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Screening of Tomato Advance Lines Cherry and Bayberry (NUYT) Against Tomato Fruit Borer, *Helicoverpa armigera* (Hubner) under field Conditions

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Tomato advanced lines of cherry and bayberry were screened out against *H. armigera* under field conditions during spring 2020 in RCB design with three replications. None of the tested tomato line was free from *H. armigera* infestation. However, tomato lines bayberry 0012 and cherry 18004 were found to be most resistant with larval population of 0.62 and 0.52 and fruit infestation of 8.66 and 4.30 percent, respectively. While bayberry tomato lines 0010, 0011, 0015 and cherry 18007 were observed as most susceptible with larval population of 2.11, 1.91, 2.02 and 1.88 and percent fruit infestation 37.66, 33.00, 38.66 and 32.20, respectively. Biological parameters of *H. armigera w*ere significantly affected when offered the resulted resistant and susceptible tomato lines. Egg incubation, larval duration, pupal duration, % adult emergence and adult longevity were significantly low on susceptible tomato line while oviposition rate, % egg, % larval survival and pupal viability was comparatively high on susceptible tomato lines.

Keywords: *Helicoverpa armigera,* Tomato, Resistant lines, Cherry, Bayberry, Screening.

INTRODUCTION

Tomato (*Lycopersicon esculentum*) is a major vegetable crop cultivated in many countries of the world (Babalola et al.2010). Worldwide production of tomatoes was 177 million tones, leading by China (56.3 million tons), which was accounted 32% of the total production, followed by EU (24.2), India (18.4), US (13.0), and Turkey (12.6) million tons, respectively, with global tomato exports of 85 billion US dollars (FAO, 2017). In Pakistan, tomatoes are grown in two seasons, spring and autumn. The area of tomato cultivation in Pakistan is 63.20 thousand hectares and tomato production in 2017 amounted to 601.098 thousand tons. The average tomato production for the year was 9510.60 kg / ha (FAO, 2017). Among different cultivars Cherry tomato, *Solanum lycopersicum* (L.) is similar to cherries with small size, good taste and bright red color (Charlo et al. 2007). The demand for cherry tomato has increased in markets due to their high quality (Rosales et al. 2011). Similarly, Chinese bayberry is an economically significant crop in South China and is cultivated on large scale (Chen et al. 2004). The fruit is well liked for its attractive color, good taste, important micro-nutrients and bioactive ingredients such as antioxidants (Zhang et al. 2010). In addition, the bayberry tomato goes through various changes in color, taste, acidity as well as other quality parameters at the stage of fruit growth and development, which provides a useful model for evaluating the quality of tomato fruit. Tomato production in Pakistan is less as compared to many other developing countries. There are many factors that causes low yield. Tomatoes have been attacked by various insects, including Tomato fruit borer, *Helicoverpa armigera*. Larvae of fruit borer are polyphagus and attacked tomato fruit at every stage of development, significantly reducing their economic values (Gajete et al.2004). Tomato fruit borer, *H. armigera* is most devastating pest found worldwide and commonly in Oceania, Africa and Asia (Guo, 1997). Worldwide losses

due to this pest are about 5 billion dollar (Sharma, 2001). In Pakistan, fruit losses due to *H. armigera* are 53% (Inayatullah, 2007) in tomato fruit. The larvae of *H. armigera* decrease the growth and regeneration of plant at various stages. They feed on fruit, flower, stem, leaves and cause significant economic setbacks and also affecting its quality and quantity (Tay et al. 2013).

The unavailability of genotype(s) resistant to the attack of *H. armigera* forced the farmers to use pesticides which give quick results but the indiscriminate use of pesticides results in several environmental and health hazards problems. Host plant resistant is considered as important component of IPM it is ecologically acceptable. The development and use of resistance tomato cultivars minimize the pest problems to an acceptable level and reduce the number of spray application. Moreover, it is compatible with other IPM strategies. The present research was an attempt to screen out the advance tomato lines against *H. armigera* and to study the biological attributes of *H. armigera* on these advance tomato line. The objective of this study was to know the infestation/ incidence level of *H. armigera* on tomato lines, to study the biology of *H. armigera* reared on tomato fruits under controlled condition.

MATERIALS AND METHODS

The Present research work on Bayberry and Cherry tomato candidate lines in relation to *H. armigera* was carried out under National Uniform Yield Trails (NUYT) at Horticultural Research Institute, National Agriculture Research Centre Islamabad (NARC), Pakistan.

