International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 12, December 2022

Analysis of Insect Pests Resistance in Exotic Tomato Genotypes in Arid Climate

Zeshan Hassan, Azhar Abbas Khan*, Saqi Kosar Abbas, Fazeela Saleem, Sana Rubab, Abdul Jabbar, Umbreen Shahzad*

[1]College of Agriculture, Bahauddin Zakariya University, Multan, Bahadur Sub Campus, Layyah, Pakistan.
Author for correspondence* Associate Professor, College of Agriculture, Bahauddin Zakariya University, Multan, Bahadur Sub Campus, Layyah, Pakistan.

Abstract:- Tomato (*Lycopersicon esculentum)* belongs to family Solanaceae. It is an important economic crop of world. Tomato is the second most significant vegetable crop in the world (Mohammed *et al.*, 2010). Various Factors involved for reduced the tomato production like seed quality low, disease attacked and the important factor is insect pest infestation (Hoffmann et al., 2007). Mainly Insect pests are polyphagous that attacked on tomato. Insect pest are resistant against 80% of insecticides available in Pakistan. Therefore, the aim of the present study was to evaluate the insect pest's resistance of Aphid, Fruit borer and shoot fly in exotic varieties of tomato in arid climate in field condition for the identification of best tomato varieties against insect pests to minimize the use of insecticides. The experiment was conducted at agriculture fields south of the Layyah city, Punjab, Pakistan. The results showed that the varieties Ontario 7716, ZhongShuy 4 and 8 A II were evaluated as more resistant varieties against aphid with the infestation population (1.133, 1.567 and 2.724 respectively). The results imparted that the percentage infestation for fruit borer varied significantly on different varieties. Cromco, Dwarf Moneymaker and F4T5 ISL were identified as resistant varieties with fruit infestation (12.889%, 14.278% and 15.482% respectively). Muchamiel, Pusa Ruby and Nunhem's Tuckqueen showed resistance against Shoot fly maggot (6.900, 12.733 and 13.433 respectively). Hence, we have identified various levels of resistance in different exotic tomato genotypes, which will help to use them as directly introduced varieties or could be further exploited in developing incest pest resistance tomato breeding programme.

Key words: Tomato, exotic tomato varieties, Tomato insect pests, fruit borer infestation, shoot fly population, aphid population, resistant variety, susceptible variety

INTRODUCTION

Tomato (*Lycopersicon esculentum)* is an important, very popular and most important vegetable plant in the world. That crop belonged to the family "Solanaceae". Tomato has grown mostly in both tropical and sub-tropical regions of the world. From the last few years tomato get a favorable ranking according to it consumption, popularity and demand in the world (Ali *et al*., 2012). In ranking of vegetables production a demand tomato come in next after the potato used. Tomato is the second largest significant vegetable crop in the world after potato (Mohammed *et al.*, 2010*).* In Pakistan tomato have very important placed due to its consumption and demand. In production and demand tomato have second major vegetable rank in Pakistan (Mirza *et al.*, 2007). In Pakistan it is cultivated round the year. Its area under cultivation, during 2010-11 was 52300 hectare, with a total production of 529600 tones, and a yield was 10.1tones/hectare (Anonymous, 2010-11). This statement show that the yield increased (9.6-10.1tones/hectare) and also the area of the production increased progressively from (29400-52300 hectare) at same session of period (FAO, 2010-11). The province wise Balochistan is the leading province of Pakistan for tomato production Then KPK, Sindh and at the end Punjab (MINFAL, 2010). The largest tomato production country is china, where the production of tomato is 48.6 million tones (PARC 2015).

Average production of tomato in Pakistan is quite low as compared to other major tomato producing countries of the world. Several factors like poor quality seeds, diseases, over use of pesticides and insect infestation etc.) The tomato plant is more soft and tender as compared to other plants. It is damaged by an array of pests. The use of Insecticide for the control of insect pest also caused infestation and other problems for crop. Over use of insecticide developed resistance mechanism in insect pests. These insect pests resist against 80% of pesticides available in Pakistan. So, these insecticides do not perform better for controlling these insect pests (Shaheen *et al.*, 2008). Tomatoes, wherever grown are host of wide variety of insect pests. About 100-200 species are reported to attack tomatoes worldwide (Lange and Bronson 1981). All plant parts of tomato offered food, shelter and reproduction sites for the insect pests. They can attack the plant from first emergence from seed bed to until harvest. Our preliminary study has provided us information that 3 insect pests have caused heavy infestation in tomato i.e. Tomato fruit worm, Shoot Fly and Aphid (unpublished data). So, the Present study was about these three insect pests.

Tomato aphids are soft boded and are also polyphagous insect pest (tomato, chilli, potato and cabbage, leafy green vegetables and legumes. They also attacked on tress. The aphid injured the plant by three ways. First, feeding Preferred with proper nutrient transfer in the plant. Second, the green peach aphid can transmitted the diseases approximately 100 diseases (cucumber mosaic virus etc.) and by 3rd way the aphids excrete large amount honey dew that makes the plant preferable for fungus attack. The leaves color become discolored and yellow. In the worldwide 34-36% losses caused due to aphid in tomato (Dhandapani et al., 2003). In Pakistan, significant yield losses in tomato have been reported due to aphid infestation (Mohammad Sajjad et al., 2011).

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 12, December 2022

Tomato fruit worm is a polyphagous insect pest it mostly attacks on tomato, peppers, Eggplant, okra, Beans and Maize. It is a chewing insect pest, feeds on tomato leaves, fruit and preferred the unmatured green fruit. In Tomato, yield losses around 34-36% were reported due to tomato fruit worm infestation worldwide (Talekar et al., 2006; Dhandapani *et al*., 2003). There was huge reduction in tomato yield due to attacked of insect pests has been reported (Hoffmann *et al.*, 2007). At the World level the annual crop loss of tomato due to fruit worm is approximately 5 billion US dollar (Sharma, 2001). In Pakistan, 32-35% fruit infestation caused by Tomato fruit worm was observed in tomato (Latif *et al.*, 1997). In Peshawar, Khyber Pakhtunkhwa Province 53 % loss due to tomato fruit worm (Inayatullah, 2007).

