

Pubescence as a plant resistance character against *Spilosoma obliqua* Walker in the interspecific crosses of soybean

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ABSTRACT

Spilosoma obliqua Walker (Lepidoptera; Arctiidae), a polyphagous insect often cause serious economic damage to several crops, particularly soybean (*Glycine max* (L.) Merr.). One wild accession *Glycine soja* is found to be resistant to this insect. An attempt was made to determine the relationship of the pubescence tip sharpness, length and density with resistance to *S. obliqua* with the help of 'Scanning Electron Microscopy (SEM)', and common compound microscope in the interspecific crosses between *G. max* and *G. soja*. The pubescence tip sharpness and pubescence density on the adaxial leaf surface of soybean were found to be important in determining resistance to *S. obliqua* but the length of the pubescence did not show any association with resistance to this insect. A comparison between the use of SEM and common compound microscope to identify pubescence types revealed that the common compound microscope can serve the purpose of distinguishing sharp tip and blunt tip pubescence types and whereby determining the resistant and susceptible cultivars of soybean to *S. obliqua*

keywords: *Glycine max*, *Glycine soja*, *Spilosoma obliqua*, pubescence, insect resistance.

INTRODUCTION

Spilosoma obliqua Walker (Lepidoptera; Arctidae), commonly known as Bihar hairy caterpillar is a serious pest of several crops, particularly soybean (*Glycine max*). Most of the cultivated varieties of soybean are susceptible to this insect. However, *Glycine soja* L. Sieb. & Zucc. (Syn. *Glycine formosana* Hosokawa) has been reported to be a source of resistance to this insect (Ram *et al.* 1989) and that resistance is controlled by one incompletely dominant gene (Bhattacharyya and Ram 1995). Pubescence as a plant resistance factor interferes with insect oviposition, attachment of eggs to plant surface, feeding and ingestion of many insects (Maxwell and Jennings 1980). Turnipseed and Sullivan (1976) indicated that differences in population density of *Empoasca fabae* on different types of the hosts were due to relative length and erectness of leaf trichomes. However, Broersma *et al.* (1972) suggested that trichome orientation was more important than density as a factor of resistance to the leaf hopper (*E. fabae*) in soybean, in general, mechanical effects of pubescence depend on four main characteristics of the trichomes: density, length, erectness and shape (Norris and Kogan 1980).

In view of the above, an attempt was made to determine the relationship of the pubescence tip sharpness, length and density with resistance to *S.*

obliqua with the help of scanning electron microscope and common compound microscope in the interspecific crosses of soybean.

MATERIALS AND METHODS

The experimental materials consisted of four parental lines Bragg, Ankur and PK 472 of *Glycine max* (susceptible to *Spilosoma obliqua*) and one wild accession *Glycine soja* (resistance to *Spilosoma obliqua*). Interspecific crosses (Bragg x *G. soja*; Ankur x *G. soja* and PK 472 x *G. soja*) were made and F₁ generations were raised to obtain seeds of F₂ generations. All the parental lines, 3 F₁'s and 3 F₂'s were grown in a compact family block design (Panse and Sukhatme 1978) in the field and leaves were screened in the laboratory against *S. obliqua* under forced feeding. The equal area of leaflets of test plant and Bragg (as susceptible check) were kept in one perforated polythene packet while in the other packet, the leaflets of test plant were kept with leaflets of *Glycine soja* (as resistant check). In order to make distinction between leaves of the test plants and the checks, the trifoliate leaves of the test plants were kept intact and those of the check plants were kept as separate leaflets. Ten larvae of same age which were under starvation for 12 hours were placed in each packet. The test plant were categorized as resistant, moderately resistant and susceptible based upon the feeding behaviour of larvae after 24 hours.

The data for pubescence tip sharpness, length

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and density were recorded from the adaxial leaf surface of the parental lines, three F1's and ten plants of different resistant, moderately resistant and susceptible plants of three F2's under compound microscope. Five microscopic fields were measured from each leaf sample and the mean values were calculated.