Field Experiment

Screening of Bayberry and Cherry tomato candidate lines against *H. armigera* infestation under field conditions

The Bayberry Fresh tomato (BF) candidate lines were 0010, 0011, 0012, 0015, 0018 and 0020 and the Cherry tomato lines were 18001, 18002, 18003, 18004, 18005, 18006, 18007 and 18008. All the experimental plots were kept free from pesticides application during the whole growing season at Vegetable Section Farm field during, following RCB design with three replicates.

Twenty seeds of tomato were placed in a line of one foot. Healthy tomato seedlings were transplanted in well prepared 9×35 meters plots during March, 2019. Plant to plant and row to row distance was 20 and 30 inches, respectively. Each row (candidate line) was labeled with numbers.

The following parameters were studied:

Larval infestation / plant

Larval infestation was determined by observing randomly selecting five plants from each line per replication at weekly intervals till crop maturity. The mean larval infestation per plant was then calculated.

% fruit infestation

% fruit infestation was determined by observing the number of infested fruits (presence of holes by *H. armigera* larvae) at the time of picking. Following formula was used to calculate mean fruit infestation.

$$\text{Mean fruit infestation} = \frac{\text{total number infested fruit}}{\text{total number of observed fruits}} \times 100$$

Yield (Kg ha^{-1})

Tomato fruits of each line were picked and weighted after every picking, then total yield was obtained by adding the yield of all picking and was then converted into kg/ha by given formula.

$$\text{Yield}(\text{Kg ha}^{-1}) = \frac{\text{yield plot}^{-1}}{Plot\ area\ (m^2)} \times 10000$$

RESULTS AND DISCUSSION

Mean larval infestation of *H. armigera* on different tomato lines with various time intervals.

Results in (Table 1) showed significant difference in overall mean larval infestation of *H. armigera* on different tomato lines. The highest mean larval population was recorded on bayberry tomato line 0010 (2.05 larvae/plant) followed by bayberry tomato line 0015 (2.02 larvae/plant). The lowest mean larvae were recorded on cherry tomato line 18004 (0.52 larvae/ plant).

The results indicated that at the initial stage of plant growth, the mean larval infestation plant^{-1} was low as (0.29) larvae plant^{-1} in the first week of April, which increased significantly with the passage of time and significant peak of larval infestation (2.04) plant^{-1} was recorded in the last week of May. These findings are in line with (Parihar and Singh, 1986) who reported almost similar trend of increase in population of *Helicoverpa armigera*. Similar findings have also been reported by (Khanam et al. 2003) that in all the tested varieties the infestation was low at early fruiting stage and increased gradually at the ripening stage of fruit.

Significant variation in % fruit infestation of different tomato lines to *H. armigera* was recorded in (Table-2). However, lowest fruit infestation (4.30%) was recorded on cherry tomato line 18004 followed by bayberry 0012, cherry 18008, 18003, 18002, 18005, 18001, 18006, 18007 and bayberry 0020, 0018, 0011, 0015, 8.66, 12.00, 17.33, 17.00, 24.00, 23.66, 25.50, 32.20, 26.33, 29.33, 33.00 and 38.66) mean % infestation, respectively. The highest (38.66) % infestation was recorded on bayberry tomato line 0015.

Table1: Mean larval infestation plant^{-1}of *H. armigera* on different tomato lines with various time intervals.

	Mean larval infestation plant^{-1}								
Candidate Lines	**04-04-20**	**11-04-20**	**18-04-20**	**25-04-20**	**02-05-20**	**09-05-20**	**16-05-20**	**23-05-20**	**Mean**
00I0	0.38a-c	1.26b	1.39a-c	1.933a	2.64a	2.69a	2.79a	3.31a	2.11a
0011	0.29b-d	1.08d	1.34a-c	1.79b	2.19c	2.54b	2.63b	2.94b	1.91 c
0012	0.18b-d	0.18i	0.33e	0.433j	0.64j	0.81j	0.81k	1.08l	0.62 i
0015	0.43a	1.26b	1.44ab	1.81b	2.29b	2.84a	2.76a	2.71c	2.02 b
0018	0.39ab	1.36a	1.54a	1.60d	1.94d	2.01d	1.98e	2.38d	1.68 d
0020	0.34a-d	1.18c	1.38a-c	1.52d	1.76e	1.76f	2.13d	2.21e	1.61 d
18001	0.28b-d	0.98ef	1.23bc	1.38f	1.54f	1.61g	1.88f	1.98g	1.42 f
18002	0.23d	0.61g	0.81d	1.01h	1.18h	1.21h	1.51h	1.71i	1.08 g
18003	0.18a-d	0.56g	0.76d	1.03h	1.14h	1.18hi	1.44i	1.59j	1.02 g
18004	0.23d	0.24i	0.24e	0.39j	0.43k	0.46k	0.51l	0.59m	0.52 j
18005	0.26cd	0.93f	1.19c	1.31g	1.41g	1.56g	1.86fg	2.06f	1.41 f
18006	0.31a-d	1.01e	1.34a-c	1.48e	1.64f	1.89e	1.83g	1.91h	1.51 e
18007	0.29b-d	0.96ef	1.39bc	1.68c	2.19bc	2.34c	2.46c	2.94b	1.88 c
18008	0.31a-d	0.49h	0.58d	0.733i	0.94i	1.06i	1.11j	1.166k	0.83 h
LSD	0.1246	0.0647	0.2435	0.0406	0.1017	0.1036	0.0426	0.0171	0.0798

