±0.2 ef	0.5±0.3 f	$F_{11,24}$= 85.1	< 0.001
Barley	0.2±0.1 g	0.6±0.3 fg	3.5±0.4d f	7.9±1.3 c	15.5±1.5 a	11.1±2 b	6.1±0.8 cd	4.9±0.4 cd	4.7±0.7 d	3.7±1.1 de	3.1±1.5 dg	1.1±0.2 eg	$F_{11,24}$= 56.6	< 0.001
Maize	0.2±0.0 g	0.3±0.1 g	1.5±0.2 fg	4.2±0.3 de	13.9±1.5 a	9.0±1.1 b	7.3±1.4 bc	5.7±0.7 cd	4.5±0.2 de	3.8±0.3 de	2.7±0.6 ef	1.4±0.5 fg	$F_{11,24}$= 86.5	< 0.001
Felon	0.3±0.3 e	0.2±0.0 de	0.3±0.1 ce	0.5±0.0 be	1.8±0.3 a	1.0±0.1 b	0.9±0.2 bc	1.0±0.1 b	0.7±0.3 bd	0.5±0.3 be	0.3±0.4 ce	0.2±0.1 de	$F_{11,24}$= 16.2	< 0.001
Pea	0.5±0.3 d	1.6±0.9 bd	2.4±1.2 ad	3.8±0.9 ab	4.6±0.9 a	4.1±0.1 ab	3.7±1.0 ab	3.5±1.0 ac	3.5±1.3 ac	2.8±1.0 ad	1.1±0.4 cd	0.9±0.1 d	$F_{11,24}$= 7.8	< 0.001
Lentil	0.3±0.1 cd	0.4±0.0 bd	0.7±0.4 ad	1.2±0.2 ad	1.8±0.0 a	1.6±1.0 ab	1.5±0.6 ac	1.0±0.5 ad	0.8±0.4 ad	0.5±0.3 bd	0.4±0.2 bd	0.2±0.3 d	$F_{11,24}$= 5.0	< 0.01
Grass pea	0.3±0.1 c	0.9±0.2 bc	1.3±0.9 ac	1.9±0.1 ab	2.3±0.3 a	2.0±0.6 ab	1.5±0.3 ac	1.4±0.1 ac	1.4±0.5 ac	1.3±0.9 ac	1.3±0.2 ac	1.1±0.4 ac	$F_{11,24}$= 3.7	< 0.003
Chickpea	0.2±0.1 c	5.0±1.2 b	5.6±1.2 b	13.0±1.3 a	15.2±1.2 a	14.7±1.1 a	7.1±1.6 b	6.3±0.6 b	5.7±1.5 b	5.3±1.3 b	5.5±0.7 b	1.4±0.1 c	$F_{11,24}$= 56.5	< 0.001
Black gram	0.3±0.0 f	0.6±0.1 df	0.8±0.2 cf	1.5±0.4 bc	2.5±0.5 a	2.0±0.4 ab	1.2±0.4 be	1.3±0.2 bd	0.9±0.3 cf	0.7±0.0 cf	0.5±0.2 ef	0.5±0.2 ef	$F_{11,24}$= 16.5	< 0.001
Mung bean	0.4±0.4 c	0.7±0.1 bc	0.5±0.3 c	1.2±0.3 ac	1.8±0.5 a	1.6±0.2 ab	1.1±0.1 ac	1.0±0.2 ac	1.0±0.3 ac	1.1±0.4 ac	0.7±0.4 bc	0.7±0.5 bc	$F_{11,24}$= 5.2	< 0.001

Data expressed as mean ± SD. Means within a row followed by the same letter(s) are not significantly different by Tukey HSD test at $p \leq 0.05$.

spite of showing statistically same results during April-June (Table 1).