The leaf samples of all the parental lines, one F1 (Bragg x *G. soja*) and a few individual plants from each category of resistant, moderately resistant and susceptible from F2 of the same cross i.e., Bragg x *G. soja* were prepared for better observations under Scanning Electron Microscope (SEM) as per procedure of Watson (1958) and observed for pubescence tip sharpness and length under Phillip 515 SEM at varying magnifications and selected areas were photographed using INDU / ORWO 125 ASA black and white 120 mm films.

Correlations between response to *S. obliqua* and different pubescence characters were estimated. For the purpose of calculating correlation response to *S. obliqua*, the reaction was scored as 1 for resistance, 3 for moderately resistance and 5 for susceptibility. Similarly, the pubescence tip shape were also scored as 1 for sharp pointed, 3 for moderately sharp and 5 for blunt.

RESULTS

The tip of the pubescence of all the cultivated varieties, namely Bragg, Ankur and PK 472 which were susceptible to *S. obliqua* was blunt (Plate 1, 2 and 3). In contrast, a sharp, pointed pubescence tip was observed in the wild resistant line *G. soja* (Plate 4). In F1's of Bragg x *G. soja*; Ankur x *G. soja* and PK 472 x *G. soja* which showed a moderately resistant reaction against *S. obliqua*, the tip sharpness was intermediate between the parental lines (Tables 1, 2 and Plate 5)

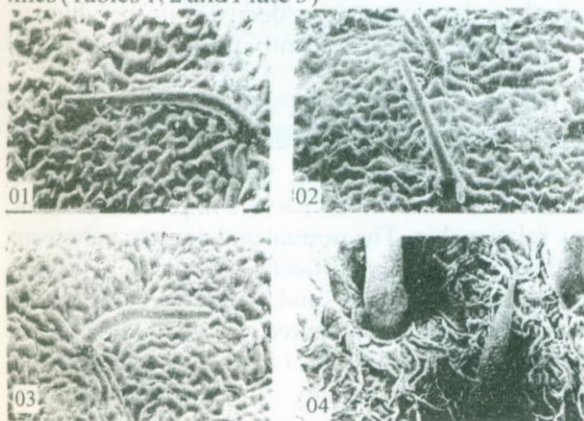


Figure 01: Line → Bragg → Susceptible
 Figure 02: Line → Ankur → Susceptible
 Figure 03: Line → PK 472 → Susceptible
 Figure 04: *Glycine soja* → Resistant

Table 1: Response of *Spilosoma obliqua* to leaves of different soybean genotypes with different tip shape, length and density of pubescence on the adaxial leaf surface under compound microscope

Materials	Reaction to <i>S. obliqua</i>	Number of Samples	Pubescence tip shape**	Length of Pubescence (mm)	Density of Pubescence per 1.3sq. mm
Bragg	S	10	B	0.288 ± 0.006	14.8 ± 0.50
Ankur	S	10	B	0.195 ± 0.006	11.6 ± 0.56
PK 472	S	10	B	0.183 ± 0.004	08.5 ± 0.62
<i>Glycine soja</i>	R	10	SP	0.147 ± 0.005	24.2 ± 0.32
F1(Bragg x <i>G. soja</i>)	MR	06	MS	0.226 ± 0.006	21.4 ± 0.47
F1(Ankur x <i>G. soja</i>)	MR	08	MS	0.197 ± 0.004	17.5 ± 0.42
F1(PK 472 x <i>G. soja</i>)	MR	05	MS	0.201 ± 0.009	15.2 ± 0.61
F2(Bragg x <i>G. soja</i>)	R	10	SP	0.299 ± 0.007	18.5 ± 0.52
	MR	10	MS	0.279 ± 0.009	16.3 ± 0.43
	S	10	B	0.232 ± 0.005	14.9 ± 0.59
F2(Ankur x <i>G. soja</i>)	R	10	SP	0.192 ± 0.008	19.2 ± 0.49
	MR	10	MS	0.212 ± 0.007	17.5 ± 0.59
	S	10	B	0.165 ± 0.006	14.2 ± 0.65
F2(PK 472 x <i>G. soja</i>)	R	10	SP	0.210 ± 0.008	15.9 ± 0.48
	MR	10	MS	0.235 ± 0.007	14.5 ± 0.61
	S	10	B	0.281 ± 0.006	10.6 ± 0.39

