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PHYSICAL ATTRIBUTES OF WHEAT VARIETIES IN RELATION TO INFESTATION BY *RHYZOPERTHA DOMINICA* (F.)

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ABSTRACT

This study aims to explore the susceptibility of wheat varieties in storage against *Rhyzopertha dominica* (F.). Twenty promising wheat cultivars were tested for resistance in non-choice conditions at the Department of Entomology, MSSSoA, Odisha during 2021-22. The wheat varieties were premeditated for their physical components through correlation analysis and the level of influence on insect preference and development was determined. The variety DBW303 which had a high median development period, low adult emergence and susceptible index was found to be resistant. Similarly, the variety PBW373 which recorded a low median developmental period with higher adult emergence, and susceptible index, was found to be susceptible. Among the physical traits, varieties with grain hardness exhibited a negative relationship with progeny development and thus conferred resistance.

Key words: *Rhyzopertha dominica*, wheat, adult emergence, median development period, susceptibility index, growth index, grain hardness, length breadth ratio, thousand seed eight, physical constituents,

Wheat is a vital cereal grain cultivated worldwide, and in India, it is the second largest food grain crop after rice (MoA, 2014). Food grains lose about 20-25% due to warehoused pests in India (Rajashekar and Shivanandappa, 2010). Stored wheat is frequently attacked by *Rhyzopertha dominica* (F.); *Sitophilus oryzae* (L.); *Sitophilus granarius* (L.) and *Trogoderma granarium* (Everts). Among them, *R. dominica* is a primary pest (Mark et al., 2010). In stored wheat due to various warehouse pests including *R. dominica*, losses occur to about 10-15% (Ahmed, 1980). As far as the reproduction of *R. dominica* is concerned wheat is a suitable host based on higher adult emergence (551/ 5 pairs) than maize (121/ 5 pairs) (Bashir, 2002); it *R. dominica* is categorized as a polyphagous pest (Ajaykumara et al., 2018), and one of the most significant pests that harm grains including corn, rice, wheat, sorghum, and other grains as well as starch-based substrates and some packaging made from wood. Due to weight loss from damaged cereals creating frass, unpleasant odours from insect secretions, and a decrease in nutritional value. This unpleasant odour affects the grain unfit for human consumption and decreases germination capacity and important amino acids (Arthur et al., 2012). The grub and adult stages are more dangerous to stored cereal grains and spent most of their life inside the kernel, feeding on both the germ and endosperm, directly causing damage and changes in grain physicochemical properties. Chemical fumigants have been widely used to control microbes and pests in warehoused grain (Navarro, 2006). However, using chemical fumigants improperly might leave toxic residues in the grain and endanger the health of the person using them. (Navarro, 2012). Major stored grain pests like *Liposcelis bostrychophila* and *R. dominica* are developing resistance to chemical fumigants (Lorini et al., 2007). Therefore, resistant varieties to the pest if developed, would provide post-harvest protection free of cost. Resistant variety is a significant constituent that is one of the cheapest and ecological approaches and governs the level of losses and harm during storage. So far very less work has been carried out on the assessment of different varieties of wheat grains against *R. dominica*. All stored pests exhibit a preference or non-preference for grain varieties (Sarin and Sharma, 1983) and hence the present study.

