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Role of Physico-Chemical Parameters in Stored Wheat for Resistance to *Rhyzopertha dominica* (Coleoptera: Bostrychidae)

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ABSTRACT

The physical and biochemical parameters were analyzed for twenty five wheat genotypes/ varieties which lead to understand the factors that evoke *R. dominica* resistance. Among the genotypes/ varieties analyzed biochemically, the genotype LOK1 showed the more phenol and amylase activity which reduced the *R. dominica* incidence. Correlation coefficient was done between the per cent weight loss and physico-chemical parameters. Result revealed that the weight loss per cent was significantly negative correlation with 100 seed weight and seed volume, while the same was negatively correlated with seed hardness and seed diameter.

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INTRODUCTION

In India, wheat holds the second position among cereals with an estimated production of 109.52 Million MT during 2021 (Anonymous 2021). Wheat is rich in carbohydrates and protein (10-18%) was far higher as compared with the cereals which meets the 20 % global calorie requirement. After harvest, the wheat has to be stored for several months to years before processing. Several pests were attacked the wheat in storage condition which reduced the seed quality, weight, viability and commercial value. Among them most damaging one is lesser grain borer, *Rhyzopertha dominica* (Coleoptera: Bostrychidae). They feed the kernel inner portion and also make contamination with their feces and skin casting. Some variants of even the identical grains appear to be less enticing to a particular insect for its growth and development. These are referred to as resistant varieties or less susceptible ones. Protection of grain with use of resistance varieties which govern by host plant resistance such tolerance, antibiosis and antixenosis were acceptable, as they are environmentally safe, effective and cheap. The levels of resistance were found to be influenced by nutritional and biochemical components in cereal varieties along with the physical properties of grains. These factors also influenced the key digestive enzymes of insects thereby affecting their normal growth and development. Thus resistant varieties of wheat with favorable physico-biochemical characteristics and digestive enzyme inhibitors can be used as an effective management measure against insect pests in storage (Arya 2018). The developmental stage of insects also affected by the physical and biochemical properties of grains. Finding the biological elements causing insect resistance would benefit from correct information on the fluctuation in insect developmental rate with the change in grain properties. Nowadays, perilous chemical pesticides that are used to control stored insect pests are increasingly being replaced by biological and physical techniques (Nawrot *et al*. 2006). In present study, which achieved to understand the influence of biophysical and biochemical parameters in twenty five wheat genotypes/varieties on lesser grain borer infestation.

MATERIALS AND METHODS

The experiments were conducted at Department of Entomology, CP College of Agriculture, SD Agricultural University during 2020-2021. The wheat genotypes/varieties and test insect, lesser grain borer were collected from wheat research station, Vijapur and test insect was cultured in local wheat variety. The genotypes/varieties were screened through the both free choice and force choice technique and observation of Weight loss (%), adult emergence (Number), development period (Number) and Susceptibility Index (SI) were recorded by Ibrahim *et al.* (2022).

100 seed weight (g) and seed volume (ml) were measured the following procedure by Phrike *et al.* (1982). Seed hardness and seed diameter was measured automatically by using Single Kernel Characterization System (SKCS) available at Wheat Research Station, Vijapur. For analysis of biochemical parameters (total soluble sugar (mg/g), starch (mg/g), soluble protein (mg/g), phenol (mg/g) and amylase activity (µg/g)), the 500 g sample of each genotypes/varieties were dried in hot air oven and grinded into powder form by using the Cyclotec Sample Mill. The extraction and estimation of biochemical contents was carried out from finely wheat powder by adopting standard procedure for each parameter and standard was done for each before the estimation.

Total soluble sugar of each genotypes/varieties was estimated by Anthrone reagent method with slight modification by using glucose as standard (Somogyi 1952). Starch content of wheat seed was assessed by Anthrone reagent method and glucose used to draw standard graph (McCready *et al.* 1950). The soluble protein was done by dye-binding method by using BSA (Bovine Serum Albumin) or standard protein solution as standard (Bradford 1976). The estimation of phenol of wheat genotypes/ varieties was assessed by FCR (Folin Ciocalteu Reagent) method with slight modification (Malik and Singh 1980). Gallic acid was used as standard stock solution. Amylase activity present in each genotypes/ varieties was estimated by Bernfeld method with slight modification (Bernfeld 1955) and maltose was used as standard.

Table 1. Physical parameters of different wheat genotypes/ varieties.

