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Screening for Antixenosis Resistance of Winter Wheat Genotypes to Cereal Leaf Beetles (*Oulema melanopus* L.)

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A B S T R A C T

The crop damage caused by cereal leaf beetles of the genus *Oulema melanopus* L (Coleoptera: Chrysomelidae) has been increased in recent decades. The purpose of these studies was to evaluate the antixenosis resistance to cereal leaf beetle in Indian wheat varieties/genotypes/advanced breeding lines of winter wheat (*Triticum aestivum* L.) created in India. The investigations were conducted under field conditions on natural infestation of existing population of cereal leaf beetle on wheat plants. The extent of differences between 33 genotypes was established to the infestation of cereal leaf beetles and their host suitability. The lowest incidence and degree of damage by cereal leaf beetles was observed in cultivar Ajanta i.e. 3.33 and 7 % respectively while the highest incidence and degree of damage was found in cultivar HB-208 i.e. 35.55 and 37% respectively. Results of our investigations can contribute to the identification of genotypes as host plants of the cereal leaf beetles and their usage in the bridging process.

Introduction

Wheat is a key cereal crop for global food security as it constitutes an important source of calories and the main source of protein in more than 80 countries. In terms of calories, about 30 % of the world population is dependent on wheat and its derivatives as primary sources of dietary energy, wheat being responsible for 13 % to 57 % of calorie intake depending on the country. Furthermore, wheat is the second principal source of calories in highly populated countries such as China and India as well as in 26 other countries, while in a further 16 countries it is the third principal calorie source. In total about 85 % of the global population depends on wheat as a basic calorie source. India is today the second largest wheat producer in the whole world. Wheat cultivation has traditionally been dominated by the northern region of India and major wheat producing states are Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, Rajasthan, Bihar, Maharashtra, Gujarat, Karnataka, West Bengal, Uttarakhand, Himachal Pradesh, and Jammu & Kashmir. Out of these states Punjab and Haryana have been prolific wheat producers. In India, wheat is ravaged by a number of insect pests viz., Termites, *Odontotermes obesus* (Ramb); shoot fly, *Atherigona naqvii* (Steyskal); Brown wheat mite, *Petrobia latens* (Muller); Armyworm, *Mythimna separata* Walker); Cutworms, *Agrotis ipsilon* (Hufnagel) and Aphid, *Sitobion avenae* (Fabricius) (Deol, 1982). It has been estimated that global yield losses due to insect pests in the pre-green revolution era were about 5.1%, however, the losses increased to 9.3% in the post-green revolution in 1990s (Dhaliwal *et al.,* 2010). Insect pests are dynamic and highly adaptable. Changes in environmental temperature can modify their physiology, behavior, voltinism and distribution.

In recent decades economic damage caused by cereal leaf beetle is increasing. The cereal leaf beetles *Oulema melanopus* L is an oligophagous insects, whose host plants belong to the family Gramineae, but preferring wheat, barley and oats. In these agroecosystems, they are pests with economic importance. The phase of population gradation of *O. melanopus* and important economic damage were reported in North America (Olfert *et al.,* 2004, 2006, Philips *et al.,* 2011, Onychko 2012). The crop damage from cereal leaf beetles in certain areas of Europe could also lead to yield losses (Huusela-Veistola 2010, Tanasković *et al.,* 2012, Onychko 2012). In a mass attack caused by *Oulema* spp., the assimilation processes of infested plant can be reduced up to 80% (Campbell *et al.,* 1989) and yield losses reach 1t/ha, or 0.5-4% in winter wheat and 3-8% in barley (Ulrich *et al.,* 2004).

The current control methods of this pests are mainly chemicals. The natural enemies (predators and parasitoids) have not a determining role in lowering the density or maintain them below the economic threshold (Laznik, 2010).

The modern tendency in the wheat breeding is not only aiming to increase the productivity of cultivars and to improve grain quality, but also to create plant cultivars, which are resistant to pests.

As the result, the effectiveness of plant breeding increases significantly, because the additional costs for the application of chemicals (insecticides) are not required and thus reduces the danger of environmental contamination. In this aspect, the growing of resistant varieties is a desirable non-chemical control method.

The purpose of these studies was to evaluate the antixenosis resistance to cereal leaf beetles in Indian wheat varieties/genotypes/advanced breeding lines of winter wheat (Triticum aestivum L.) created in India. The establishment of the resistance of wheat varieties and lines to biotic stress factors and the causes of specific reaction of genotypes, suggest studies on the suitability of various wheat genotypes as host plants of the cereal leaf beetles.