* S=susceptible;MR=Moderately Resistant and R=Resistant
 ** B=Blunt;MS=Moderately Sharp and SP=Sharp and Pointed

Table 2: Resopnse of *Spilosoma obliqua* to leaves of different soybean genotypes with different tip shape and length of pubescence on the adxial leaf surface under Scanning Electron Microscope(SEM)

Samples	Materials	Reaction to <i>S. obliqua</i> *	Pubscence tip shape**	Length of the pubescence(mm)
1	Bragg	S	B	0.28
2	Ankur	S	B	0.20
3	PK 472	S	B	0.18
4	<i>Glycme soja</i>	R	SP	0.15
5	F1(Bragg x <i>G. soja</i>)	MR	MS	0.23
6	F2(Bragg x <i>G. soja</i>)	R	SP	0.14
7	F2(Bragg x <i>G. soja</i>)	R	SP	0.30
8	F2(Bragg x <i>G. soja</i>)	MR	MS	0.26
9	F2(Bragg x <i>G. soja</i>)	MR	MS	0.28
10	F2(Bragg x <i>G. soja</i>)	S	B	0.23
11	F2(Bragg x <i>G. soja</i>)	S	B	0.21
12	BC 1(Bragg x <i>G. soja</i>) x <i>G. soja</i>	R	S	0.30

* S=Susceptible;MR=Moderately Resistant and R=Resistant
 ** B=Blunt;MS=Moderately Sharp and SP=Sharp and Pointed



Figure 05: F1(Bragg x *G. soja*) → moderately resistant

The different categories of the F2 plants of the above three crosses which were resistant, moderately resistant and susceptible showed a high

correlation between resistance to *S. obliqua* and sharpness of the pubescence tip ($r=0.742$, $P=0.01-0.001$) as these groups had sharp (Plate 6), moderately sharp (Plate 7) and blunt (Plate 8) pubescence tips. Sharp pubescence tip of the resistant backcross [(Bragg x *G. soja*) x (*G. soja*)] (Plate 9) confirms this relationship.

The length of the pubescence was measured on the adaxial leaf surface under compound microscope (Table 1) and under SEM (Table 2) of different experimental materials. The cultivars Bragg, Ankur and PK 472 recorded significantly longer pubescence than *Glycine soja* (Tables 1 and 2). The length of pubescence of all the F₁'s which were moderately resistant varied from 0.197 ± 0.004 mm in Ankur x *G. soja* to 0.226 ± 0.006 mm in Bragg x *G. soja*. In F₂'s a relationship between length of pubescence and resistance to *S. obliqua* could not be established (Table 1). A non-significant correlation coefficient ($r = 0.112$) was recorded for these two characters. The results were similar in the measurements taken by using SEM (Table 2).

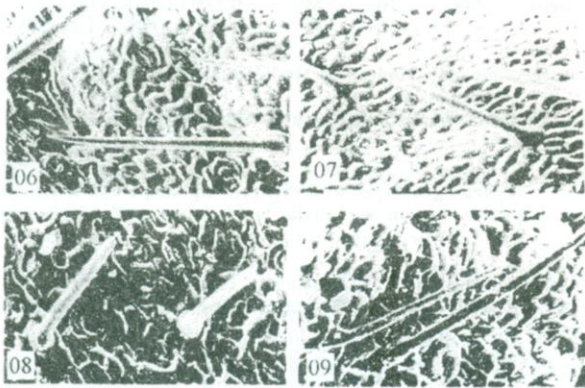


Figure 06: F₂ (Bragg x *G. soja*) → Resistant
 Figure 07: F₂ (Bragg x *G. soja*) → Moderately resistant
 Figure 08: F₂ (Bragg x *G. soja*) → Susceptible
 Figure 09: Backcross x (Bragg x *G. soja*) x *G. soja* → Resistant