MATERIALS AND METHODS

Twenty wheat varieties were evaluated at the laboratory of the Department of Entomology, MSSSoA, Parlakhemundi (18.80615^0 N, 84.1409820E) from 2021 to 22. The selected varieties viz; DBW303, DBW222, DBW110, DBW252, DBW107, DBW16, DBW14, DBW173, DBW39, DBW187 were collected from the ICAR-Indian Institute Wheat and Barley Research, Karnal, Haryana; HD2687, HD2967, HD2968, PBW373, PBW502, PBW590, Sardar-97, UP2338, PBW343 from seed processing unit, Masodha, Department of seed science and technology, Anduat Kumarganj, Ayodhya and a local collection KW51-were used. These were kept in the oven for disinfestation (Singh, 1989) and to raise the moisture content in varities near equilibrium (Solomon, 1951). This healthy and sound seed material was used for screening. *Rhyzopertha dominica* culture was collected from the storage Entomology laboratory, at Centurion University. Beetles were mass multiplied in the laboratory on wheat variety- KW 51 and maintained at 27±2°C and 65± 5%RH. Five pairs of newly emerged adults were released into plastic jars of 250 g capacity containing 20 g healthy seeds from each variety and replicated thrice in a complete randomized design. The insects were removed after 7 days of oviposition, and the jars were then maintained under the same experimental conditions. Observation on adult emergence (Nwana and Akibo-Betts, 1982), median development period (Howe,1971), susceptibility index (Dobie, 1974) where 0–3 (resistant), 4–7 (moderately resistant), 8–10 (susceptible) and>11 (highly susceptible), and growth index were made (Soumia et al., 2015). Twenty grains were taken from each replication, the length and breadth were measured using digital vernier callipers, and the length-breadth ratio was calculated. Likewise, thousand seed weight (TSW) was recorded and counted and weighed in electronic balance and expressed in g. Using a texture analyser (Brookfield, Model: CT3 10K, USA), hardness of the grains was determined by pressure exertion method. (Taghinezhad et al., 2016). Data analysis was done using SPSS statical software version 16.0.

RESULTS AND DISCUSSION

The results on adult emergence, median developmental period, susceptibility index and growth index under non-choice condition showed that there exists a significant difference in varieties. Adult emergence the ranged from 2.67 to 76.00 adults (Table 1). The maximum number of adults emerged in PBW373 (76.00) followed by SARDAR-97 (66.00) and HD2968 (64.00). Minimum adult emergence was noted in variety DBW 303 (2.67) followed by HD2687 (3.67), and they were statistically at par. Swamy et al. (2022) reported that *R. dominica* adult emergence was the least in rice variety BPT2411, under-free choice (13.00 adults/ 100 g) and non-choice (16.33 adults/ 100 g), and it was found to be resistant. Similarly, the five wheat varities were evaluated by Lal et al. (2014) with *R. dominica*, and Lok-1 was found to be the most vulnerable with maximum population buildup (26.25 adults). The median developmental period of *R. dominica* varied from 30.67 to 47.00 days (Table 1). The maximum developmental period was observed in DBW303 (47 days) followed by HD2687 (46.33 days) which were statistically at par while the minimum developmental period was recorded in PBW373 (30.67 days). Kumawat et al. (2022) reported that the developmental period of *R. dominica* varied from 51.33 to 35.00 days while the Mehta (2020) reported somewhat similar results. Nemaram and Bhargava (2012) claimed that the maximum developmental period was found in wheat variety Raj4037 (50.53 days); while lowest way in Lok-1 (41.65 days). In test varieties of wheat, the susceptibility index varied from 1.96 to 14.12 (Table 1); maximum was observed in PBW373 (14.12); the lowest index was observed in case of DBW303 (1.96) which was at par with HD2687 (2.79). DBW303 and HD2687 were found to be resistant, whereas varieties namely PBW373, Sardar-97, HD2968, and DBW14 were highly susceptible. Resistance/ susceptibility status among the varieties detected according to the growth index of the test insect, revealed that it ranged from 0.17 (DBW303) and 2.48 (PBW373). These results are in line with Samyal et al. (2006) and Sayed et al. (2006). The variety PDW 291 was the least preferred for *R. dominica* infestation on account of minimum adult emergence (25.44), grain damage (4.10), and weight loss (1.31) (Singh and Sharma, 2021). Kumawat et al. (2022) observed the highest F1 emergence (54.30), minimum development period (35 days) and susceptibility index (11.09) in the variety HI-1567. Baghla et al. (2023) reported that maximum grain damage (35%), weight loss (15.40%), and population buildup (39.44 adults) were in the variety Lok-1. The thousand seed weight varied from 37.37 to 53.40 g, maximum was recorded in HD2687(53.40 g) followed by UP2338 (50.83 g) and PBW590 (50.30 g) and the lowest was in DBW187 (37.37g), PBW343 (39.30 g) and PBW373 (40.50 g) (Table 1). This was found to have a non-significant and negative effect with susceptibility index (r = -0.295), growth index (r = -0.291), adult emergence (r = -0.285), and but positive response with median development

