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Morphological characters of tomato in relation to resistance against tomato fruit borer, *Helicoverpa armigera* (Hubner)

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ABSTRACT

The study on relation of morphological characters to fruit infestation of *H. armigera* was conducted in College Farm, N.M.C.A, Navsari Agricultural University, Navsari, Gujarat during two consecutive years 2012-13 and 2013-14. The result showed that the correlation of plant height (r= 0.7775), branches plant^{-1} (r= 0.7874), and fruits plant^{-1} (r= 0.7388) with infestation of *H. armigera* were significantly positive, while the effect of fruit pericarp thickness (r= -0.9576) exhibited significantly negative association with the damage of tomato fruit borer. However the stem diameter, fruit diameter, locules fruit^{-1} and calyx fruit^{-1} showed positive but non-significant association with fruit infestation recorded 0.4855, 0.3048, 0.3413 and 0.3943 correlation values, respectively.

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INTRODUCTION

Tomato, *Lycopersicon esculentum* Miller is one of the most important herbaceous plants belonging to the Solanaceae family. It is one of the most common, leading, widely consumed, popular and staple important vegetable crop. The total area and production of various vegetables in India are 92.05 million hectares and 162.18 million tonnes, respectively, of which tomato is cultivated in an area of 8.79 lakh hectares with production of about 182.26 lakh tonnes and productivity levels of 20.7 tonnes/ha (Anonymous, 2014). The damage caused by insect-pests is one of the main constraints which limit the production of tomato. Among the insect pests, tomato fruit borer is highly destructive pest causing serious damage and responsible for significant yield loss up to 55 per cent (Talekar *et al.*, 2006). However, tomato fruit borer causes 40-50 per cent damage to the tomato crop (Pareek and Bhargava, 2003). Cultivation of *Helicoverpa*-resistant tomato cultivars is limited due to a lack of data on potential genetic sources and plant mechanisms (antixenosis) of resistance. Role of physio-chemical factors is important to identify a source of resistance in plants against pests (Dhillon *et al.*, 2005).

Resistance levels may vary from only a slight plant defence to an almost total immunity against the insect pests. Resistance is a result of one or more mechanisms involving different morphological traits of the host plant and biochemical contents of plant which affecting the biology and behaviour of phytophagous insects those feed on the plants. Therefore, host plant resistance or varietal resistance constitutes an important field of study with the hypothesis that different germplasms of tomato possess varied degree of population and infestation of *H. armigera*.

The plant resistance is controlled by several

morphological and biochemical factors. The host-plant may be deficient in certain nutritional elements which required by the insect and hence prove resistant. The nutritionally deficient plant may show antibiotic and antixenoitic effects on the insect. The antibiosis may result from the absence of certain nutritional substances in the host plant and/or an imbalance of available nutrients. Morphological resistance factors interfere physically with the locomotors mechanisms and more specifically with the mechanisms of host-selection, feeding, ingestion, digestion, mating and oviposition (Norris and Kogan, 1980).

MATERIAL AND METHODS

Eleven germplasms of tomato were screened for their relative susceptibility to fruit borer. One month old seedlings were transplanted in the plot on 10-10-2012 and 13-11-2013 with spacing 45 × 60 cm. the experiment was laid out in Randomized Block Design with three replications. The per cent fruit infestation was recorded from ten randomly selected and tagged plants, started three week after transplanting of tomato seedlings.

Whereas, percentage of fruit damaged on weight basis at the time of each picking was recorded from total number of damaged and healthy fruits by using following formula Pradhan (1969) :

$$\text{Per cent fruit infestation (Wt. basis)} : \frac{\text{Weight of infestation fruits}}{\text{Total weight of fruits}} \times 100$$

Method of observations of morphological characters of tomato germplasms :

The observations on morphological parameters *viz.*, plant height and number of branches plant^{-1} were recorded at 100 days after transplanting (DAT), whereas observations on number of calyx, pericarp thickness and diameter of fruit were taken from the selected germplasms for resistance to fruit borer in each replication at 60 DAT of tomato germplasms during *Rabi* 2012-2013 and 2013-2014. The methods suggested by Kashyap and Verma (1986) and Sankhyan and Verma (1996) was used for recording the following observations. The details of morphological parameters are given here under.

Plant height, stem diameter and number of branches plant^{-1}:

Height and stem diameter of each germplasm was taken from ten randomly selected plants in each replication. It was measured in centimeter with help of scale and digital vernier caliper. Similarly, the number of branches plant^{-1} was counted on same plant. Thus, the average plant height and number of branches plant^{-1} were worked out.

