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SCREENING OF TOMATO GENOTYPES FOR RESISTANCE TO TOMATO FRUIT BORER (*HELICOVERPA ARMIGER* HUBNER) IN PAKISTAN

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Tomato genotypes viz., Roma Local, Rio Grande, Tanja, Chico III, Long Tipped, Red- Top, FS-8001, FS-8002, Tropic, Pakit, Peelo, NARC-1, Roma VFN, Pant Bahr, Ebein, Nova Mech, Rockingham, Nagina, Shalkot-96, Pomodoro, Manik, Gressilesse, Nadir, Early Mech, Tommy, Pusha Rubi, Tropic boy, Big Long, Sahil, Sun 6002, Money-Maker and Royesta were evaluated to screen out the suitable resistamt/susceptible genotypes against the fruit borer in Pakistan. The results imparted that the percentage of fruit infestation and larval population per plant on tested genotypes of tomato varied significantly. Roma VF, NARC-1 and FS-8002 were categorized as susceptible genotypes with fruit infestation (37.69%, 37.08% and 36.41%, respectively) and larval population per plant (1.02%, 1.02% and 0.84 %, respectively). Whereas, the genotypes Sahil, Pakit and Nova Mecb had fruit infestation (12.30%, 13.14% and 13.96%, respectively) and larval population per plant (0.42%, 0.42% and 0.43%, respectively) and declared as resistant genotypes to tomato fruit borer. Lower values of host plant susceptibility indices (HPSI) were recorded on resistant genotypes. Sahil, Pakit and Nova Mecb could be used as a source of resistance for developing tomato genotypes resistant to tomato fruit borer.
Keywords: screening, tomato genotypes, fruit borer

INTRODUCTION

Tomato, (*Lycopersicon esculentum* Miller) is an important vegetables crop of Pakistan. The popularity of tomato and its products, continue to rise as it contains a significant amount of the vitamin A and C. Among vegetables, tomato is the second major vegetable, produced in Pakistan (Mirza, 2007). Its area under cultivation, during 2009-10 was 63 thousand/ha, with a total production of 562.9 thousand tones, and a yield 10522 Kg/ha (Agricultural Statistics of Pakistan, 2010). This yield is very low as compared to that of the developed countries, where it can reach up to an average of 1562 Kg/hectare. Of the various factors, responsible for its low yield, in Pakistan, the insect pests are the most important.

Tomato, like other vegetables, is more prone to insect pests and diseases mainly due to their tenderness and softness as compared to other crops. It is devastated by an array of pests; however, the major damage is caused by the tomato fruit borer, *Helicoverpa armigera* (Hübner) (Lepidoptera: Noctuidae).

Tomato fruit borer has been found to cause a yield loss of up to 35% in tomato and up to 37.79% in Karnataka, India (Dhandapani *et al*., 2003). In USA alone, *Helicoverpa* spp. causes a loss of more than one billion dollars to various crops, despite insecticide applications, worth another $250 million per year (Anonymous, 1976; Johnson *et al*., 1986).

Control of the insect pests through the application of insecticides cause ill effects like development of insecticide resistance in the pests, pest resurgence, environmental pollution and health hazards. Now trend has been shifted towards an integrated pest management (IPM). Host plant or varietal resistance constitutes an important tool for the integrated management of the pest insect. There are many reported studies, where the populations of *Heliothis spp*. were managed, using host-plant resistance, alone or in conjunction with other methods (Lukefahr *et al.*, 1971; Lukefahr, 1982).

The development and cultivation of *Helicoverpa armigera* resistant tomato cultivars is very limited in the Pakistan due to the lack of information about resistant tomato cultivars. Therefore, there is a need for borer resistant tomato varieties to minimize the use of insecticides. But, work done in this regard, is quite sketchy and needs more extensive research. Thus, owing to the lack of information, on this side, the present study was undertaken to screen out various available genotypes of the tomatoes, showing resistant and susceptible responses to the fruit borer in Pakistan.

