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Morphological and Physiological Parameters of Soybean Resistance to Insect Pests

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Abstract: The role of physio-morphological characters in determining resistance-susceptibility of soybean (*Glycine max* L. Merril) genotypes was studied. Ten soybean varieties Psc-62, NARC-VII, Ajmeri, V-I, Soy 95-1, Davis, NARC-VI, S-69-94, Psc-56 and S-72-60 were studied for relative resistance against whitefly (*Bemisia tabaci),* jassid (*Amrasca bigutella* Ishida) and soybean looper (*Pseudoplusia includens* Walker). Significant differences were found to exist among all cultivars for physical parameters, leaf area and leaf hair density and non-significant differences for moisture contents. Leaf area and moisture contents showed positive correlation with whitefly (0.508,0.88), jassid (0.405, 0.913) and soybean looper infestation (0.426, 0.821, respectively) and leaf hair density on abaxial surface of leaf has significantly negative correlation (-0.75, -0,74, -0.926, respectively) with these insect pests. The variety V-1 and Ajmeri are comparatively more resistant having population of whitefly 1.29, jassid 0.62 per leaf respectively. Psc-56 suffered minimum infestation percentage of soybean looper (10). Davis was most susceptible to all three insect pests having infestation of whitefly, jassid and soybean looper (6.39, 2.09, 33.33%, respectively).

Key words: Soybean, physio-morphological characters, insect pests, Pakistan

Introduction

Soybean (*Glycine max* L. Merril) is grown as vegetable and oilseed crop. Soybean looper (*Pseudoplusia includens* Walker) is one of the serious pests of soybean crop. In Pakistan the study pertaining to the losses caused by soybean insect pests is not available. In Georgia, USA, the soybean looper is the third most cost bearing pest for its control. Total losses due to the looper was $ 0.4 million and all other insect pest accounted for $ 215,000 in 1996 and most of these losses were due to threecorned alfalfa hopper, white flies, beet armyworm and Mexican bean beetle. The average controlling cost per unit was maximum $10.00 for soybean looper and $ 8.25 for other insect pests (McPherson, 1996). Traditional chemical control of insect pests increased the cost of production, yield losses, health problems and environmental deterioration. The rationale approach for sustainable development is integrated pest management. Potential alternative or addition to chemical and cultural control is the use of host plant resistance.

The development of resistant varieties is an integral part of integrated pest management. Because crops resistant to insect attack have played a strategic role inducing both insect damage and use of insecticides (Luginbill, 1969). The introduction of resistant soybean genotypes and their continuous replacement with a better blood is a very important link in its integrated pest management (IPM). Biochemical and morphological characteristics are known to contribute to plant resistance to insect pests (Norris and Kogan, 1980). The latter have effects through their physical interference with the mechanisms of host selection, feeding, ingestion, digestion, mating and oviposition (Chiang and Norris, 1983). The investigation made by Agarwal *et al.* (1978), Ahmad and Haq (1987), Ahmad *et al.* (1987), Yousaf and Ahmad (1990), Javed *et al.* (1992) and Ali *et al.* (1995) showed that resistance in plants is not governed by a single factor but a combination of several factors which complement one another to produce it.

The study was carried out on ten soybean varieties to determine the role of morpho-physiological plant factors, which contribute towards resistance against insect pests.

Materials and Methods

The experiment was conducted at National Agricultural Research Center, Islamabad, Pakistan during 2001. The observations were recorded at weekly interval during the growth period of the crop. Ten plants were selected randomly in each replication for recording the observation.