Number of calyx :

The number of calyx was counted on ten mature fruits of average size in each germplasm were selected from three replications and worked out the average number of calyx fruit^{-1}.

Number of fruits plant^{-1} :

The total number of fruits comprising of both healthy and infested per plant was counted at each picking on ten randomly selected plants of each germplasm from each replications.

Diameter, pericarp thickness and number of locules fruit^{-1} :

At the time of harvesting, ten mature fruits of average size from each germplasm were selected from three replications. The diameter of fruits was measured at centre of fruit, whereas fruits were cut transversely to measuring the pericarp thickness and number of locules fruit^{-1}. The both observations were recorded with the help of digital vernier caliper and average worked out for each germplasms.

RESULTS AND DISCUSSION

The pooled data on different morphological characters of tomato germplams with relation to fruit infestation of *H. armigera* for two consecutive years of 2012-13 and 2013-14 are presented in Table 1.

Plant height :

The data revealed that all tested tomato germplasms were significantly differed from each other with respect to plant height. It is evident from the data that fruit damage correlated with plant height exhibited significantly positive (r= 0.7775) association among them indicating that increase in plant height with decreases in fruit infestation. The plant height in different germplasms was significantly varied from 80.80 to 118.43 cm. However, the germplasm NTL-14 was recorded lowest plant height (80.80 cm) which was at par with NTL-7 (81.38 cm) and NTL-3 (83.40 cm). The maximum plant height was observed in germplasm GT-2 (118.43 cm). The rest of germplasms *viz.*, NTL-11, NTL-13, NTL-6, NTL-12, NTL-2, NTL-1 and NTL-10 possessed 88.65, 89.95, 90.97, 98.03, 100.45, 105.07 and 108.72 cm plant height, respectively.

The present results are in agreement with that of Khanam *et al.* (2003) who recorded average plant height in variety V-187 (100.3 cm) and lowest plant height in V- 433 (68.63 cm) which had positive but non-significant (r= 0.243) correlation with tomato fruit borer infestation. However, Rath and Tripathy (2006) revealed that highly significantly positive correlation 0.925 with per cent fruit infestation on weight basis. Daboul *et al.* (2011) observed positive correlation (0.2) between plant height and fruit moth infestation.

Stem diameter (cm) :

It was clearly marked from the data that stem diameter

showed positive and non-significant (r= 0.4855) influence on fruit damage of *H. armigera*. The data revealed that the significantly minimum stem diameter (1.14 cm) was exhibited by NTL-7 which recorded lowest fruit infestation (11.72 %). The germplasm NTL-7 was statistically similar with NTL-6 by recording 1.18 cm stem diameter. The significantly maximum stem diameter found in NTL-3 (1.81 cm) with higher per cent of fruit infestation (23.11 %). The stem diameter in germplasms *viz.*, NTL-13, GT-2, NTL-11, NTL-14, NTL-2, NTL-12, NTL-1 and NTL-10 had registered moderate size of stem diameter which ranged from 1.24 to 1.75 cm which was moderately infested by fruit borer.

The present finding collaborates with Khanam *et al.* (2003) who found that positive and non-significant association (r= 0.101) between stem diameter of different tomato varieties and tomato fruit infestation. However, Daboul *et al.* (2011) noted negative but non-significant correlation (-0.99) of stem diameter with fruit moth infestation.

Number of branches plant^{-1}:

Correlation co-efficient revealed that the number of branches per plant had significant and positive association (r= 0.7874) with per cent damage of fruits. The number of branches ranged from 10.20 to 13.80 in different tomato germplasms which were significantly different from each other. The germplams NTL-14 was found resistant to *H. armigera* by recording significantly minimum number of branches per plant (10.20 branches plant^{-1}). The germplasm NTL-14 was statistically similar with NTL-7 (10.33 branches plant^{-1}), NTL-11 (10.97 branches plant^{-1}) and NTL-3 (11.28 branches plant^{-1}). The maximum number of branches was observed in GT-2 (13.80 branches plant^{-1}) with maximum fruit damage (31.05 %) which was statistically at par with NTL-13 (12.63 branches plant^{-1}). The remaining germplasms *viz.*, NTL-6, NTL-12, NTL-2, NTL-1 and NTL-10 registered intermediate number of branches per plant (11.62 to 12.63 branches plant^{-1}) and they were found to be at par with each other.