MATERIALS AND METHODS

***Varietal Screening*:** Seeds of thirty two varieties, viz., Roma Local, Rio Grande, Tanja, Chico III, Long Tipped, Red Top, FS-8001, FS-8002, Tropic, Pakit, Peelo, NARC-1, Roma VFN, Pant Bahr, Ebein, Nova Mech, Rockingham, Nagina, Shalkot-96, Pomodoro, Manik, Gressilesse, Nadir, Early Mech, Tommy, Pusha Rubi, Tropic boy, Big Long, Sahil, Sun 6002, Money Maker and Royesta, were sown in the field. The experiment was replicated three times with plot size of 6.11 m x 12.23 m. 3-4 leaf stage seedlings were transplanted in the field. No plant protection measures were applied in the experimental field. Number of larvae plant^{-1} and fruit infestation per plant, from five randomly selected plants, in each variety, was recorded at weekly intervals for preliminary screening experiment.

Nine varieties of tomatoes, based on the the preliminary screening trials, were sown in the same experimental area next year. Data on the fruit infestation, by the pest and larval population of *H*. *armigera*, were recorded by following the same procedure as in preliminary screening experiment.

The average larval-population plant^{-1}, for each variety, was calculated by the simple arithmetic means (Wakil *et al*., 2009).

Damaged and undamaged fruits, from randomly selected five plants, in each variety, were counted, at weekly intervals. Percent fruit-infestation was calculated by the following formula (Wakil *et al*., 2009).

$$\text{Fruit Infestation Percentage} = B/A \times 100$$

Where

A= Total fruits (damaged + undamaged), and

B= Damaged fruits

The HPSI's based on the larval population caused by *H*. *armigera* on different selected cultivars of tomatoes was determined by using an IBM compatible computer, with a Microsoft Office Excel package to determine the resistance/susceptibility levels within the genotypes, under study. However, HPSI may be calculated by the following formula (Iqbal, 2008).

$$\text{HPSI (\%)} = (B - A)/B \times 100$$

Where

A = Larval population/fruit infestation on a single cultivar and B = Larval population /fruit infestation on all cultivars of the tomatoes on average basis

***Statistical Analysis*:** The data were analyzed for analysis of variance to determine the significance of treatments. The means were compared by a DMR Test at P=0.05. IBM compatible computer was used for analyzing the data with MSTAT package.

RESULTS

Fruit infestation and larval population per plant on tested genotypes of tomato varied significantly (Table 1). The percentage of tomato fruit infestation ranged from 37.69 (Roma VFN) to 12.30 (Sahil). The results presented in Table 1 revealed that the maximum infestation of fruits was recorded on genotype Roma VFN (37.69%), and it did not show a significant difference with that recorded on NARC-1 (37.08%), FS-8002 (36.41%) with the larval population per plant, i.e. 1.02%, 1.02% and 0.84%, respectively. Therefore, these three genotypes were categorized as susceptible to tomato fruit borer on the basis of fruit infestation.

Table 1. A Comparison of means for the data regarding the larval population of the fruit borer/plant and fruit infestation/plant on different genotypes of tomato during 2007

Genotypes	Fruit Infestation (%)	Larval population (%)
Tropic boy	34.93 bcd	1.21 a
Royesta	33.57 def	1.08 ab
Long Tipped	36.14 abc	1.07 ab
Money-Maker	34.91 bcd	1.06 bc
Ebein	34.18 cde	1.03 bcd
NARC-1	37.08 ab	1.02 bcde
Roma VFN	37.69 a	1.02 bcde
Pant Babr	28.41 ijk	0.96 bcdef
Shalkot-96	33.22 def	0.96 bcdef
Chico III	32.11 efgh	0.92 cdefg
Tommy	30.02 hij	0.92 cdefg
Nagina	33.24 def	0.92 cdefg
Peelo	28.27 ijk	0.92 cdefg
Pusba Rubi	32.53 defg	0.90 defg
Sun 6002	31.49 fgh	0.89 efg
FS-8002	36.41 abc	0.84 fgh
FS-8001	30.42 ghi	0.83 fgh
Tanja	27.63 jkl	0.80 gh
Pomodoro	25.63 lm	0.79 ghi
Rio grande	28.36 ijk	0.72 hij
Rockingbam	26.08 kl	0.72 hij
Manik	23.24 m	0.66 ijk
Nadir	16.74 no	0.62 jkl
Early Mecb	16.04 nop	0.57 klm
Roma Local	17.49 n	0.51 lmn
Big long	14.50 opqr	0.47 mn
Gressilesse	15.38 nopq	0.44 mn
Pakit	13.14 qr	0.43 mn
Tropic	13.96 pqr	0.42 m
Nova Mecb	13.96 pqr	0.42 m
Sahil	12.30 r	0.42 m
Red Top	14.82 opq	0.41 m

Tommy, Pant Bahr and Rio Grande showed intermediate response towards the resistance against the tomato fruit borer had 30.02%, 28.41% and 28.36% fruit infestation, respectively and larval population per plant, i.e. 0.92%, 0.96% and 0.72%, respectively. Whereas, Fruit infestation was recorded as 12.30%, 13.14% and 13.96% on three resistant genotypes, i.e. Sahil (0.42% larval population plant^{-1}), Pakit (0.43% larval population plant^{-1}) and Nova Mecb (0.42% larval population plant^{-1}).