The population of white fly and jassid per leaf was recorded by counting an upper, middle and lower portion of the plants and average was calculated. Percentage soybean looper infestation was obtained on the basis of leaf injury. For plant parameters ten plants from each replication and nine leaves (upper, middle and lower) from each plant were selected. Leaf hair per cm^2 on abaxial surface of leaves were counted under microscope and leaf

area was measured by leaf area meter. Moisture contents were determined by applying the following formula (Ali *et al.*, 1994).

$$\text{Moisture contents} = \frac{\text{Wt. of fresh leaves - Wt. of dry leaves}}{\text{Wt. of fresh leaves}} \times 100$$

Data was statistically analyzed by randomised complete block design and Duncan's multiple range test (Duncan, 1955) was used to determine the levels of significant difference among soybean varieties with regards to studied plant parameters and insect pests infestation. A multiple regression analysis and correlation matrix was used to identify those measured factors, which correlated with soybean resistance to insect pest's infestation. Using the insect infestation data as the dependent variable and the data on studied plant parameters as independent variables ran the regression.

Results and Discussion

Results of comparison of three plant parameters among the soybean varieties indicated that significant differences ($P < 0.001$) in trichome density on abaxial surface of the leaf and leaf area (Table 1). However, the differences in moisture contents were not significant. The differences in infestation of white fly, jassid and soybean looper were significant ($P < 0.001$). The white fly infestation was minimum 1.29, 1.65 per leaf on V-I and Ajmeri followed by Psc-56, NARC-V-I, Soy-95-1, NARC-VII, Psc-62, S-72-60 and S-69-94 having 1.89, 2.13, 3.18, 3.25, 3.46, 3.71 and 5.14 per leaf respectively and was maximum 6.39 per leaf on Davis (Table 2). For jassid the genotypes Amjeri and V-I suffered minimum infestation 0.62 and 0.63 per leaf, followed by Psc-56, Soy 95-1, NARC-VI, NARC-VII, S-72-60, Psc-62 and Davis having 0.98, 1.02, 1.13, 1.68, 1.88, 1.92 and 2.09 per leaf respectively and maximum infestation was on genotype S-69-94. The genotype Davis suffered maximum looper infestation 33.33% and minimum infestation 10% was on Psc-56.

The linear correlation and linear regression between whitefly, jassid and looper infestation and studied plant parameters in soybean varieties including trichome density and leaf areas are illustrated in Fig. 1 and 2.

The equation of multiple regression of whitefly, jassid and looper with leaf areas are ($Y = 0.33x + 1.45$, $Y = 0.10x + 0.85$, $Y = 1.37x + 15.10$ respectively) and with leaf hair density are ($Y = -0.50x + 6.05$, $Y = -0.17x + 2.40$, $Y = -2.55x + 36.88$, respectively).

Morphological and physiological factors in plants may interfere with the mechanism of host selection, feeding, ingestion, digestion, mating and oviposition and used by insect pest (Norris and Kogan, 1980). Trichoms may specially contribute to such resistance by interfering with insect oviposition attachment to the plant feeding and ingestion. Whitefly, jassid and looper infestation is positively correlated with leaf area ($R^2 = 0.343$, $R^2 = 0.263$, $R^2 = 0.6$ respectively) correlation matrix is (0.508, 0.405, 0.426, respectively), (Table 3).

These results are differed from that of Hassan *et al.* (1999), who observed non-significant correlation between leaf area and whitefly and jassid infestation. Leaf hair density has negatively significant correlation with infestation of whitefly, jassid and looper ($R^2 = 0.776$, $R^2 = 0.812$, $R^2 = 0.926$) and correlation matrix values are (-0.753, -0.745, -0.926 respectively) shown in (Table 3). These findings are in conform to those of Chiang and Norris (1985) and Beach and Todd (1988). These results are also similar to the findings of Hassan *et al.* (1999), Ali *et al.* (1999) who reported negative significant correlation between jassid and leaf hair density. Kogan (1972) and Khan *et al.* (1986) reported that pubescence on soybean foliage may strongly influence larval resistance for looper as the maximum bean beetle (*Epilachna varivestis* Mulsant) and the cabbage looper (*Trichoplusia ni* Hubner). The results are partially contrary to the findings

Table 1: Comparison of selected parameters among soybean cultivars grown under field conditions