The result of present investigation is highly agreement with result of Rath and Tripathy (2006) who recorded significantly positive correlation between number of branches and fruit infestation on number basis (0.819) and weight basis (0.916). Similarly, the highest number of branches was recorded in V-433 while, lowest number of branches on V-167 and positive correlation (0.256) of number of branches with tomato fruit borer infestation (Khanam *et al.*, 2003).

Number of fruits plant^{-1}:

The data clearly marked that strong and significant

Table 1 : Morphological characters of different tomato germplasms in relation to fruit borer infestation (Pooled data of 2012-13 and 2013-14)

Sr. No.	Germplasms	Fruit infestation (%)	Plant height (cm)	Stem diameter (cm)	No. of branches/ plant	No. of fruits/ plant	Fruit pericarp thickness (cm)	Fruit diameter (cm)	No. of locules /fruit	No. of calyx/ fruit
1.	NTL-1	29.57 (24.94)*	105.07	1.51	12.35	35.69	0.51	4.31	5.42	5.23
2.	NTL-2	20.94 (13.17)	100.45	1.39	12.13	33.74	0.61	4.22	3.25	5.26
3.	NTL-3	28.51 (23.11)	83.40	1.81	11.28	30.16	0.52	3.23	2.37	5.21
4.	NTL-6	25.93 (19.40)	90.97	1.18	11.62	30.41	0.54	3.73	2.60	5.26
5.	NTL-7	19.58 (11.72)	81.38	1.14	10.33	26.07	0.61	3.04	2.90	5.33
6.	NTL-10	31.52 (27.52)	108.72	1.75	12.55	36.12	0.49	5.98	5.12	6.36
7.	NTL-11	23.96 (16.77)	88.65	1.37	10.97	26.77	0.56	3.13	2.28	5.48
8.	NTL-12	27.44 (21.42)	98.03	1.50	11.93	31.76	0.54	4.09	2.48	5.43
9.	NTL-13	24.96 (18.08)	89.95	1.24	12.63	36.32	0.56	4.60	2.62	5.36
10.	NTL-14	18.45 (10.32)	80.80	1.38	10.20	25.06	0.62	4.38	2.60	5.18
11.	GT-2	33.71 (31.05)	118.43	1.33	13.80	37.61	0.39	3.80	2.40	5.33
S.E ±										
Treatment (T)		1.06	2.63	0.02	0.43	1.13	0.02	0.17	0.10	0.08
(Y × T)		1.49	3.72	0.02	0.61	1.60	0.03	0.24	0.14	0.12
C.D. (P=0.05)										
Treatment (T)		3.02	7.51	0.05	1.24	3.22	0.05	0.49	0.28	0.23
(Y × T)		NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V. (%)		9.99	6.77	2.84	8.97	8.69	8.43	10.38	7.72	3.71
Correlation (r)			0.7775**	0.4855	0.7874**	0.7388**	-0.9576**	0.3048	0.3413	0.3943

*Figures in parentheses are original values while those outside are arcsine transformed values; NS = Non-significant; ** indicates significance of values at P=0.05, respectively

positive correlation (r= 0.7388) existed between number of fruits per plant and fruit infestation. The significantly lowest number of fruits was observed in moderately resistant germplam NTL-14 (25.06 fruits plant^{-1}) which showed minimum fruit damage (10.32 %) and it was statistically at par with germplasms NTL-7 (26.07 fruits plant^{-1}) and NTL-11 (26.77 fruits plant^{-1}). The next three germplasms *viz.*, NTL-3, NTL-6 and NTL-12 recorded minimum number of fruits with 30.16, 30.41 and 31.76 fruits plant^{-1}, respectively. The germplasms *viz.*, NTL-2, NTL-1, NTL-10 and NTL-13 recorded 33.74 to 36.32 numbers of fruits per plant. Moreover, the germplasm GT-2 showed significantly highest number of fruits (37.61 fruits plant^{-1}).

The result of present investigation matched with the results of Rath and Tripathy (2006) who reported significant positive correlation (0.813) between numbers of fruit plant^{-1} with tomato fruit borer damage on weight basis.