		Parameters			
Sl. No.	Genotypes/ varieties	100 seed weight (g)	Seed volume (ml)	Seed hardness	Seed diameter (mm)
1	GW 11	3.67^{op}	0.20^{g}	62.00^{gh}	2.62^{k}
2	GW 173	4.00^{mno}	0.29^{c}	70.00^{defg}	2.73^{ij}
3	GW 190	3.59^{p}	0.20^{g}	76.00^{bcde}	2.80^{ghi}
4	GW 273	3.59^{p}	0.23^{f}	75.00^{bcdef}	2.76^{i}
5	GW 322	4.07^{lmn}	0.22^{g}	68.00^{efg}	2.81^{ghi}
6	GW 366	5.62^{cde}	0.40^{b}	59.00^{h}	2.97^{de}
7	GW 451	4.39^{kl}	0.26^{de}	67.00^{fg}	2.91^{ef}
8	GW 496	4.95^{hij}	0.23^{ef}	58.00^{h}	2.97^{de}
9	GW 499	4.63^{jk}	0.40^{b}	73.00^{cdef}	2.79^{ghi}
10	GW 503	3.85^{nop}	0.40^{b}	78.00^{abcd}	2.63^{k}
11	GW 1339	4.45^{k}	0.40^{b}	76.00^{bcde}	2.92^{ef}
12	GDW 1255	5.10^{fgh}	0.40^{b}	79.00^{abcd}	3.13^{bc}
13	VD 18-07	5.93^{bc}	0.28^{cd}	79.00^{abcd}	2.82^{ghi}
14	VD 18-09	4.55^{k}	0.40^{b}	82.00^{abc}	2.87^{fgh}
15	VD 18-12	5.03^{ghi}	0.40^{b}	86.00^{a}	3.03^{d}
16	VD 18-13	6.34^{a}	0.60^{a}	80.00^{abc}	3.27^{a}
17	VD 18-14	5.77^{bcd}	0.40^{b}	84.00^{ab}	3.17^{b}
18	VD 18-16	5.46^{def}	0.40^{b}	77.00^{abcd}	3.06^{cd}
19	VD 19-05	6.08^{ab}	0.40^{b}	82.00^{abc}	3.28^{a}
20	VD 19-06	4.94^{hij}	0.40^{b}	80.00^{abc}	2.88^{efg}
21	VD 19-09	4.04^{lmno}	0.30^{c}	86.00^{a}	2.78^{hi}
22	HI 8498	4.70^{ijk}	0.39^{b}	77.00^{abcd}	3.04^{d}
23	HI 8737	5.35^{efg}	0.40^{b}	78.00^{abcd}	3.02^{d}
24	HD 2932	4.33^{klm}	0.40^{b}	70.00^{defg}	2.79^{ghi}
25	LOK 1	3.75^{nop}	0.40^{b}	83.00^{ab}	2.65^{jk}
	SEm ±	0.12	0.01	2.66	0.03
	CD at 5%	0.35	0.03	7.84	0.09
	CV %	4.39	4.91	6.12	1.80

Notes: Treatment mean with common superscript letter (s) are not significant by DNMRT at 5% level of significance.

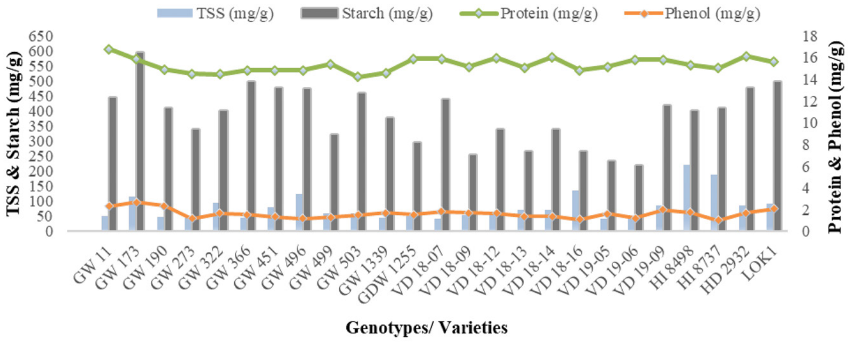

Fig. 1. Biochemical parameters of different wheat genotypes/varieties.

