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Morphological and Biochemical Basis of Resistance in Barley Against Corn Leaf Aphid, *Rhopalosiphum maidis* (Fitch.)

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ABSTRACT. *The morphological characteristics (leaf colour, glossiness of leaf, days to earing, days to maturity, number of tillers/meter row) and biochemical constituents (leaf surface wax, total free amino acids, total sugars, soluble proteins, phenols) of barley genotypes were analyzed to study their effect on resistance/susceptibility of these genotypes against corn leaf aphid, Rhopalosiphum maidis (Fitch.). The results showed that biochemical constituents viz leaf surface wax and phenols contributed towards resistance as the genotypes having high amount of these two constituents supported less number of aphids per plant. The other constituents (total free amino acids, total sugars, soluble proteins) were found to be responsible for susceptibility of the plants, as plants having high amount of these supported more number of aphids/plant. The morphological traits were not found to contribute either towards resistance or susceptibility.*

INTRODUCTION

Barley, *Hordeum vulgare* L., an important crop of India, is attacked by many pests including corn leaf aphid, *Rhopalosiphum maidis* (Fitch.) which is probably the most important cereal aphid species in tropical climates. However, this species occurs throughout the world (Blackman and Eastop, 1984). This pest feeding on cereals may cause direct yield loss (Kieckhefer and Kantack, 1980, 1986), at the same time serve as a vector of several plant viruses affecting cereal crops. Various strategies have been worked out to control this pest including host-plant resistance which has been an important tool in Integrated Pest Management Programme. In host plant resistance, the process of host-plant selection based upon secondary metabolites present in the plant

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is of immense importance (Ezueh, 1981). Due to the importance of the subject, it was thought imperative to study the effect of various morphological and biochemical characteristics of plants on susceptibility or resistance of barley genotypes against corn leaf aphid.

MATERIALS AND METHODS

Twenty four genotypes of barley were grown under field condition in plots of 3x0.92 m for each genotype during November after following recommended package of practices. Simultaneously, all the genotypes were also sown in pots under green house conditions. The observations on the number of aphids appearing over a particular genotype in both the environments were recorded throughout the crop season. Based upon the reaction of a particular genotype to corn leaf aphid, genotypes were grouped *viz.*, tolerant, susceptible and highly susceptible. Ten genotypes constituting these three groups were selected for analysis of biochemical constituents *viz.* leaf surface wax, free amino acids, total sugars, soluble proteins and total phenols. Leaf surface wax was estimated by the method of Ebercon *et al.* (1977) and expressed as $\mu g/cm^2$ (Stickler *et al.*, 1969). Free amino acids were estimated spectrophotometrically according to the method of Yemm and Cocking (1955). Total sugars were determined as per method given by Yemm and Willis (1954). The amount of soluble protein was estimated using the method by Lowry *et al.* (1951). Total phenols were determined by the method of Swain and Hillis (1959). The amount of all these constituents present in a particular genotype was correlated with the corresponding aphid population attacking that particular genotype and the results were further analyzed for their relationship to susceptibility or resistance.

The morphological characteristics of all the 24 barley genotypes were observed under field conditions by visual observation method. The observations on leaf colour and waxiness of leaf were recorded at flag leaf stage of the crop, while data on days to earing, days to maturity, plant height (cm) and number of tillers per meter row length were recorded at maturity stage of the crop. All the characteristics were correlated with aphid infestation to draw conclusions about their role towards susceptibility/resistance.

RESULTS AND DISCUSSION

Biochemical characteristics *vs* corn leaf aphid infestation

The biochemical characteristics of ten genotypes constituting a group amongst resistant/susceptible categories based upon their performance under field conditions were analyzed and their effect on corn leaf aphid was observed (Table 1).

Table 1. Biochemical characteristics of barley genotypes (leaf tissues) and their correlations with corn leaf aphid population.