Mean followed by different letter(s) are significantly different @ P value ≤ 0.05

Table 2: Mean fruit infestation of *H.* armigera and infestation index of different tomato lines

	Tomato lines	Mean fruit infestation	Infestation index
Bayberry	00I0	37.66 a	****
	0011	33.00 b	****
	0012	8.66 h	*
	0015	38.66 a	****
	0018	29.33 cd	***
	0020	26.33 de	***
Cherry	18001	23.66 e	***
	18002	17.00 f	**
	18003	17.33 f	**
	18004	4.30 i	*
	18005	24.00 e	***
	18006	25.50 e	***
	18007	32.20 bc	****
	18008	12.00 g	**
	LSD 0.05%	3.2860	

Mean followed by different letter(s) are significantly different @ P value ≤0.05

*Resistant (0-10.0)

**Moderate resistant (10.1- 20.0)

*** Moderate susceptible (20.1 - 30.0)

**** Susceptible (30.1- 40.0)

(Table 2) also indicate the infestation index of different tomato lines. It was found that among the tested tomato lines, bayberry 0012 and cherry 18004 were found to be the most resistant with infestation level ranging from (0-10%). While the cherry tomato line 18008, 18002 and 18003 were categorized as moderately resistant with infestation level ranging from (11-20%). Cherry tomato line 18006, 18005, 18001, 0018 and bayberry 0020 were declared as moderately susceptible while the remaining cherry tomato lines 18007, 0015, 0011 and bayberry 0010 were found to be the most susceptible tomato lines to the *H. armigera* infestation.

Mean yield kg ha-1 of different tomato lines

Results in (Table 3) revealed significant differences in the yield (kg ha^{-1}) of different tomato lines. The maximum yield (9033 kg ha^{-1}) was obtained from cherry tomato line 18004, followed by bayberry 0012 (8533 kg ha^{-1}). The yield of these two lines was not significantly different from each other but was significantly higher than rest of the tested lines. The minimum yield (1133 kg ha^{-1}) was obtained from bayberry tomato line 0020.

Results further revealed that none of the tested line was free from the attack of *H. armigera*. Present findings are in agreement with that of Usman et al. (2013) who also found none of the tested genotype was free from the attack of *H. armigera*. In the present study the tested varieties differed in their level of fruit infestation that's why these lines are classified as resistant, moderate resistant and susceptible.

Table 3: Mean yield (kg ha^{-1}) of different tomato lines.

	Tomato lines	Yield kg ha^{-1}
Bayberry	0010	2533 g
	0011	3533 f
	0012	8533 a
	00I5	1334 h
	0018	6200 b
	0020	1133 h
Cherry	18001	2800 g
	18002	5533 c
	18003	6266 b
	18004	9033 a
	18005	4633 de
	18006	3100 fg
	18007	5100 cd
	18008	4266 e
	LSD	**0.5837**

*Mean followed by different letters is significantly different @ P value ≤ 0.05

Tomato lines 0012 and 18004 were categorized as resistant, 18002, 18003 and 18008 were declared as moderate resistant while 0010, 0011, 0015 and 18007 were found to be the most susceptible among the tested genotypes. The larval infestation level in the tested genotypes was ranging from (0.52-2.11 larvae/plant). Usman et al. (2013) tested 14 tomato genotypes against *H. armigera* and recorded different infestation level. Similarly, Sajjad et al. (2011) screened 32 tomato genotypes for resistant against *H. armigera* and found certain levels of susceptibility in tomato against fruit borer in Pakistan categorizing 3 genotypes as resistant with infestation level of 12.30-13.96% and larval population of 0.42-0.43/P and 3 genotypes as susceptible with fruit infestation 36.4-37.7% and larval population of 0.84 to 10.02%.