Materials and Methods

Field trials and experimental genotypes

This study was carried out at FOA SKUAST-K Wadura campus during Rabi season (2017-18). A set of 30 wheat genotypes (released wheat varieties/advanced breeding lines/germplasm lines) with 3 check varieties were screened for their resistance against cereal leaf beetle. The cultivars were sown in Augmented Block Design with genotype to genotype spacing of 50 cm and plant to plant spacing of 10 cm. The packages of practices were followed as per recommendations of SKUAST-K. However, no insecticidal treatment was given to experimental material. The genotypes were screened under natural infestation in the field.

Estimation methods

The relative resistance of wheat genotypes against cereal leaf beetle *Oulema melanopus* was recorded on 3 plants per entry of each genotype.

The degree of damage was determined during the phase of flowering (BBCH 61-69) after the development of the larvae and was defined as a percentage of leaf area damaged by cereal leaf beetles over the entire surface of the leaf flag.

The percentage of flag leaf damaged was evaluated on a scale ranging from 1 to 5 (Rouag *et al.*, 2012) on the basis of which varieties were classified as resistant, moderately resistant, moderately susceptible and Susceptible (Table 1).

Statistical analysis

Data obtained from the experiments have been analyzed using standard statistical procedures.

Results and Discussion

Incidence of cereal leaf beetle *Oulema melonopus* on different wheat genotypes

A perusal of data in figure 1 revealed that the Wheat cultivar 'HB-208 had the highest incidence of 35.55 per cent followed by GW-120 with 31.11 per cent and was significantly different from it. The least incidence of 3.33 per cent was observed in cultivar AJANTA and hence the incidence ranged from 35.55 to 3.33 per cent and the total average for all genotypes was 18.89%.

Degree of damage by cereal leaf beetle on 33 wheat genotypes

The degree of damage on the leaves of 33 wheat genotypes showed variation from 5 to 37% and the total average for all genotypes was 23.53%.

Very low damages were reported on the Indian wheat varieties namely Ajanta (7%) followed by GW-496 (9%). The highest damage (37 %) was found on the cultivar HB-208, it was closely followed by GW-120, GW-322, DL-788-2 and GW-173 with leaf damage of 36.9, 35, 35, and 34.6 percent respectively.

The results obtained from percentage of leaf damage are presented in Figure 2, revealed that there 2 genotypes *viz.*,

Ajanta and GW-496 genotype were resistant; cultivars AKW-381, AKW-1071, C-306, CHHOTI LERMA, OPAN-1796, OPAN 3004, DBW-16, DL-784-3, DL-803, and gw-190 were categorized as Moderately resistant; SW-1, SW-2, VL-22, HD-1925, HD-208, GW-503, GW-322, GW-273, GW-173, GW-120, GW-89, GW-40, GW-10, DWR-195, DWR-39, DWR-16, DURGAPURA-65, DL-788-2, DL-153-2, DBW-14 and D-134 as Moderately susceptible while as no genotype with complete susceptibility was found.

Table.1 Scale for scoring intensity of flag leaf damaged by cereal leaf beetle

Scale	Percentage of flag leaf damaged	Grade
1-2	<10%	Resistant varieties
2-3	10-20%	Moderately Resistant varieties
3-4	20-40%	Moderately Susceptible varieties
4-5	>40%	Susceptible varieties.