Genotype	Leaf surface wax ($\mu g/cm^2$) waxy/non-waxy	Free amino acids (mg/g fresh weight)	Total sugars (mg/g fresh weight)	Soluble proteins (mg/g fresh weight)	Total phenols (mg/g fresh weight)	Mean Aphid population
AR-18	0.08 (Non-waxy)	12.27	7.31	46.45	8.39	53.20
AR-19	0.12 (Non-waxy)	17.34	8.26	37.73	4.64	40.67
BH-75	0.17 (Non-waxy)	14.39	6.38	30.47	3.69	35.93
AR-25	0.11 (Non-waxy)	10.99	6.42	45.57	5.35	42.06
Clipper	0.13 (Non-waxy)	11.19	9.45	42.19	5.30	61.67
AR-4	0.42 (Waxy)	9.44	4.71	25.91	13.67	14.60
AR-48	0.33 (Waxy)	4.09	5.50	44.43	13.99	19.00
AR-52	0.27 (Waxy)	9.90	4.47	16.03	15.84	20.06
AR-66	0.27 (Waxy)	7.62	3.81	23.35	9.76	16.67
AR-5	0.21 (Non-waxy)	5.90	3.45	27.43	16.65	17.80
'r'	(-0.8327)* (0.7123)*	(0.5991)	(0.9121)*	(0.8550)*	(-0.7508)	

'r' = Correlation coefficient with average peak aphid population
* Significant at 5%

Leaf surface wax

The genotypes (AR-48, AR-52, AR-66 and AR-5) having high amount of leaf surface wax had low incidence of aphids as compared to AR-19, AR-25,

BH-75 and clipper which had less amount of leaf surface wax leading to susceptibility to corn leaf aphid infestation. The present findings confirm the reports of Tsumuki *et al.* (1987b) and Tsumuki *et al.* (1989) who also observed that barley lines having high leaf surface wax harboured few aphids.

Total free amino acids

The correlation coefficient between total free amino acids and corn leaf aphid population was positive but non-significant. The amount of total free amino acids varied from a minimum of 4.09 mg/g in the genotype AR-48 to a maximum of 17.34 mg/g in AR-19. The results confirm the findings of Niraz *et al.* (1985), Tsumuki *et al.* (1987a) and Tsumuki *et al.* (1987b).

Total sugars

A significant, positive correlation was observed between total sugars and number of aphids harboured by barley genotypes. Total sugar content varied between 3.45 mg/g in AR-5 to 9.45 mg/g in clipper, of which the former was found to be tolerant while the latter susceptible to aphid infestation. Similar results were reported by Niraz *et al.* (1985) and Tsumuki *et al.* (1987b).

Soluble proteins

A 2.5-fold increase in soluble protein content was found in AR-18 in comparison to AR-52. The genotypes having higher soluble protein contents were supporting many aphids in comparison to those having low soluble proteins. These results are similar to those observed by Niraz *et al.* (1985) who also reported a direct relationship between soluble proteins and aphid infestation in wheat crop.

Total phenols

Total phenols varied from a minimum of 3.69 mg/g in BH-75 to a maximum of 16.65 mg/g in AR-5. A higher concentration of phenols, was associated with few aphids, thus contributing towards resistance. There was a

negative and significant correlation between amount of total phenols and number of aphids per tiller. The results are similar to those of Leszczyuski *et al.* (1985) and Niraz *et al.* (1985).

Morphological characteristics of barley genotypes *vs* corn leaf aphid infestation

The impact of morphological characteristics of barley genotypes on aphid infestation is presented as follows:

Waxiness/non-waxiness leaf

Two types of variations *i.e.* waxy and non-waxy were observed in the leaf surface of different genotypes (Table 1). It was observed that aphid population was positively and significantly correlated with non-waxy leaf surface. In an earlier study, Weibull (1993) also observed that the infestation of *R. padi* was more common on non-waxy plants than on waxy ones in wheat crop.

CONCLUSIONS

The biochemical characteristics (leaf surface wax, total free amino acids, total sugars, soluble proteins and total phenols) of ten genotypes constituting a group having tolerant, susceptible and highly susceptible, showed a noticeable effect on aphid population. Leaf surface wax and total phenols were found to impart tolerance in plants against corn leaf aphid attack. However total sugars, soluble proteins and free amino acids contributed towards susceptibility of plants against the infestation of corn leaf aphid. The morphological characteristics were found to have no significant effect on susceptibility/resistance of barley genotypes against corn leaf aphid except waxiness and non-waxiness of the leaf surface..

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