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Reproductive Fitness and Feeding Preference of *Rhyzopertha dominica* in Different Major Cereals

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ABSTRACT

A laboratory experiment was carried out in the Department of Entomology, School of Agricultural Sciences, Nagaland University, Medziphema, Nagaland in order, to estimate the reproductive fitness and feeding preference on selected stored cereal grain due to lesser grain borer (*Rhyzopertha dominica*). Wheat, rice, maize, sorghum, finger millet and barley were used in experiment. The assessed parameters were ovipositional preference (in both choice and no-choice test) and feeding preference. The results revealed that wheat was the most preferred host grain in ovipositional preference with 75.50 and 23.75 eggs laid in no choice and choice test respectively, and was followed by rice, sorghum, barley, maize and finger millet. Similarly, wheat was also most preferred in comparative storage losses with 41.25% grain damage and 20.95% weight loss, and was followed by rice, barley, maize, finger millet and sorghum after 90 days of storage.

Keywords Lesser grain borer, Ovipositional preference, Feeding preference, Wheat.

INTRODUCTION

The problem of feeding the ever-increasing human population is not solved by simply producing more food. It is important to protect food from damage and attacks by pests for economic, health and quality of life. According to the Food and Agriculture Organization of the United Nations (FAO 2019), insects are responsible for about 20% of this loss, or about 260 million tonnes of food per year. Numerous insect pests, including the smaller grain borer (*Rhyzopertha dominica* (Fab), rice weevil, granary weevil and Khapra beetle, attack the grain kept in the warehouse godowns in big or small amounts.

Rhyzopertha dominica (Fabricius 1792) (Coleoptera: Bostrichidae), the lesser grain borer, a primary pest of stored grain, mainly wheat, occurs all over the world and survives on a variety of other grains like rice, sorghum, oats, pearl millet, barley, chickpeas, peanuts and beans (Edde 2012). The larvae

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and adults *R. dominica* insect attack whole grains and cause extensive damage (Williams *et al*. 1981). They spend most of their life inside the kernel and causes serious damage in warm climates. In case of serious infestation of this pest in the flours, the flour turns yellowish and mouldy, has a pungent, obnoxious odour and becomes unfit for human consumption (Egal *et al*. 2005).

Wheat is commonly stored together with other grains such as barley, rye, oats and triticale. They contain major nutritive groups, important for the development and fitness of *R. dominica.* Wheat, barley, rye, oats and triticale differ in the amount of proteins, starch and other nutrients they possess but *R. dominica* has the genetic plasticity to thrive independently in each of these grains (Sheeba and Bai 2021). It is important to assess the influence of smaller grains on progeny production and feeding preferences of *R. dominica.* Thus, considering all the point mentioned above, the following investigation entitled "reproductive fitness and feeding preference of *R. dominica* in different major cereals" was undertaken.

MATERIALS AND METHODS

The laboratory experiment was conducted at storage laboratory of the Department of Entomology, School of Agricultural Sciences, Medziphema campus. The experiment was carried out in a Complete Randomized Design (CRD) replicated four times. Rice, Wheat, Maize, Sorghum, Finger millet and Barley seeds were used in the experiment.

Ovipositional preference

No choice test: For no choice test, 100 grains from each type (Rice, Wheat, Maize, Sorghum, Finger millet and Barley) were kept in separate petri dishes. Newly emerged male and female adults were released in each petri dish. The petri dishes were kept in incubator. Released insects were allowed to oviposit for two days. A similar test was continued four times using the same insects. After each test the grains were collected and the grains containing eggs were separated out by examining with magnifying glass and the numbers of egg laid were counted.

Choice test: For choice test, 50 grains (not cracked or broken) from each type (Rice, Maize, Wheat, Sorghum, Finger millet and Barley) were kept together in one petri dish (5" diameter). 100 pairs of newly emerged adults were released into the choice paradigm. The Petri dish was kept in incubator. Released insects were allowed to oviposit for two days. After two days, the grains were collected and the grains containing eggs were separated out by examining with magnifying glass and the numbers of egg laid were counted.

Feeding preference

To determine the response of *R. dominica* males and females to different grains, 50 pairs of newly emerged weevils were placed in the center of test arena, a plastic container with a lid (60×40×25 cm). Four replications with six treatments containing 100 g of rice, wheat, maize, sorghum, Barley and finger millet were offered in separate Petri dishes. Feeding preference parameters included: grain damage, remained grain weight and weight loss percentage. Damaged grains were separated manually from undamaged grains using a magnifying glass and were weighed, separately. Results were recorded at 30 days interval i.e., 30, 60 and 90 days.