The results further indicated that significantly highest mean larval infestation (2.05 larvae plant^{-1}) was recorded on bayberry tomato line 0010 followed by tomato lines (0015, 0011, 18007, 0018, 0020, 18001, 18005, 18002, 18003, 18008, 18012) with (1.94, 1.85, 1.78, 1.64, 1.54, 1.36, 1.32, 1.03, 0.99, 0.80 and 0.56) larvae plant^{-1} respectively. The lowest mean larval infestation (0.39) larval plant^{-1} was recorded on cherry tomato line 18004. These results are in line with (Thakur et al. 2018) who tested eight different tomato varieties against *H. armigera* and founded larval infestation ranged from 0.17 to 1.45 larva plant^{-1} in tested varieties. Muahmmad et al.(2012) recorded 1.50 larvae/plant as the highest larval population on hybrids Roma VFN and NARC-1. (Usman et al.2012) recorded minimum number of larvae/plant on genotypes 'Chinar' (1.52 larvae) and 'R165' had significantly the highest larval population/plant (2.10 larvae). Muahmmad et al. (2012) recorded 1.50 larvae/plant as the highest larval population on hybrids Roma VFN and NARC-1. (Usman et al.2012) recorded minimum number of larvae/plant on genotypes 'Chinar' (1.52 larvae) and 'R165' had significantly the highest larval population/plant (2.10 larvae). The variation in the infestation level of *H. armigera* attack may be due to their genetic makeup the morphological and biochemical plant factor could also be one of the important factors. These tomato lines has never been tested so it needs further study to explore the physical and biochemical source of resistant against *H. armigera* in the tested tomato line. Variation in yield of tomato was observed among the tested tomato line. Such variation may be due to genetic yield traits but may also be due to the response of these lines. In the present study the tomato line with lower pest population gave higher yield. Yield variation is also reported by (Khan et al.2001), (Usman et al.2013) and (Sajjad et al.2011). Tomato line 1084 had less larval population given higher yield while 1015 yielded minimum because of high larval population.

CONCLUSION

Based on the present study, the tomato candidate lines 18004 and 0012 showed resistant to mean larval infestation of *H. armigera* and high yield in kg/ ha^{-1}. Therefore, it is recommended for the farmers and IPM programs to use the tomato line 18004 and 0012. Further study is needed to explore the physical and biochemical plant factors responsible for resistance and susceptibility against *H. armigera.*

CONFLICT OF INTEREST

The authors declared that present study was performed in absence of any conflict of interest.

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AUTHOR CONTRIBUTIONS

JK conceived and designed the idea and analyzed the data. JR performed the experiment. AR assisted in data analysis and designed the manuscript. MS analyzed the manuscript. AB and MA reviewed the manuscript. MH supervised and helped in data collection. AU assisted in designing the experiment. ZS reviewed the manuscript. All authors read and approved the final version.

REFERENCES

Ayvaz, A., K. Eyüp, S. Karabörklü and A.S. Tunçbilek. 2008. Effects of cold storage, rearing temperature, parasitoid age and irradiation on the performance of *Trichogrammaevanescens*. J. Stored. Prod. Res. 44(3): 232-240.

Babalola, D.A., Y.O. Makinde, B.T. Omonona and M.O. Oyekanmi. 2010. Determinants of post-harvest losses in tomato production: a case study of Imeko-Afon local government area of Ogun state. Actasatech 3 (2), 14-18.

Charlo, H.C.O., R. Castoldi, L.A. Ito, C. Fernandes and L.T. Braz. 2007. Production of cherry tomato under protected cultivation carried out with different types of pruning and spacing. In *XXVII International* Horticultural Congress-IHC2006: International Symposium on Advances in Environmental Control, Automation 761: 323-326.

Chen K., Xu C., B. Zhang and I.B. Ferguson. 2004. Red bayberry botany and horticulture. Hortic.Rev. 30: 83-114.

FAO.2017. Year wise world tomato statisticshttp://www.fao.org/faostat/en/#data/QC.