Soybean varieties	Leaf area	Moisture contents	Leaf hair density
S-69-94	44.65a	56.74	187.2cd
S-72-60	42.00ab	56.11	179.1cd
Davis	41.55ab	58.75	163.3d
Psc-56	40.90ab	52.19	325.4a
V-I	35.55ab	49.67	253.8b
Psc-62	34.66b	55.68	196.2b-d
Soy-95-1	34.33b	54.16	225.9bc
Ajmeri	22.66c	52.30	236.2bc
NARC-VII	18.00c	56.45	216.7b-d
NARC-VI	16.33c	54.05	232.4bc

Table 2: Mean infestation of whitefly, jassid and soybean looper on soybean varieties

Soybean varieties	Whitefly	Jassid	S. looper
S-69-94	5.94a	2.19a	30.00ab
S-72-60	3.71b	1.88ab	33.33a
Davis	6.39a	2.09a	33.33a
Psc-56	1.89bc	0.98bc	10.00b
V-1	1.29c	0.63c	13.33ab
Psc-62	3.46bc	1.92ab	26.66ab
Soy 95-1	3.18bc	1.02bc	23.33ab
Ajmeri	1.65bc	0.62c	20.00ab
NARC-VII	3.25bc	1.68ab	20.00ab
NARC-VI	2.13bc	1.13bc	16.66ab

Means followed by different letters differ significantly at $P < 0.001$

Table 3: Correlation between insect infestation and resistance factors

Correlation matrix	Leaf area	Moisture contents	Leaf hair density
Whitefly	0.508	0.888	-0.752
Jassid	0.405	0.913	-0.745
Looper	0.426	0.821	-0.926

Critical region: $|r|$ $P > 0.38$ significant at 1% level of probability

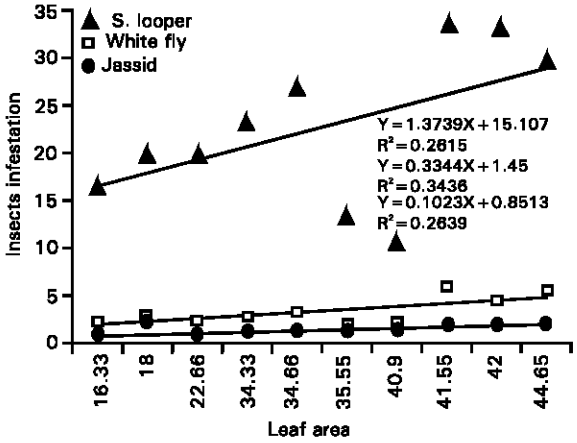

Fig. 1: Leaf area vs insects infestation

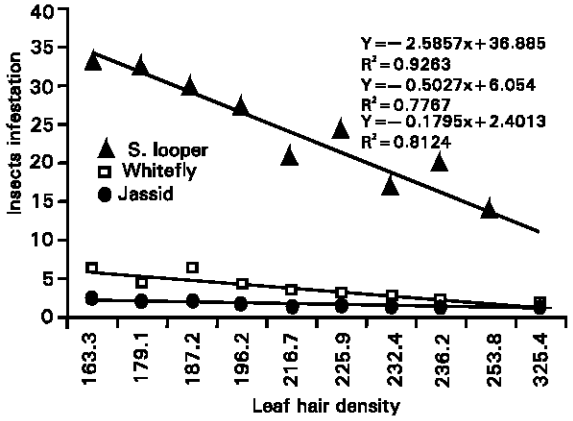

Fig. 2: Leaf hair density vs insects infestation

of Yousaf and Ahmad (1990), Zia *et al.* (1987), Ali *et al.* (1995) who showed positive correlation between whitefly and leaf hair density. Moisture contents have positive correlation with whitefly, jassid and looper infestation with correlation matrix (0.88, 0.903, 0.821, respectively) but Hassan *et al.* (1999) showed nonsignificant correlation between moisture contents and whitefly and jassid infestation.

It may be concluded from the present study that comparative resistance against whitefly, jassid and looper measured in terms of increase reflection of their population in soybean varied with their genotypes tested. These variations were found to be mainly associated with the changes in leaf area and leaf hair density which were positively and negatively correlated to the changes against insect pests respectively.

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