Grain damage percentage: Percent of grain damage was calculated using the following formula:

$$\text{Grain damage percentage} = \frac{\text{Number of damage seed}}{\text{Total number of seed}} \times 100$$

Weight loss percentage

$$\text{Weight loss (\%)} = \frac{\text{Initial weight of grains} - \text{Final weight of grains}}{\text{Total weight of grains}} \times 100$$

Adult emergence: The progeny emergence was determined by counting insects separated from grains.

Statistical analysis

The data obtained from different treatments were subjected to statistical analysis as per the statistical guidelines by Gomez and Gomez (1984). Wherever appropriate, the findings were converted to arc sine

values. The significance of treatment was determined by a critical difference (CD) test at a 5% level of significance for the comparison of treatments.

RESULTS AND DISCUSSION

Ovipositional preference

No choice test

The mean data presented in Table 1 and Fig. 1 shows that the ovipositional preference of lesser grain borer was found statistically significant in all four observations. The mean number of eggs laid in wheat was recorded to be highest, followed by rice, sorghum, barley and finger millet on the 2nd, 4th, 6th and 8th day inspections. For instance, on the 2nd day observation, wheat showed the highest number of eggs laid (52.00), followed by rice (48.75) and sorghum (42.50). The lowest egg laid was recorded in finger millet (28.00). The number of eggs laid had enhanced when observed at 4th days, the maximum eggs laid observed in wheat (67.50) followed by rice (58.25) and barley (49.75). At 6th day in this no-choice test, wheat was the most susceptible host grain with eggs laid (74.00), though this value was statistically significant to rice (56.25), barley and sorghum (48) was found statistically at par with each other and finger millet (32.50), respectively. The highest eggs laid (75.50) at 8th day, this level was higher than those observed from other grains, all of which differed statistically from rice and also each other. Wheat was the most preferred host grain with 75.50 eggs laid, followed by rice (64.25), barley (54.75) and finger millet (28.00).

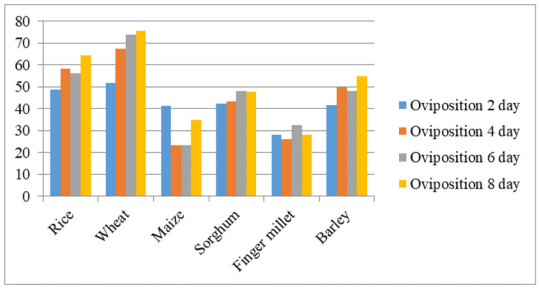

Fig. 1. Oviposition preference of *Rhyzopertha dominica* on different cereal grains in no choice test.

Choice test

The mean data presented in Table 2 and Fig. 2 shows that the ovipositional preference of lesser grain borer was found statistically significant in all four observations. The average number of eggs laid in wheat was recorded to be highest, followed by rice, sorghum, barley and finger millet on the 2nd, 4th, 6th and 8th day inspections. For instance, on the 2nd day observation, wheat demonstrated the highest number of eggs laid (19.00), followed by barley (17.25), maize (11.25), rice (10.25) and sorghum (4.75). The lowest egg laid was recorded in finger millet (3.25). The number of eggs laid had enhanced when observed at 4th days, the maximum eggs laid observed in wheat (20.25) followed by barley (19.25), while sorghum (12.75), maize (12.50) and rice (12.25) were found at par with each other. At 6th day in this choice test, wheat was the most susceptible host grain with eggs laid (22.50) and barley (22.25) were found statistically at par with each other, followed by sorghum (15.50), finger millet (14.75) and rice and maize (13.75) which were found

Table 1. Oviposition preference of *Rhyzopertha dominica* on different cereal grains in no- choice test.

Treatments	Oviposition No choice test			
	2 DAS	4 DAS	6 DAS	8 DAS
Rice	48.75	58.25	56.25	64.25
Wheat	52.00	67.50	74.00	75.50
Maize	41.25	23.25	23.50	35.00
Sorghum	42.50	43.25	48.25	47.75
Finger millet	28.00	26.00	32.50	28.00
Barley	41.75	49.75	48.25	54.75
SEm ±	0.15	0.26	0.22	0.26
CD at 5%	0.46	0.78	0.68	0.78

Table 2. Oviposition preference of *Rhyzopertha dominica* on different cereal grains in choice test.