RESULTS AND DISCUSSION

Physical parameters

The physical parameters like 100 seed weight, seed volume, seed hardness and seed diameter were evaluated for 25 genotypes/varieties and the results obtained are presented in the Table 1. Significantly maximum weight of 100 seed was displayed in VD 18-13 (6.34 g) followed by VD 19-05 (6.08 g). GW 190 (3.59 g) and GW 273 (3.59 g) recorded the least 100 seed weight. The maximum seed volume was noticed in VD 18-13 (0.60 ml). The GW 11 and GW 190 recorded minimum seed volume (0.20 ml). VD 19-09 displayed highest (86.00) seed hardness and GW 496 recorded least seed hardness (58.00) which was statistically at par with wheat varieties LOK 1 (59.00) and GW 366 (59.00). VD 19-05 recorded maximum seed diameter (3.28 mm) which was followed by the VD 18-13 (3.27 mm). The variety GW 11 (2.62 mm) displayed least seed. The seed weight showed a significant factor in development of *R. dominica.* Further, 100 seed weight of eight genotypes ranged between 2.61 and 3.71 g by Kakade *et al*. (2014). Accords to Naseri *et al.* (2022) the seed hardness is a main factor responsible for the resistance and susceptibility of the examined chickpea cultivars to *C. maculates.* Lale and Kartay (2006) also reported the F1 adults were damaged and developed more in Coma (small seed with soft kernels) than in Bende (large seed with hard kernels). Correlation coefficient between the weight loss (%) and different physical parameters (Table 2) are revealed that weight loss (%) established was significantly negative correlation with 100 seed weight (r = -0.439*) and seed volume (r = -0.407*), While the same was negatively correlated with seed hardness (r = -0.170) and seed diameter (r = -0.301). From the correlation matrix, the result showed that the weight loss (%) decreased with increased in seed hardness to reduces the consumption of insect. Ileke and Olotuah (2013) reported that high susceptibility of cultivar IFE Brown to *C. maculatus* infestation was due to the soft seed coat, which could easily be damaged by the larvae. Our results are in support of the work done by the above workers.

Table 2. Correlation between the weight loss (%) and physical parameters of wheat genotypes/varieties.

Parameters	Weight loss	100 seed weight	Seed volume	Seed hardness	Seed diameter
Weight loss	1.00	-0.439*	-0.407*	-0.170	-0.301
100 seed weight		1.00	0.672**	0.268	0.907**
Seed volume			1.00	0.451	0.540**
Seed hardness				1.00	0.406*
Seed diameter					1.00

* Significant at 5% level of significance (r = 0.396).
**Significant at 1% level of significance (r = 0.505).

Biochemical parameters

The results on content of biological parameters are presented in Fig.1. The data of all the biochemical parameters of various wheat genotypes/varieties in the test were showed significant difference among various wheat genotypes/varieties. The wheat genotype HI 8498 recorded the highest amount of total soluble sugar (220.27 mg/g) and least amount was dis-

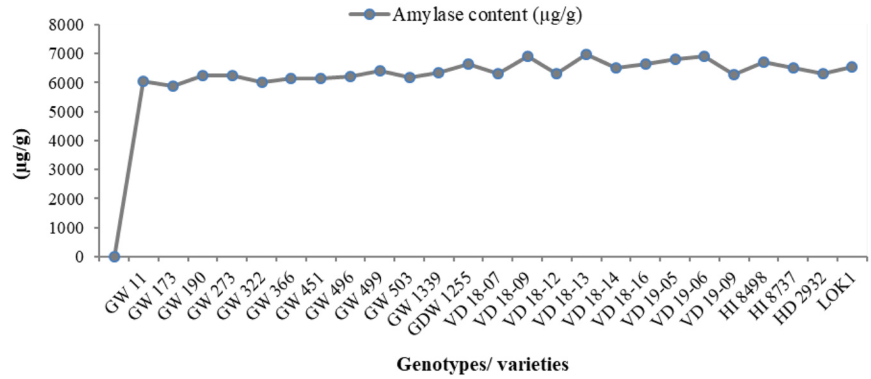

Fig. 2. Amylase content of various wheat genotypes/varieties response to *R. dominica.*