Different classes of infested flag leaves according to degree of attack

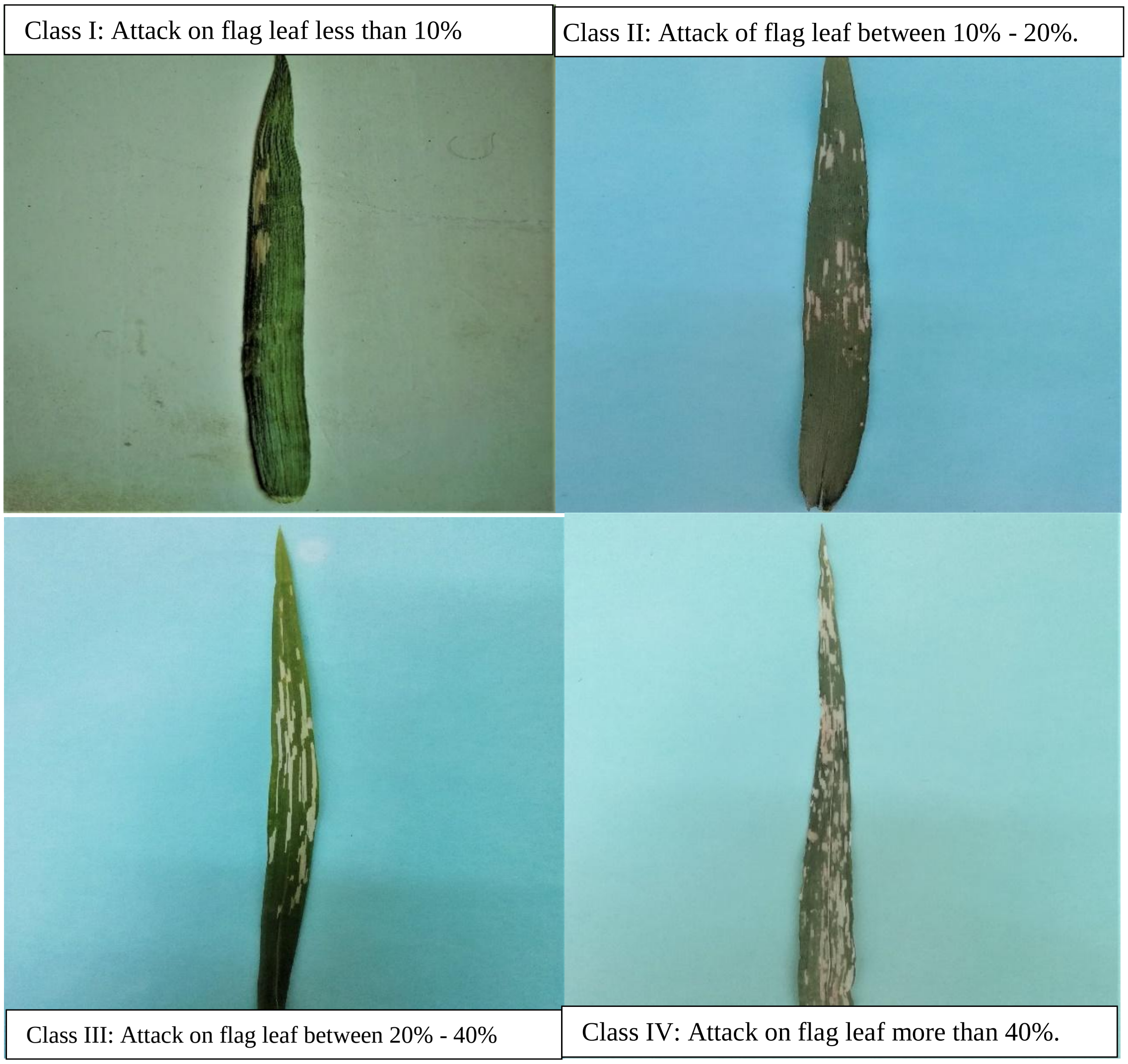

Fig.1 Incidence of *Oulema melonopus* on different wheat genotypes

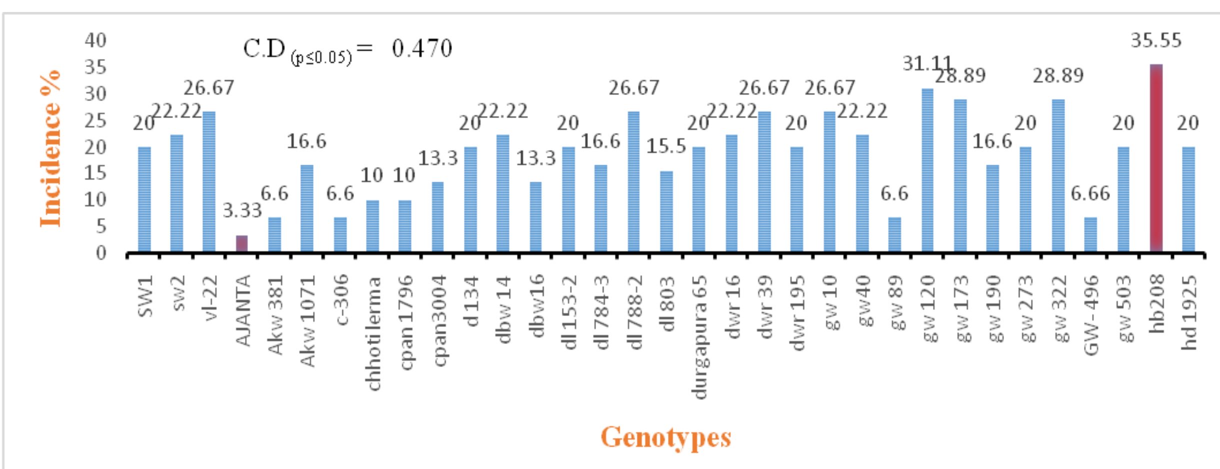

Fig.2 Degree of damage by *Oulema melonopus* on 33 wheat genotypes

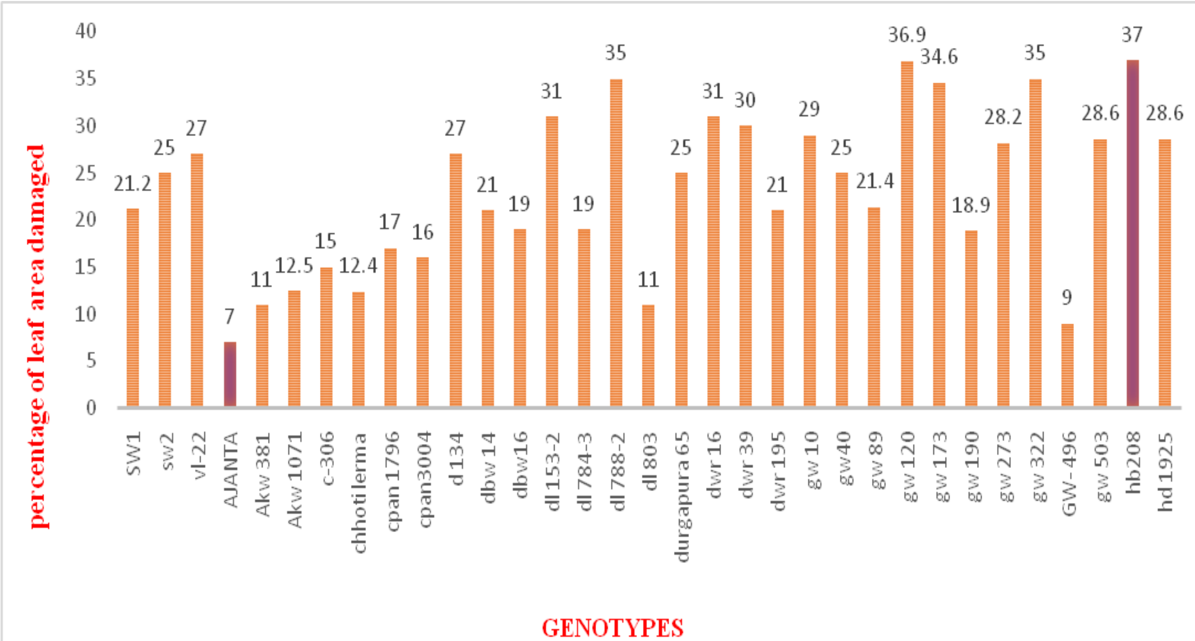

Table.2 Categorisation into resistant/susceptible genotype for relative resistance against *O. melonopus*

S. no	Scale	Percentage of flag leaf damaged	Grade	Genotypes
1	1-2	<10%	Resistant varieties	AJANTA, GW-496
2	2-3	10-20%	Moderately Resistant varieties	AKW-381, AKW-1071, C-306, CHOTTI LERMA, OPAN-1796, OPAN-3004, DBW-16, DL-784-3, DL-803, GW-190.
3	3-4	20-40%	Moderately Susceptible varieties	HD-1925, HD-208, GW-503, GW-322, GW-273, GW-173, GW-120, GW-89, GW-40, GW-10, DWR-195, DWR-39, DWR-16, DURGAPURA-65, DL-788-2, DL-153-2, DBW-14, D-134, VL-22, SW-1, SW-2.
4	4-5	>40%	Susceptible varieties	---
(Rouag *et al.*, 2012)				

Results indicate that some of the Indian wheat genotypes selected for their relative resistance to *Oulema melanopus* have mechanisms of non-preference (antixenosis) in terms of oviposition and feeding by the beetle. Lower feeding on plants of certain genotypes such as AJANTA and GW-496 are indicative of antixenosis. *Oulema melanopus* did not feed actively on plants of the genotype AJANTA and GW-496. Adults feed actively when they are reproductively active and cause substantial damage to host plants (Haynes and

Gage 1981; Kher *et al.,* 2011); therefore, it was unusual that there was only slight feeding on AJANTA and GW-496 plants. This needs further exploration to identify plant morphological and biological characters that may be involved in hindering feeding and oviposition by adults. Other genotypes that appeared to exhibit greater antixenosis included AKW-381, AKW-1071, C-306, CHOTTI LERMA, OPAN-1796, OPAN-3004, DBW-16, DL-784-3, DL-803, GW-190. Given that strong antixenosis is absent in HD-1925, HD-208, GW-503, GW-322, GW-273, GW-173, GW-120, GW-89, GW-40, GW-10, DWR-195, DWR-39, DWR-16, DURGAPURA-65, DL-788-2, DL-153-2, DBW-14, D-134, VL-22, SW-1 and SW-2, it is important to test whether any of these genotypes possess antibiotic characters that may hinder *O melonopus* physiology resulting in cessation of continued feeding or death.

Hence, antixenosis in most wheat genotypes results from a variety of plant morphological and physiological characters. Results of this examination can contribute to the identification of genotypes as suitable hosts of cereal leaf beetles and their usage in the bridging programs. We have not explored what mechanisms confer antixenosis in the genotypes we studied and this warrants further research.

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