Treatments	Oviposition Choice test			
	2 DAS	4 DAS	6 DAS	8 DAS
Rice	10.25	12.25	13.75	14.50
Wheat	19.00	20.25	22.50	23.75
Maize	11.25	12.50	13.75	14.50
Sorghum	4.75	12.75	15.50	16.75
Finger millet	3.25	11.50	14.75	16.25
Barley	17.25	19.25	22.25	22.75
SEm ±	0.22	0.16	0.23	0.24
CD at 5%	0.68	0.49	0.69	0.66

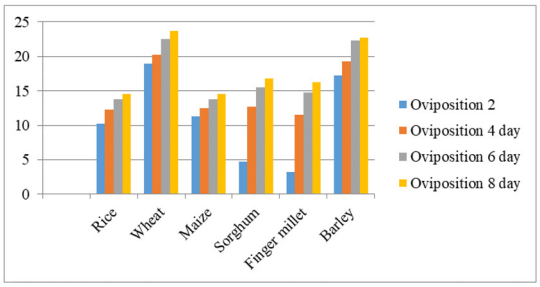

Fig. 2. Oviposition preference of *Rhyzopertha dominica* on different cereal grains in choice test.

Table 3. Number of adult emergences of *Rhyzopertha dominica* on different cereals.

Treatments	Number of adult emergence		
	30 DAS	60 DAS	90 DAS
Rice	2.50	7.50	13.75
Wheat	3.50	10.75	21.25
Maize	1.00	4.00	10.25
Sorghum	1.25	4.75	9.75
Finger millet	1.00	3.50	8.75
Barley	2.00	6.00	8.00
SEm ±	0.14	0.17	0.10
CD at 5%	0.43	0.52	0.32

statistically at par with each other. At 8th day, wheat was the most preferred host grain with 23.75 eggs laid, followed by barley (22.75), sorghum (16.75) and finger millet (16.25) were found at par with each other followed by maize (16.75) and rice (14.50) were found at par with each other. The obtained results is in partial conformity with the finding of Shukla *et al.* (2020) who investigated that TL 174 had the highest fertility (121.33 eggs), whereas K 65 and HI 774 had the lowest (30.33 and 27.33 eggs, respectively). In terms of oviposition preference, HI 774 ranked second with 73.33 eggs, followed by UPT 72294 and HD1982, with 67.33 and 54.00 eggs, respectively. K 65 and HI 774 produce 30.33 and 27.33 eggs, respectively, making them less recommended for egg production. Similarly, Kumar *et al.* (2017) assessed biological parameters such as egg duration, hatching percentage, larval and pupal periods, development period, fecundity, male and female longevity, sex ratio, pre-oviposition, oviposition, and post-oviposition period. Results showed that maize hybrid was the least preferred host for *R. dominica,* followed by paddy variety, Sumati, and sorghum variety, M 35-1. Female longevity was longer in all hosts. The study also found that the shortest pre-oviposition, oviposition, and post oviposition periods were recorded in Maize hybrid DHM-111.

Adult emergence

The mean data presented in Table 3 and Fig. 3 shows that the maximum number of adults of lesser grain borer (3.50) was recorded in wheat after 30 days followed by rice (2.50), barley (2.00) and sorghum (1.25). While minimum number of adult recorded on finger millet and maize (1.00) which were found statistically at par after 30 days inspection. The number of adult emergence was increased after 60 days and the maximum number of adult was observed in wheat (10.75) which was significantly differ from other host grain followed by rice (7.50), barley (6.00), sorghum (4.75) and maize (4.00), respectively. While, the minimum adult emergence after 60 days was observed in finger millet (3.50). At 90 day, the highest adult emergence was recorded in wheat (21.25) followed by rice (13.75), maize (10.25), sorghum (9.75) and finger millet (8.75) while minimum number of adults was recorded in barley (8.00). These findings are similar with the findings of Aslam *et al.* (2017) who found that temperature and nutrition have a direct impact on the lesser grain borer's life cycle. *R. dominica* egg laying was lowest at 25°C and on a diet of oats (egg laying rate of 9.66). After 10 days of observation, larval emergence was lowest at 25°C with diet oat (14.66) and highest at 32°C with diet wheat (27.66). After 45 days, pupae development was highest at

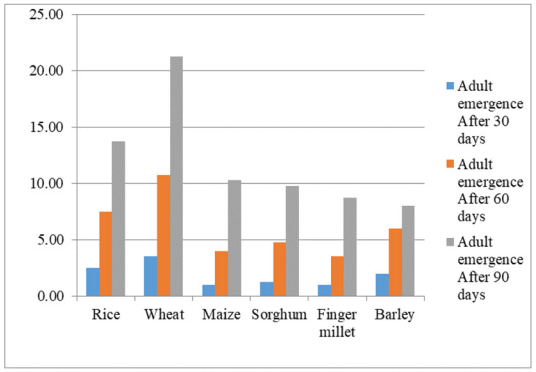

Fig. 3. Number of adult emergences of *Rhyzopertha dominica* on different cereal.

Table 4. The seed damage in different cereals grains due to *R. dominica* infestation.