played in VD 18-07 (41.67 mg/g). Similarly, highest starch content was recorded in the GW 173 (592.24 mg/g), while the least (219.00 mg/g) was recorded in genotype VD 19-06. The starch content of different wheat genotypes/varieties was higher than the total soluble sugar, soluble protein, phenol and amylase. The maximum soluble protein content was demonstrated in GW 11 (16.77 mg/g) and variety GW 503 recorded minimum amount of soluble protein (14.21 mg/g), but it was par with varieties GW 322 (14.45 mg/g) and GW 273 (14.49 mg/g). The variety GW 173 (2.70 mg/g) recorded the highest phenol, while lowest was displayed in HI 8737 (1.01 mg/g). The genotype VD 18-13 recorded significantly maximum (6970.73 µg/g) amylase content followed by VD 19-06 (6909.23 µg/g). The lowest amylase content was recorded in the variety GW 173 (5870.41µg/g) followed by varieties GW 322 (6014.03 µg/g) and GW 11 (6058.53 µg/g) but were statistically at par (Fig. 2). Physical, biochemical, nutritional and technological property of cereal grains has fundamental influence on developmental period of insects. The amount of protein, starch, fat, and physical characteristics vary from variety to variety. Understanding the impact of variations in food value in connection to the growth rate of feeding insects can be facilitated by having knowledge of all the aforementioned factors. Demissie *et al.* (2015) worked on biochemical factors (carbohydrate content, total soluble sugars, lipid content) of maize cultivars against *Sitotroga cerealella.* Followed by Lazar *et al.* (2014) reported the mung bean *Vigna radiata* (L.), the seeds with high soluble starch content are more favorable to *C. maculatus* than the seeds with low starch content. According to Towo *et al.* (2003), the phenol content was responsible for forming a complexes with food nutrition which making them into less susceptible and less soluble to enzymatic degradation and less available for absorption, hence these leads to reduced weight loss/ varieties in genotypes with high phenol content. The development of *R. dominica* was greatly influenced by biochemical properties of different wheat genotypes/varieties. The results on biochemical properties and their correlation with weight loss (%) revealed that weight loss (%) exhibited negative and significant correlation with soluble protein (r = -0.489*), but it had non significant negative correla-

Table 3. Correlation between the weight loss (%) by *R. dominica* and biochemical parameter of wheat genotypes/varieties.

Parameters	Weight loss (%)	Soluble protein (mg/g)	Starch (mg/g)	TSS (mg/g)	Phenol (mg/g)	Amylase (µg/g)
Weight loss (%)	1.00	-0.489*	-0.011	-0.073	-0.093	-0.194
Soluble protein (mg/g)		1.00	0.055	-0.094	0.426*	0.034
Starch (mg/g)			1.00	0.235	0.491*	-0.792**
TSS (mg/g)				1.00	-0.128	0.064
Phenol (mg/g)					1.00	-0.408
Amylase (µg/g)						1.00

* Significant at 5% level of significance (r = 0.396).
**Significant at 1% level of significance (r = 0.505).

tion with other the biochemical parameters including starch (r = -0.011), total soluble sugar (r = -0.073), phenol (r = -0.093) and amylase (r = -0.194) Table 3. From foregoing discussion, it is concluded that all biochemical parameters were negatively correlated with per cent weight loss. These result also showed that the increase in weight loss (%) was observed with decrease in all bio-chemical parameters. The lowest weight loss per cent was recorded in the wheat variety LOK 1 which showed the degree of resistance against *R. dominica* was due to the low amount of nutrition like soluble protein and total soluble sugar, high phenol and medium total protein and amylase content present in seeds. None of the varieties was free from insect damage. Similar report was done by Arya (2018) observed that the weight loss (%) exerted negative and non significant correlation with protein, starch, total soluble sugar, phenol content and amylase in various wheat genotypes/varieties. The possible reason for reduced weight loss due to the increased phenol content presence in such genotypes/ varieties which cause reduced consumption by *R. dominica.* The results of present study were closely supported by the work done by above workers. Thus the physico-chemical factors play a important role in insects feeding, preferences, survival and weight loss of grains. The insect resistance mechanisms of cereal grains depend on the physiochemical and biochemical characteristics of the grain as well as the post-harvest insect's subsequent biochemical and physical adaptation to these parameters (Warchalewski *et al.* 2002). During storage period, the chemical composition and food quality of grain does not change for insect. Thus the biophysical and biochemical factors not harm to human but it can act barrier for insect attack.

CONCLUSION

The variability of biochemical factors in different genotypes/ varieties leads a various responses by *R. dominica*. The resistance of genotypes/ varieties governed by the different biochemical factors such phenol, amylase and total protein rather than the physical parameters. The adult lesser grain borer preferred the genotypes have more total soluble sugar, protein, starch and less seed hardness. Other digestive enzymes such protease, lipase and amylase activity have not been analyzed in present study which they may also probably play an important role in resistance in wheat genotypes. Thus, it appears that wheat genotypes employ many defense mechanisms, suggesting that resistance may arise from nutrient deficiencies or the buildup of diverse biochemical.

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