Pericarp thickness (cm) :

It can seen from pooled data of both the year (2012-13 and 2013-14) that wider pericarp thickness (NTL-14 with 0.62 cm) showed least per cent fruit infestation (10.32 %) whereas germplasm GT-2 having significantly narrow pericarp thickness (0.39 cm). The wider pericarp thickness after NTL-14 was found in germplasm NTL-7 and NTL-2 by recording 0.61 and 0.61 cm, respectively. The germplasm *viz.*, NTL-10, NTL-1, NTL-3, NTL-12, NTL-6, NTL-13 and NTL-11 registered moderate pericarp thickness ranged from 0.49 to 0.56 cm, respectively. However, the pericarp thickness exhibited strong and negative correlation (r= -0.9576) with per cent fruit infestation.

The present result are in agreement with that of Rath and Tripathy (2006) who reported that negative and significant association (r= -0.885) between fruit pericarp thickness and per cent fruit infestation on number basis. Sharma and Bharadwaj (2009) revealed that pericarp thickness had positively correlated (r= 0.7677) with fruit damage. Earlier, in brinjal highly significant and positive correlation between pericarp thickness and fruit infestation of *L. orbonalis* reported by Naqvi *et al.* (2009), Chandrashekhar *et al.* (2009), Jat and Pareek (2003) and Subbaratnam (1982).

Fruit diameter (cm) :

The data of Table 1 exhibited positive and non-significant correlation (r= 0.3048) between fruit diameter and per cent fruit infestation caused by *H. armigera*. The moderately resistant germplasm NTL-7 recorded significantly minimum fruit diameter (3.04 cm) and it was statistically at par with NTL-11 (3.13 cm) and NTL-3 (3.23 cm). The maximum fruit diameter (5.98 cm) was found in NTL-10 which significantly differed from all other germplasms. The rest of the germplasms *viz.*, NTL-6, GT-2, NTL-12, NTL-2, NTL-1, NTL-14 and NTL-13 recorded intermediate size of fruit diameter ranged from 3.73 to 4.60 cm.

The results of present studies are in conformity with those of Amutha and Manisegaran (2005) and Rath and Tripathy (2006) who noted positive correlation between fruit damage and diameter of fruit with (r = 0.609) and (r = 0.782) correlation values, respectively. Also, The present finding are in support with the result of Naqvi *et al*. (2009) and Subbaratnam (1982) who computed significantly positive correlation between diameter of fruits and *L. orbonalis* infestation in brinjal. Prasad *et al.* (2014) noted that fruit diameter showed negative correlation (r= -0.09) but it was non-significant with infestation of *L. orbonalis*.

Number of locules fruit^{-1} :

Perusal of data on number of locules fruit^{-1} revealed that the significantly minimum number of locules of tomato fruits was observed in germplasm NTL-11 (2.28 locules fruit^{-1}). Whereas, the significantly maximum number of locules fruit^{-1} was recorded in NTL-1 with 5.42 locules and it was followed by NTL-10 (5.12 locule fruit^{-1}). The rest of germplasms *viz.*, NTL-3, GT-2, NTL-12, NTL-6, NTL-14, NTL-13, NTL-7 and NTL-2 registered 2.37, 2.40, 2.48, 2.60, 2.60, 2.62, 2.90 and 3.25 locules fruit^{-1}, respectively. However, number of locules fruit^{-1} showed positive and non-significant correlation (r= 0.3413) with fruit infestation caused by *H. armigera.*

Rath and Tripathy (2006) noted negative and non-significant correlation (-0.260) of number of locules fruit^{-1} with per cent fruit infestation on weight basis, earlier.

Number of calyx fruit^{-1} :

The data clearly marked that positive but not significant correlation (r= 0.3943) existed between number of calyx per fruit^{-1} and fruit infestation. The significantly less number of calyx fruit^{-1} was observed in germplasm NTL-14 showed 5.18 calyx per fruit. The germplasms *viz.*, NTL-3, NTL-1, NTL-2, NTL-6, NTL-7, GT-2, NTL-13, NTL-12 and NTL-11 showed intermediate number of calyx fruit^{-1} ranged from 5.21 to 5.48. Moreover, the germplasm NTL-10 showed significantly maximum number of calyx fruit^{-1} (6.36 calyx fruit^{-1}). Similar results were also reported by Madhusudan *et al.* (2011), Kambrekar (2012) and Sachan *et al.* (2006).

Conclusion :

The present study indicates that morphological characteristics such as plant height, number of branches, number of fruits tree^{-1}, fruit diameter can be used as marker traits by breeder to develop insect resistant germplasm/ varieties of tomato through breeding programs. Further research is needed to study the morphological characteristics of tomato fruit in relation to *H. armigera*.

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