Treatments	% Seed damage		
	30 DAS	60 DAS	90 DAS
Rice	19.75	26.00	35.75
	(26.31)	(30.64)	(36.72)
Wheat	20.75	30.75	41.25
	(27.08)	(33.66)	(39.96)
Maize	13.25	23.25	33.00
	(21.30)	(28.82)	(35.06)
Sorghum	15.75	21.00	30.50
	(22.67)	(27.24)	(33.52)
Finger millet	12.00	16.00	30.75
	(19.94)	(23.53)	(33.66)
Barley	16.75	19.50	34.50
	(24.68)	(26.17)	(35.96)
SEm ±	1.37	0.98	0.31
CD at 5%	4.06	2.91	0.96

Note : Data in parentheses are transformed to angular values.

32°C with diet wheat (24.66) and lowest at 25°C with diet oat (18.33). Our results strongly correlate with Mahroof and Phillips (2008) who reported that wheat is suitable for *L. serricorne* development.

Feeding preference

Extent of seed damage (%)

The analyzed mean data as presented in Table 4 shows the significant difference on extent of seed damage (%) of *R. dominica* on different cereals. The maximum seed damage per cent was found in wheat on all three observation days, and seed damage due to lesser grain borer was found statistically significant on the 30, 60 and 90 days observations. On the 30 day observation, wheat showed the highest level of grain damage (20.75%) which was statistically at par with rice (19.75%) followed by barley (16.75%), and sorghum (15.75%) while minimum per cent seed damage was observed in finger millet (12.0%). The per cent grain damage had increased when observed at 60 days. This was evident in wheat, rice, maize barley, sorghum, barley and finger millet. At 60 days in this test, wheat was the most damaged host among the other hosts with a seed damage of 30.75%, significantly more than rice (26.0%), maize (23.25%), sorghum (21.0%) and barley (19.50%).While the lowest damage was observed in finger millet (16.00 %). The highest grain damage (41.25%) was evident in wheat at 90 days which was significantly higher than other hosts, followed by rice (35.75%), barley (34.50%), maize (33.00%). The minimum damage (30.50%) was recorded in finger millet.

Seed weight loss (%)

The data given in Table 5 showed the significant difference on seed weight loss (%) of *R. dominica* on different cereals. The highest weight loss per cent of host grain was recorded in wheat and are itemized as follows: 11.37%, 15.99% and 20.95% at 30, 60 and 90 days after storage, respectively. At 30 days, the lowest seed weight loss was recorded in finger millet (6.09%). On day 60, the highest weight loss was found in wheat (15.99%) and was followed by rice (13.86%), maize and sorghum (11.81 and 11.39%) were found statically at par with each other. At 90 days, the weight loss per cent in wheat (20.95), barley (18.05), rice (17.76), maize (16.95), sorghum (15.68) and finger millet (14.73) were statistically different to each other. The findings are partially in agreement with Awadalla *et al.* (2023) who reported that during the first generations, the higher weight lost was on hile oat (0.65 ± 0.02 g) and the least weight loss was on maize (0.40 ± 0.02g). During the second generation, the highest weight loss was on rice followed by wheat and represented by, 1.08 ± 0.08 and 1.01 ± 0.08 g, respectively. While the least weight loss was

Table 5. The weight loss in different cereals grains due to *R. dominica* infestation.

Treatments	% Seed weight loss		
	30 DAS	60 DAS	90 DAS
Rice	9.72	13.86	17.76
	(18.48)	(21.86)	(24.92)
Wheat	11.37	15.99	20.95
	(20.11)	(23.57)	(27.24)
Maize	7.02	11.81	16.95
	(15.55)	(20.10)	(24.31)
Sorghum	8.08	11.39	15.68
	(16.75)	(19.72)	(23.33)
Finger millet	6.09	8.77	14.73
	(14.43)	(17.22)	(22.57)
Barley	8.11	9.33	18.05
	(16.87)	(17.78)	(25.14)
SEm ±	0.44	0.48	0.28
CD at 5%	1.31	1.43	0.83

Note: Data in parentheses are transformed to angular values.

on maize (0.74 ± 0.02g). Similarly, Abebe (2009) employed percentage of seed damage and median developmental time as indices of the sensitivity of maize varieties to the attack of *R. dominica,* in addition to weight loss.

CONCLUSION

This study conducted to examine the ovipositional and feeding preference of lesser grain borer in stored grains. Among the six stored cereal grains tested for the ovipositional and feeding preferences, wheat was found to be the most preferred host as the highest number of eggs laid was recorded in wheat and least preferred host was finger millet. In case of feeding preference tests, the maximum weight loss and per cent grain damage were recorded in wheat followed by rice, barley, sorghum, maize and finger millet. Thus, the study concluded that wheat was the most preferred host grain in ovipositional and feeding preferences for lesser grain borer (*Rhyzopertha dominica*) among the stored grains.

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