In different resistant materials, the density of pubescence varied from 15.9 ± 0.48 (in F₂'s of PK 472 x *G. soja*) to 24.2 ± 0.32 (in *G. soja*) whereas in moderately resistant materials it varied from 14.5 ± 0.61 (in F₂'s of PK 472 x *G. soja*) to 21.4 ± 0.47 in F₁ (Bragg x *G. soja*). In the susceptible materials, the pubescence density was much less (8.5 ± 0.62 in PK 472 to 14.9 ± 0.59 in F₂'s of Bragg x *G. soja*) (Table 1). The value of correlation coefficient ($r=0.462$, $P=0.1-0.05$) between the pubescence density and response to *S. obliqua* indicated that higher density of pubescence is responsible for imparting resistance to *S. obliqua*.

The pubescence tip shape and length has been observed under compound microscope as well as SEM. Some photomicrography of the adaxial leaf surface of the parental lines has been taken from

compound microscope to compare results with SEM (Plate 10, 11, 12 and 13).

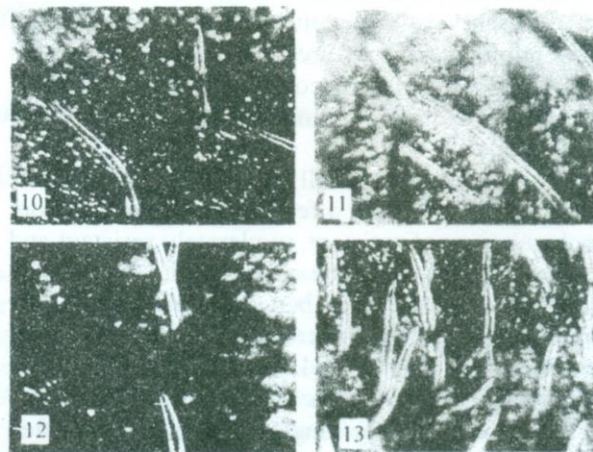


Figure 10: Bragg → Susceptible
 Figure 11: Ankur → Susceptible
 Figure 12: PK 472 → Susceptible
 Figure 13: *Glycine soja* → Resistant

DISCUSSION

Pubescence as a plant resistance factor interferes with insect oviposition, attachment to the plant, feeding and ingestion. However, glabrous form of plants may be more resistance to some species. In general, purely mechanical effects of the pubescence depends on four main characteristics of the trichomes: density, length, erectness and shape (Norris and Kogan 1980).

In the present study, a fairly high degree of association between pubescence tip sharpness and resistance to *S. obliqua* was observed. Ting (1946) reported for the first time that the sharp tip pubescence (Pb) was dominant over blunt tip (pb) in soybean and was controlled by a single pair of genes. Sharp tipped pubescence present on soybean leaves may result in an increase in the time required to complete development, a decrease in the ultimate weight of the insect or a combination of these factors (Lambert *et al.* 1992).

From this study, it is evident that the higher density of pubescence is responsible for imparting resistance to *S. obliqua*, whereas length of the pubescence and resistance to *S. obliqua* did not show any relationship. The normal and densely pubescent isolines caused a significant reduction in feeding damage, oviposition and subsequent nymphal population when compared to glabrous isolines (Elden and Lambert 1992) in soybean, orientation, greater length and density of plant pubescence are important in determining resistance to potato leaf hopper, *Empoasca fabae* Harris (Broersma *et al.* 1972; Turnipseed 1977). Lee (1983) also reported that pubescence interferes with oviposition, feeding

and attachment mechanism of the leaf hopper nymph (*E. fabae*), thus reducing survival on pubescent soybean lines.

In contrast, as discussed by Singh *et al.* 1971, pubescent soybean cultivars are more susceptible to soybean pod borer, *Laspeyresia glycinivorella* Mats., since adults prefer soybean with more dense pubescence for oviposition.

The pubescence tip shape was studied using SEM as well as common compound microscope in the present study and from the results it can be concluded that common compound microscope can serve the purpose of distinguishing sharp tip and blunt tip pubescence types and consequently the resistance and susceptible genotype against *Spilosoma obliqua*.

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