Table 1. Impact of various wheat varieties on development parameters of *R. dominica*

Variety	Adult emergence (no)*	Median developmental period (MDP) (days)	Susceptibility index	Growth index	Thousand seed weight (g)	Length breadth ratio	Grain hardness (N)
DBW303	2.67 (1.76)^{j}	47^{a}	1.96^{j}	0.17^{ij}	42.17^{ghi}	1.66^{d}	80.00^{m}
DBW222	28.33 (5.37)^{f}	37.33^{fgh}	8.96^{ef}	0.76^{ef}	41.87^{ghi}	1.67^{d}	83.61^{l}
DBW110	19.00 (4.41)^{g}	38.67^{de}	7.62^{g}	0.49^{gh}	45.50^{d}	2.04^{abc}	115.82^{bc}
DBW252	11.00 (3.39)^{i}	41.33^{b}	5.79^{i}	0.27^{hij}	41.83^{ghi}	1.84^{bcd}	117.00^{b}
DBW107	14.67 (3.89)^{h}	37.67^{efg}	7.13^{gh}	0.39^{hi}	43.20^{efg}	1.84^{bcd}	116.15^{b}
DBW16	13.33 (3.72)^{hi}	39^{cd}	6.64^{h}	0.34^{hij}	42.77^{fg}	1.98^{abcd}	108.00^{fg}
DBW14	53.67 (7.36)^{c}	32.33^{k}	12.32^{b}	1.66^{bc}	44.30^{def}	1.87^{bcd}	99.99^{i}
DBW173	13.00 (3.67)^{hi}	40^{c}	6.4^{hi}	0.32^{hij}	42.47^{gh}	1.89^{bcd}	109.33^{f}
DBW39	43.33 (6.62)^{d}	36^{ij}	10.48^{d}	1.2^{d}	42.83^{fg}	1.76^{cd}	82.85^{l}
DBW187	25.33 (5.08)^{f}	38.33^{def}	8.43^{f}	0.66^{fg}	37.37^{k}	1.83^{bcd}	111.44^{e}
HD2687	3.67 (2.04)^{j}	46.33^{a}	2.79^{j}	0.08^{j}	53.40^{a}	2.04^{abc}	119.00^{a}
HD2967	27.67 (5.31)^{f}	37.33^{fgh}	8.9^{ef}	0.74^{ef}	44.70^{de}	1.90^{bcd}	113.67^{d}
HD2968	64.00 (8.03)^{b}	35.67^{ij}	11.66^{bc}	1.79^{b}	40.83^{hij}	1.65^{d}	85.07^{k}
KW51	14.33 (3.85)^{hi}	40^{c}	6.66^{h}	0.36^{hij}	47.23^{c}	2.26^{a}	98.59^{i}
PBW343	52.00 (7.25)^{c}	36.33^{hi}	10.88^{d}	1.43^{cd}	39.30^{j}	1.77^{cd}	106.65^{gh}
PBW373	76.00 (8.75)^{a}	30.67^{l}	14.12^{a}	2.48^{a}	40.50^{ij}	1.77^{cd}	57.92^{n}
PBW502	34.00 (5.87)^{e}	36.67^{ghi}	9.63^{e}	0.93^{e}	44.77^{de}	2.08^{abc}	90.83^{j}
PBW590	30.00 (5.52)^{ef}	38^{def}	8.96^{ef}	0.79^{ef}	50.30^{b}	2.15^{ab}	114.41^{cd}
SARDAR-97	66.00 (8.15)^{b}	35^{j}	11.98^{b}	1.89^{b}	40.57^{ij}	1.74^{cd}	59.2^{n}
UP2338	51.67 (7.22)^{c}	36^{ij}	10.96^{cd}	1.44^{cd}	50.83^{b}	2.03^{abc}	105.85^{h}
Sem$\pm$	0.07	0.50	0.18	0.02	0.84	0.03	0.78
CD (p=0.05)	0.21	1.43	0.50	0.06	2.39	0.08	2.23

