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PHYSICO-CHEMICAL FACTORS IMPARTING RESISTANCE TO STEM DAMAGE BY SPOTTED BOLLWORMS *(EARIAS* SPP.) OF COTTON

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Out of nine cultivars of cotton *(Gossypium hirsutum* L.) tested for resistance in a replicated field trial at Gujrat, Pakistan, during 1990, only FH 90 and NIAB 78 showed some resistance against the stem damage by spotted bollworms *(Earias insulana* Boisduval) and *E. vitella* (Fabricius). Of the various physical and chemical factors, stem diameter, stem bark thickness, pith diameter, hair density on stem, number of necatries per leaf, crude proteins, crude fats and total sugars were negatively correlated to the spotted bollworms infestation. The number of gossypol glands on stem, moisture contents, fibre contents and mineral contents of stem were found to the positively correlated to the stem damage by spotted bollworms. Whereas hair density and gossypol glands on the leaves and fibre ring thickness did not play any role in imparting resistance in cotton to spotted bollworms.

INTRODUCTION

Bollworms cause up to 45.56% losses in cotton yield (Satpute *et al.,* 1986). Singh and Sindhu (1982) described that *Earias* spp. caused up to 71.4% fruit shedding. As physico-chemical factors play an important role in imparting resistance in cotton (Painter, 1951), therefore, the present studies were designed to sort out the most important factors affecting resistance in cotton to spotted bollworms.

MATERIALS AND METHODS

The trials were laid out at Chak 40, Gujrat, Pakistan during 1990. In all, nine cotton cultivars viz. NIAB 78, B 557, FH 87, FH 90, FH 367, FH 390 G 9, LH 119 and LH 170 were grown in four repeats. The gross and net plot size were kept 0.0129 and 0.0086 acre, respectively. When the spotted bollworm stem damage reached its maximum, the data for bollworm infestation were recorded from randomly selected ten plants per plot. The physical characters of leaves and stem tops were recorded from randomly selected five leaves and five stems per plot.

One kg fresh weight of stem tips per plot was taken for chemical analysis. The moisture contents were estimated on the basis of fresh weight while other chemicals were estimated from the oven dried samples.

The data were analysed for differences of means and correlations were worked out with the help of a computer.

RESULTS AND DISCUSSION

A perusal of the data (Table 1) shows that cotton cultivar FH 90 was the most resistant, while NIAB 78, FH 87, FH 367, FH 390 and G 9 were moderately susceptible and B 557 and LH 170 was the most susceptible to the attack of spotted bollworms.

A go through the data (Table 1) indicates that FH 87 had the larger stem diameters followed by NIAB 78 while LH 119 had the most slender stems. FH 87 had also

Table 1. A multiple comparison between the mean spotted bollworm infestation and various stem/leaf morphological characters

Cultivar	Bollworm infestation (%)	Stem diameter (mm)	Stem bark thickness (mm)	Stem fibre ring thickness (mm)	Pith diameter (mm)	Number of gossypol GL./cm^2 of stem bark
FH 90	7.50 a	4.97 d	0.72 c	0.09 b	3.38 b	278.60 a
NIAB 78	8.75 a	4.99 d	0.83 d	0.12 e	3.25 ab	353.82 ab
FH 390	15.25 b	4.83 c	0.62 b	0.10 c	3.18 ab	437.46 b
FH 87	17.50 b	5.44 e	0.73 c	0.13 f	3.44 b	348.76 ab
FH 367	17.50 b	4.98 d	0.73 c	0.07 a	3.27 ab	451.86 b
G 9	17.50 b	4.60 ab	0.65 b	0.11 d	3.23 ab	451.30 b
LH 119	22.50 c	4.50 a	0.67 bc	0.07 a	3.07 a	447.07 b
LH 170	27.50 d	4.70 b	0.74 c	0.11 d	3.30 ab	428.93 b
B 557	27.85 d	4.67 b	0.50 a	0.10 c	3.21 ab	427.12 b
Sx	1.221	0.039	0.022	0.00	0.092	33.745

Number of hair/cm^2 of the bark	Number of nectaries/ leaf	Number of gossypol glands per cm^2 on LLS	Number of hairs per cm2 leaf surface (LLS)
664.56 d	3.33 d	96.29 c	476.92 e
594.72 b	3.00 c	115.83 e	457.17 d
803.64 f	3.00 c	91.45 b	291.01 b
686.55 e	2.99 c	80.56 a	255.99 a
641.71 c	3.33 d	92.90 bc	380.33 c
943.98 g	2.67 b	107.85 d	769.27 g
635.44 c	3.00 c	158.02 f	641.04 f
600.42 b	3.67 e	95.58 bc	391.20 c
369.21 a	1.00 a	94.33 bc	385.60 c
Sx 2.679	0.089	1.327	6.280

Any two means carrying the same letter(s) are not significantly different at P = 0.05.

more thick fibre layer (xylum). NIAB 78 had the most thick stem bark followed by LH 170. Stem pith diameter was more in case of FH 87. FH 367 and G 9 had relatively higher gossypol gland densities on stem barks, whereas the stems of G 9 were the most hairy followed by FH 390. The leaves of LH 170 had more number of necatries per leaf, followed by FH 90 and FH 367 while B 557 had the lowest number of necatries per leaf. The density of gossypol glands was the highest on the leaves of LH 119 followed by NIAB 78. Leaves of G 9 and LH 119 had the higher hair densities on their leaves. Leaves of FH 87 had the lowest densities of gossypol glands and hairs.