Due to the varied temperature, it is appeared from Table 2 that, in January pea was found as most susceptible and felon was found as less susceptible against *S. oryzae* L. where, rest of the experimental grains were statistically similar susceptible. During February-June, chickpea revealed more sensitivity than pea while felon remained same as before. Boiled rice revealed statistically similar result as chickpea in May but lentil and mung bean showed similar susceptibility as like as felon. In June, instead of boiled rice, wheat was similar as chickpea in case of most susceptibility and then in July, boiled rice again joined the same category of chickpea. Felon was less susceptible in June just like before but in July, along with this pulse, black gram, mung bean showed similarly less sensitivity to *S. oryzae* L. August was found to be more favorable to maize though it was statistically similar to wheat and chick pea and found to be less favorable to felon just like earlier. Lentil, grass pea, black gram, and mung bean also added up with felon in case of less susceptibility in August. During September to November, chick pea remained the most sensitive as earlier and felon remained the same as less susceptible till December. In September boiled rice, lentil, grass pea, black gram and mung bean showed statistically similar sensitivity as felon and then during October to November only lentil took the place of lowest susceptibility. In December, wheat expressed highest sensitivity and felon was less sensitive to the pest. Over the year, felon remained as less susceptible to the test insect, whereas, chickpea remained as the most susceptible to the rice weevil, *S. oryzae* L.

Among these experimental grains, highest percentage of weight loss was found in *C. arietinum* (Chickpea) and lowest percentage of weight loss was found in *V. mungo* (Black gram). The highest weight loss was 84.56% and the lowest weight loss was 7.09%. After chick pea, wheat was the second susceptible host for this species having a total of 68.91% weight loss over the year, followed by barley. It was found that *S. oryzae* L. causes about 15% loss of rice (Khan and Mannan 1991) and 11-16% weight loss of husked rice during four months of storage in the laboratory (Bhuiyan *et al*. 1992) which is as similar as present outcomes (Figure- 1). From Figure 1, it can be noted that the weight loss of maize as a total of 54.33% over the year that supports the results of Bhuiyah *et al.* (1990). That study stated that the weight loss of maize grains was 38.12% after 6 months of storage due to *S. oryzae* L.

Chronological position of the experimental grains according to their percentages of weight loss is as below as:

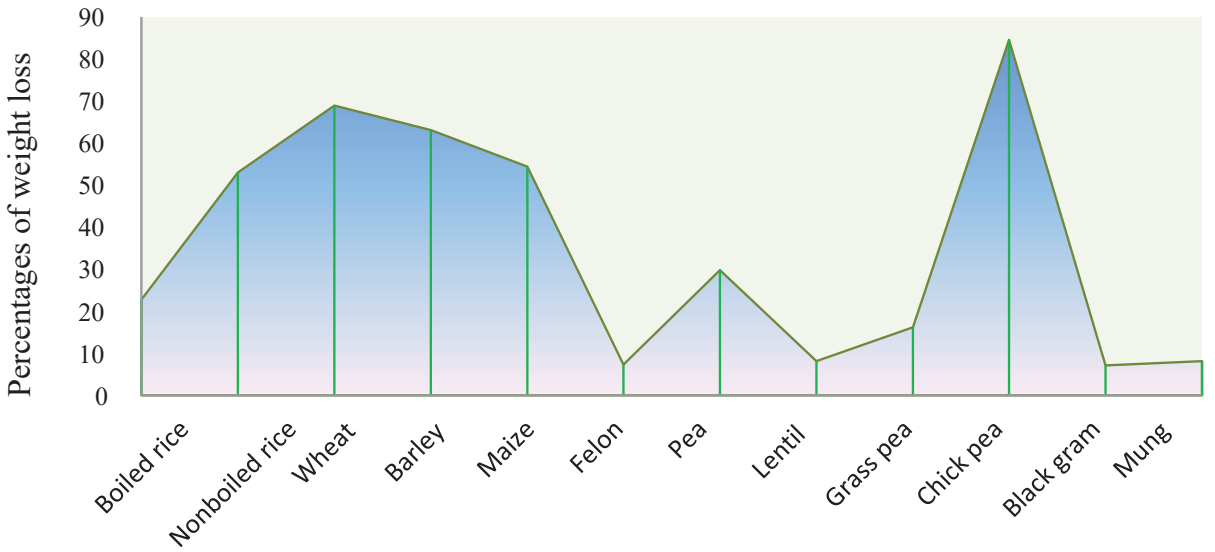


Figure 1: Percent (%) weight loss of the grains

Table 2. Comparison of the infestation rate (%) of *Sitophilus oryzae* among the grain species in each month of a year