The results regarding HPSI's, based on the larval population of fruit borer in various selected genotypes of tomato during 2007 and 2008 are depicted in Table 2. The results revealed that the genotype Roma VFN showed the highest HPSI (16% & 15%) for both years 2007 and 2008, whereas genotype Sahil showed the lowest HPSI (6%) for both years. The HPSI's for NARC-1, FS-8002, Tommy, Pant Bahr, Rio Grande, Nova Mecb and Pakit were 15% and 15%, 12% and 13%, 14% and 13%, 11% and 13%, 6% and 11%, 6% and 7%, and 6% and 7% for year 2007 and 2008, respectively.

Table 2. Host plant susceptibility indices for the years 2007 and 2008

Genotypes	Host plant susceptibility indices, HPSI based on larval population (%)		
	Years		
	2007	2008	Average
Roma VFN	16	15	16
NARC-1	15	15	15
FS-8002	12	13	14
Tommy	14	13	11
Pant Bahr	11	13	11
Rio Grande	6	11	12
Nova Mecb	6	7	9
Pakit	6	7	8
Sahil	6	6	6

The results showed that the genotype Roma appeared as susceptible with a maximum HPSI value of 16%, followed by HPSI's 14% and 13%, recorded for NARC-1 and FS-8002, respectively. The HPSI's was minimum (6.0%) for the genotypes Sahil, which showed comparative resistance. The genotypes Pakit and Nova Mecb with HPSI's values of 8.0% and 9.0%, respectively, were also found comparatively resistant.

The HPSI's for Tommy, Pant Bahr and Rio-Grande were 11%, 11% and 12%, and appeared with intermediate tolerance.

DISCUSSION

A number of plant characteristics are known to render the cultivars less suitable or unsuitable for the feeding, oviposition and development of insect pests (Rafiq *et al*., 2008). It may be due to plant trichomes (Johnson, 1956), phenol contents (Banerjee and Kalloo, 1989) and quality of host plant (Bazzaz *et al*., 1987). In contrast, some characteristics like nutrients (Goncalves-Alvin *et al*., 2004) improve the quality of host plant which resultantly favors the insects. Screening of tomato genotypes for resistance/susceptibility against tomato fruit borer was conducted to manage the fruit borer with environmently safe tactics. Similar kind of study has been documented by Khanam *et al.* (2003) who evaluated genotypic susceptibility of tomato genotypes different from those in present study.

In present study we found Sahil, Nova Mecb and Paket as resistant tomato genotypes against tomato fruit borer. It may be due to less fleshy and smooth surface of fruits of these genotypes. These genotypes may be resistant due to tight mesocarp and hard pulp of fruits (Mishra *et al.*, 1988), high ortho-dihydroxy phenols and trichome density in the foliage (Selvanarayanan and Narayanasamy, 2006). The genotypes Roma VFN, NARC-1 and FS-8002 were found susceptible, may be due to the reason of high nitrogen content (Minkenberg and Ottenheim, 1990) and high non reducing sugar in the foliage (Selvanarayanan and Narayanasamy, 2006).

The highest HPSI was found in genotypes Roma VFN (16%), NARC-1 (15%) and FS-8002 (14%). HPSI was comparatively low in the tomato genotypes Sahil (6%), Paket (8%) and Nova Mecb (9%). Therefore, these genotypes were concluded as resistant varieties. These findings are similar to the conclusion of studies carried out by Zarea-Fizabady and Ghodsi (2004) and Golabadi *et al.* (2006).

It can be concluded that out of the tested genotypes Sahil was found the most resistant. The most susceptible genotype was Roma VFN. Further work is needed on the characterization of the mechanisms of resistance in tomato genotypes against tomato fruit borer. This will ultimately provide an opportunity to breeders to incorporate those traits responsible for the resistance in tomato genotypes to develop resistant cultivars for the management of this injurious pest.

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