Correlation between physical characteristics of varieties and development of *R. dominica*

	Adult emergence	Median developmental period	Susceptibility index	Growth index
Length breadth ratio	-0.343^{NS}	0.161^{NS}	-0.211^{NS}	-0.360^{NS}
Thousand seed weight	-0.285^{NS}	0.318^{NS}	-0.295^{NS}	-0.291^{NS}
Grain hardness	-0.627**	0.408^{NS}	-0.479*	-0.666**

*Values in parentheses transformed value; Any two means having a common letter not significantly different (p= 0.05) by DMRT; *Significant at p= 0.05; **Significant at p= 0.01.

period (r = 0.318) (Table 1). These results agree with those of Gowda et al. (2019) that hundred seed weight had a negative relation with adult emergence (-0.534), susceptibility index (r = -0.510), and growth index (r = -0.524) against *S.oryzae*. Similar results were also observed by Prasad et al. (2015) on hundred seed weight. The length breadth ratio ranged from 1.65 to 2.26; maximum was noticed in KW51 (2.26) followed by PBW590 (2.15) and PBW502 (2.08); and minimum was noticed in HD2968 (1.65) followed by DBW303 (1.66) and DBW222 (1.67). Length breadth ratio was also non-significant and negative relation was observed with adult emergence (r = -0.343), susceptibility index (r = -0.211), and growth index (r = -0.360), but a positive correlation was noticed with the median development period (r=0.161) (Table 1). Gowda et al. (2019) found that adult emergence (-0.057), and growth index (r = -0.043) of *S. oryzae* were negatively correlated with the length breadth ratio of rice. Similarly, the length breadth ratio negatively correlated to weevil emergence (- 0.39) and grain weight loss (- 0.37) as reported by Prasad et al. (2015) in sorghum grain, and Stejskal and Kucerova (1996) in wheat. Lazar and Panickar (2016) observed no correlation between the seed size of mungbean genotypes and oviposition by *Callosobruchus maculatus*. The hardness of varieties ranged from 57.92 to 119.0 N with significant differences; maximum was observed in HD2687 (119.0 N), DBW252 (117 N), and DBW107 (116.15 N); and the lowest was in PBW373 (57.92 N), Sardar-97 (59.2N), and DBW303 (80N) (Table-1). The varieties having maximum grain hardness conferred resistance to *R.dominica* infestation and were hard to penetrate into the grain and varieties having least grain hardness were susceptible. Grain hardness had a significant and negative relation with susceptibility index (r = -0.479), adult emergence (r = -0.627), and growth index (r = -0.666), whereas positive and non-significant relation with median development period (r = 0.408) (Table 1). The current findings corroborated with those of Swamy et al. (2022) indicating that rice variety BPT 2411 was the least chosen by insects like *R. dominica*, *Sitotroga cerealella*, and *Tribolium castaneum* due to its highest kernel hardness 2411 (7.28 kgf). Similar findings were made by Gowda et al. (2019), with *S. oryzae*. *Trogoderma granarium* larvae gained low weight, upon feeding cultivars of rice Ali Kazemi and Khazar (Barzin et al., 2019) and wheat cultivars (Rao et al., 2004) due to seed hardness. Suleiman et al. (2015) reported that soft maize kernels are more prone to *S. zeamais* than harder kernels. Physical traits, such as grain hardness, is an important factor that affects grain resistance to *S. zeamais* (Marsaro Junior et al., 2005). The current findings support that insect responses such as adult emergence, median development period, susceptible index, growth index, and physical constituents of wheat were dependable variables for the characterization of resistance to *R. dominica*. It was observed that the characterization of varieties based on correlation analysis was helpful in choosing resistant ones viz., DBW303 and HD2687.

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AUTHOR CONTRIBUTION STATEMENT

VR and CRS conceived and designed research. VR conducted experiments. SR analyzed data. VR wrote the manuscript. CRS and SB reviewed the manuscript and approved the final manuscript.

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CONFLICT OF INTEREST

No conflict of interest

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