Cereal grain	Infestation rate (%) on different grains												F statistic	
	Boiled rice	Nonboiled rice	Wheat	Barly	Maize	Felon	Pea	Lentil	Grass pea	Chickpea	Black gram	Mung bean	F_{df}	p
January	0.4±0.2 ab	0.3±0.2 ab	0.4±0.1 ab	0.2±0.0 ab	0.2±0.0 ab	0.0±0.0 b	0.5±0.3 a	0.3±0.1 ab	0.3±0.0 ab	0.2±0.1 ab	0.3±0.0 ab	0.4±0.4 ab	$F_{11,24}$= 1.9	< 0.05
February	0.5±0.1 cd	1.4±0.3 cd	3.2±0.8 b	0.6±0.3 cd	0.3±0.1 cd	0.2±0.0 d	1.6±0.8 cd	0.4±0.0 cd	0.9±0.2 cd	5.0±1.1 a	0.6±0.1 cd	0.7±0.1 cd	$F_{11,24}$= 26.3	< 0.001
March	0.9±0.1 cd	2.1±0.6 bd	3.4±0.5 b	3.5±0.4 b	1.5±0.2 cd	0.3±0.1 d	2.4±1.2 bc	0.7±0.4 cd	1.3±0.9 cd	5.6±1.2 a	0.8±0.2 cd	0.5±0.3 cd	$F_{11,24}$= 18.6	< 0.001
April	2.0±0.3 df	2.7±0.1 ce	3.8±1.0 cd	7.9±1.3 b	4.2±0.3 c	0.5±0.0 f	3.8±0.9 cd	1.2±0.2 ef	1.9±0.1 df	13.0±1.3 a	1.5±0.4 ef	1.2±0.3 ef	$F_{11,24}$= 79.4	< 0.001
May	4.3±0.4 bc	132.9±0.8 a	14.2±0.8 a	15.5±1.5 a	13.9±1.5 a	1.8±0.3 c	4.6±0.9 b	1.8±0.0 c	2.3±0.3 bc	15.2±1.2 a	2.5±0.5 bc	1.8±0.5 c	$F_{11,24}$=155.5	< 0.001
June	4.1±0.7 d	11.9±0.7 b	14.7±0.6 a	11.1±2.0 bc	9.0±1.1 c	1.0±0.1 e	4.1±0.1 d	1.6±1.1 de	2.0±0.6 de	14.7±1.1 a	2.0±0.4 de	1.6±0.2 de	$F_{11,24}$=113.3	< 0.001
July	2.9±0.2 cd	9.9±0.5 a	11.7±0.4 a	6.1±0.8 b	7.3±1.4 b	0.9±0.2 d	3.7±1.0 c	1.5±0.6 cd	1.5±0.3 cd	7.1±1.6 b	1.2±0.4 d	1.1±0.1 d	$F_{11,24}$= 67.3	< 0.001
August	2.2±0.3 cd	3.8±0.7 bc	6.3±1.1 a	4.9±0.4 ab	5.7±0.7 a	1.0±0.1 d	3.5±1.0 bc	1.0±0.5 d	1.4±0.1 d	6.3±0.6 a	1.3±0.2 d	1.0±0.2 d	$F_{11,24}$= 39.5	< 0.001
September	1.5±0.1 d	2.7±0.4 cd	4.0±0.3 ac	4.7±0.7 ab	4.5±0.2 ac	0.8±0.3 d	3.5±1.3 bc	0.8±0.7 d	1.4±0.5 d	5.7±1.5 a	0.9±0.3 d	1.0±0.3 d	$F_{11,24}$= 21.7	< 0.001
October	1.7±0.3 bd	2.0±0.4 bd	3.6±1.1 ab	3.7±1.1 ab	3.8±0.3 ab	0.5±0.3 d	2.8±1.0 bc	0.5±0.3 d	1.3±0.9 cd	5.3±1.3 a	0.7±0.0 cd	1.1±0.4 cd	$F_{11,24}$= 13.2	< 0.001
November	1.4±0.3 be	1.8±0.2 be	3.6±1.8 ab	3.1±1.5 bc	2.7±0.6 bd	0.3±0.4 e	1.1±0.4 ce	0.4±0.2 e	1.3±0.2 ce	5.5±0.7 a	0.5±0.2 de	0.7±0.4 de	$F_{11,24}$= 12.7	< 0.001
December	0.9±0.1 bc	0.5±0.3 bc	3.2±0.9 a	1.1±0.2 bc	1.4±0.5 b	0.2±0.1 c	0.9±0.1 bc	0.2±0.3 bc	1.1±0.4 bc	1.4±0.1 b	0.5±0.2 bc	0.7±0.5 bc	$F_{11,24}$= 13.0	< 0.001