The data (Table 2) show that stem diameter and stem bark thickness were significantly negatively while density of gossypol glands on stem bark was positively correlated to the mean bollworm infestation. The stem pith diameter, hair density on stem bark and necatries per leaf were also negatively correlated to the mean spotted bollworm infestation. The stem fibre ring (xylum) thickness, gossypol glands density on leaves and the hair density on leaves did not had any affect on the bollworm infestation.

A go through the data (Table 3) shows that the resistant variety FH 90 had the lowest amount of moisture in its stem tips followed by G 9 and NIAB 78. FH 87 was the most succulent one. The crude protein contents were the highest in NIAB 78 (the most susceptible) followed by FH 390 and G 9 whereas the lowest contents were found in LH 119. The crude fat contents were more in G 9 but lower in B 557. The minerals were more in the tips of B 557 and LH 119 compared with the amounts in FH 367. LH 119 had more crude fibre in its stem tips, whereas FH 90 was low in fibre contents. The contents of sugars were higher in FH 367 followed by FH 90 while LH 119 had the lowest amount of sugars in its tips.

Table 2. Correlation matrix between the spotted bollworm infestation and various physical characters of cotton stems/leaves of different cultivars of cotton

S.B.W. infestation	Stem diameter	Bark thickness	Fibre thickness	Pith diameter	GOS.GL. on stem	Hair on stem	Necatries L.	GOS.GL. on LLS	Hairs on LLS
1	2	3	4	5	6	7	8	9	10
1.000									
-0.418*	1.000								
-0.440*	0.418*	1.000							
-0.093	0.407*	0.114	1.000						
-0.200	0.419*	0.249	0.169	1.000					
0.456*	-0.386	-0.284	-0.154	-0.248	1.000				
-0.377	0.008	0.174	0.158	0.014	0.090	1.000			
-0.361	0.244	0.694**	-0.133	0.153	-0.196	0.455*	1.000		
0.063	-0.579**	0.058	-0.346	-0.407*	0.182	0.000	0.040	1.000	
-0.027	-0.659**	-0.051	-0.206	-0.277	0.163	0.381	-0.030	0.666**	1.000

*Significant at 5% and **significant at 1% levels of probability.

Table 3. **The mean values of various chemical characters of stem tips of different cotton cultivars**

Cultivar	Moisture contents (% of the fresh weight)	Crude proteins	Crude fats	Mineral contents	Crude fibre	Total sugars
			% of dry weight			
FH 90	77.75 a	6.93 d	0.81 b	9.09 d	19.54 a	63.45 f
NIAB 78	78.38 c	7.19 e	0.93 c	9.31 e	21.08 bc	61.47 b
FH 390	79.62 g	7.13 e	0.88 c	8.73 b	20.86 abc	62.30 d
G 9	78.07 b	7.10 c	0.99 d	9.32 e	21.01 bc	61.51 bc
FH 367	79.00 e	6.74 c	0.90 c	8.37 a	20.13 ab	63.86 g
FH 87	80.24 i	6.65 bc	0.98 d	9.71 f	21.50 bc	61.33 b
LH 119	78.69 d	6.55 a	0.92 c	10.11 g	21.59 c	60.83 a
LH 170	79.93 h	6.61 ab	0.76 a	8.97 c	20.55 abc	63.11 e
B 557	79.31 f	6.98 d	0.73 a	10.10 g	20.41 abc	61.82 c
Sx	0.016	0.032	0.016	0.032	0.436	0.111

Table 4. **Correlation matrix between the mean spotted bollworm tip damage (%) and various chemical characters of stem tips of different cultivars**

Infestation	Moisture content %	Crude protein	Crude fat	Total mineral	Crude fibre	Total sugar
1.000						
0.539**	1.000					
-0.467*	-0.413*	1.000				
-0.394*	-0.145	0.075	1.000			
0.343	0.019	-0.177	-0.017	1.000		
0.144	0.216	-0.092	0.400*	0.327	1.000	
-0.130	-0.043	-0.070	-0.443*	-0.774**	-0.569**	1.000

*Significant at 5% and **significant at 1% levels of probability.

A perusal of the data (Table 4) indicates that moisture contents had highly significant positive while crude proteins and fats had significant negative correlation with the mean spotted bollworm infestation of stem tips. The crude fibre and minerals were

also positively and that the total sugars were negatively correlated to tip damage by spotted bollworms.

The findings of present studies are exactly similar to those reported by Saleem (1989), Tariq (1989) and Singh *et al.* (1984). The main controversies were for the role of mineral contents (Ahmad *et al.*, 1985), gossypol glands and hairs (Baloch, 1982). The role of okra-leaves of cotton, contents of gossypol and tannin could not be studied in the present investigations. As to the justification of above anomalies, it can be said that the resistance/susceptibility of plant depends on a number of factors, like crop stage, weather conditions, crop morphology, its chemical make up, stage of pest, etc., therefore, such differences are not unusual. It may, therefore, be concluded that the cotton cultivar FH 90 was the most resistant to the stem damage by spotted bollworms followed by NIAB 78, B 557 proved to be the most susceptible from the pool of varieties tested. The stem diameter, stem bark thickness, pith diameter, hairiness of stem and number of necatries/leaf were negatively while density of gossypol glands on stems, positively correlated to the mean tip damage by spotted bollworms. The density of hairs and gossypol glands on the lower leaf surface and fibre (xylum) ring thickness did not had any effect on spotted bollworm infestation. The moisture contents, minerals and crude fibre were positively and crude protein, crude fat and total sugar negatively correlated to the mean stem damage by spotted bollworms.

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