Gajete T.D., L.B. Gajete, J.R. Irabagon and E.B. Tiburcio. 2004. Technoguide for tomato production. In: Technoguides for Agric. Production and Livelihood Projects. pp 58-65.

Inayatullah, M. 2007. Biological Control of Tomato Fruitworm (*Helicoverpaarmigera*) Using Egg Parasitoid *TrichogrammaChilonis* (Trichogrammatidae: Hymenoptera) and *Chrysoperlacarnea* (Chrysopidae:Neuroptera). First Annual Technical Report, HEC Funded Project, 99 p.

Khanam, U.K.S., M. Hossain, N. Ahmad, M.M. Uddin and M.S. Hussain. 2003. Varietal screening of tomato to tomato fruit borer, *Helicoverpaarmigera* (Hub.) and associated tomato plant characters. Pak. J. Biol. Sci. *6*(4): 413-412.

Khan, S.M. A. Farid. F. Ullah and H. Badshah. 2001. Effect of Host density on parasitism efficacy of *Trichogrammachinolis*(Ishii). Asian J. Pl. Sci. 3(5): 647-650.

Muahmmad, A., S. Muhammad, N.U.A. Muhammad and R. Noureen. 2012. Morphological and chemical characteristics of tomato foliage as mechanisms of resistance to *Helicoverpaarmigera* (hübner) (Lepidoptera: Noctuidae) larvae. Afric. J. Biotech. 11(30): 7744-7750.

Parra, J.R. and R.A. Zucchi. 2004. Trichogramma in Brazil: feasibility of use after twenty years of research. Neo.Ent. 33: 271-281.

Parihar, S.B.S. and B.R. Singh. 1986. Incidence of *Heliothisarmigera* (Hub.) a fruit borer on tomato. Indian J. Plant Prot. 13(2): 133-136.

Rosales, M.A., L. Cervilla, E.S. Rodriguez, M.R. Wilhelmi and B. Blasco. 2011. The effect of environmental conditions on nutritional quality of cherry tomato fruits. Evaluation of two experimental Mediterranean greenhouses. J. Sci. Food Agric. 91: 152-162.

Sajjad, M., M. Ashfaq, A. Suhail and S. Akhtar. 2011. Screening of tomato genotypes for resistance to tomato fruit borer (*Helicoverpaarmigera*, Hubner) in Pakistan. Pak. J. Agri. Sci, 48(1): 59-62.

Sharma, H.C. 2001. Cotton Bollworm/Legume Pod Borer, *Helicoverpaarmigera* (Hubner) (Noctuidae: Lepidoptera): Biology and Management. Crop Protec. Compend. CAB Int'l., Wallingford, 70 p.

Singh.N., S.K. Dotasara, S.M. Jat and A.R. Naqvi. 2017. Assessment of crop losses due to tomato fruit borer, *Helicoverpaarmigera* in tomato. J. Entomol. Zool. Studies. 5 (3): 595-59.

Suryawanshi, D.S., V.M. Pawar and P.S. Borikar. 2000. Effect of insecticides on fruit yield and pest caused losses in okra. J. Maharashtra Agric. Univ. 25(2): 161-164.

Tay, W.T., M.F. Soria, T. Walsh, D. Thomazoni and P. Silvie. 2013. A brave New World for an Old World Pest: *Helicoverpaarmmigera* (Lepidoptera: Noctuidae) in Brazil. J. Pone. 8 (11): 80-134.

Usman, A., I.A. Khan and M. Shah. K. Sohail and F. Said. 2012. Influence of various biochemical factors on the occurrence of *Helicoverpaarmigera* (Hubner) in Tomato. J. Entomol. Zool. Studies. 3(3): 53-58.

Usman, A., I.A. Khan, M. Inayatullah. A.U.R., Saljoqi, and M. Shah. 2013. Appraisal of different tomato genotypes against tomato fruit worm (*Helicoverpaarmigera* Hub.) infestation. Pak. J. Zoology. 45(1): 113-119.

Zhang B., M. Kang, Q. Xie, B. Xu, C. Sun, K. Chen and Y. Wu.2010. Anthocyanins from Chinese bayberry extract protect β cells from oxidative stress-mediated injury via HO-1 up-regulation. J. Agric. Food Chem. 59 (2): 537-545.

Zucchi, R.A., R.B. Querino and R.C. Monteiro. 2010. Diversity and hosts of Trichogramma in the new world, with emphasis in South America. Egg parasitoids in agroecosystems with emphasis on Trichogramma.Springer, Dordrecht. pp. 219-236.