Data expressed as mean ± SD. Means within a column followed by the same letter(s) are not significantly different by Tukey HSD test at $p \leq 0.05$.

Table 3. Temperature record of the study period

Name of the months		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average temp. in °C	Highest	25	28	32	32	34	35	33	32	34	33	28	25
	Lowest	14	19	20	25	28	29	27	27	26	26	19	16

C. arietinum (Chickpea) > *T. aestivum* (Wheat) > *H. vulgare* (Barley) > *Z. mays* (Maize) > *O. sativa* (Non-boiled rice) > *P. sativum* (Pea) > *O. sativa* (Boiled rice) > *L. sativus* (Grass pea) > *L. culinaris* (Lentil) ≥ *V. radiata* (Mung) > *P. densiflorus* (Felon) > *V. mungo* (Black gram).

The reason of infesting different grains at different rate was size (most importantly), the moisture content, hardness, nature of surface of the grains. Similar findings were reported by Stejskel and Kucerova (1996). Hence, chickpea is most susceptible and black gram is less susceptible to experimental pest species whereas lentil and mung show equal susceptibility (Figure 1, Table 3).

According to Bello (2001), the highest infestation occurs at the temperature of 25-30°C. Khare and Agrawal (1962) observed maximum damage by *S. oryzae* L. during July –August in stored maize and wheat while, Alam (1972) found highest infestation rate by *S. oryzae* in different grains occurred between July-October and very little damage was done during the period from December to February. Findings of present study showed that, the time period of the lowest infestation in a year almost was same as the previous studies; but in case of highest infestation period, the time has come three months ahead with the temperature in between 32-35°C (Table 3). The reason for this change was that the study was run in the University of Chittagong which is a hilly-sea coast area and the rainfall pattern and humidity prevails there is somewhat different from the plain land. And again, this dissimilarity occurred due to the changed weather and climatic pattern between 21st centuries and 20th centuries.

Conclusion

Loss of stored food grains due to insect infestation is an economic problem for the farmers and the stakeholders. There is a connection between the temperature and infestation along with the grain size. Result indicated that rice weevil can infest all type of domestic grains available in Bangladesh. The kernel damage caused by *S. oryzae* L. results in degrading the food commodities both in quantity and quality. Current study has revealed that, chickpea hold the most vulnerable position but it's a matter of concern that all the available grains can be infested by this destructive pest. As the global temperature is rising up gradually, these findings will help in taking necessary effective measures to ensure healthy diet to the people of this country as well as to keep the market value.

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