Tomato Shoot Fly is also a serious pest of tomato. The tomato Shoot fly maggot attack on leaves and soft branches of tomato. Shoot fly is a polyphagous insect pest.it also attacked on cucumber, chili, potato and cabbage. It caused near about 40% (Sharma, 2001). Tomato Shoot Fly enhanced the many viral diseases like tomato yellow leaf curl virus, Tomato mottle virus and sooty mold. Polyphagous pests consumed around 80% of total pesticides available in Pakistan (Shaheen, 2008).

Due to environmental and health problems caused by the use of pesticides alternative control method that are ecologically safe and economically acceptable should be focused (Ignacimuthu, 2007). There are different approaches to overcome the problems in IPM. Host pant resistance mechanism is more effective than others to control insect pests. (Mohammad Sajjad *et al*., 2011). Study on the screening of the tomato genotypes for resistance to tomato fruit borer in Pakistan. The pest infestation has been reduced by used of resistance varieties (Amjad *et al*., 2013). Amjad Usman *et al.*, (2013) worked on different cultivars of tomato against fruit worm. He found in his studies that best results of resistance were shown in chinar cultivar among sultan and sourabh against fruit worm. Host plant resistance is the most effective as compared to the other available pest management strategies. Therefore, it is the need for the development/identification of pest resistant tomato varieties to minimize the use of pesticides. One effective solution for underdeveloped regions is to introduce exotic tomato varieties. Reduction in pest infestation to acceptable level has been reported due to the use of resistant variety alone or in combination with other control measures (Leuschner *et al.*, 1985).

The development and cultivation of insect pest resistant tomato varieties is very limited in the Pakistan due to the lack of information about resistant tomato Varieties. However, the famers have lack of awareness regarding genotypes resistant to insect pests has led to the haphazard and injudicious use of pesticide. So, there is a need to produced/developed those resistant varieties in Pakistan that minimize the use of pesticides and also resist against insect pests insect pest. Thus, owing to the lack of information, the present study was aimed to evaluate the response of various exotic tomato genotypes toward Aphid, Fruit worm and Shoot Fly infestation and to identify pest resistance in them.

MATERIALS AND METHODS

Crop growth

This experiment was conducted south of the Layyah city, Pakistan during November to April to evaluate the different exotic tomato varieties toward three major preliminary studied insect pests (Tomato fruit worm, Shoot Fly maggot and Aphid). The seeds were collected from the Centre for Genetic Resources, The Netherlands (CGN). The other materials and methods used for conducting the research experiment were presented in the following headings.

Design and layout of the experiment

The design selected for experiment was Randomized complete Block Design (RCBD). The number of replication was three used in the experiment. The layout of the experiment was designed in the way that in each replication the treatments would be repeated one time. The total field size was 1980 cm × 800 cm. All standard agronomic practices were performed. The plot was divided into ridges. The number of plants of a variety in one replication was 10. The row to row distance was 60 cm and that of plant to plant was 45 cm. The polythene black sheet was laid on the ridges to prevent the field from weeds establishment. The seeds of 22 varieties were used containing 20 exotic and 2 check Pakistani genotypes.

Treatments of the experiment

The varieties itself was treatment (Table 1). The total number of treatments was 22. The 20 exotic varieties was Moneymaker, Cromco, Robar, Nunhem's Tuckqueen, Trees Cantos Fito, Muchamiel, Dwarf Moneymaker, Fortuna, All-round, Floradel, West Virginia 63, Centennial, M.O.G. 10, Pusa Ruby, Ontario 7716, ZhongShuy 4, F4T5 (ISL), Balady, ZhongShuy 5 and 8 A II. Origin of the mostly varieties was the Netherlands. The 2 Pakistani local varieties were Riograndie and Local. The treatments would be repeated in 3 replications. The number of plants of a variety in one replication was 10.

Sowing of tomato seed

The black polythene sheet laid on the all ridges prevented the field from weeds. The suitable agronomic practices such as Ploughing, weeding and watering were done after the laid of polythene sheet on ridges (Rashid and Sing, 2000). Then the hole established in polythene sheet at the distance of 18 inch according to the plant to plant. The seeds grow in hole direct by dibbling/chopa method at 20, November. The thinning would be done after the sowing of one month at 10, December. The field leaved freely not applied any protection measures such as pesticide and fungicide etc. With the interval of time we visited the field one time in week to check the insect pest infestation. The infestation of preliminary studied insect pest of tomato field would be start in February. Data of the infestation by the pests were recorded by the following procedure.

Parameters Studied

The parameter including in experiment was an insect population at various growth stages (on vegetative stage check the population of aphid, shoot fly maggot and on fruit stage calculating the percentage of fruit borer (Ali *et al*., 2012).

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 12, December 2022

Data collection

The data were recorded of the preliminary studies insect pests.The preliminary study of the insect was Tomato fruit worm, Shoot Fly and Aphid. The infestation of these pest was start in January, when the crop was reached at full vegetative stage. Record the data of these insect pests were started from 15 February. The first of all Aphid infestation start and with days interval other 2 insect pest infestation were start. The data was recorded all the plants of all replications. The data of these 3 insect pests were recorded by following methods.

Aphid infestation

The data of aphid were recorded at 15 February. The total number of nymph and adult would be starting to record from each plant on the appearance of aphid on tomato plant (Usman *et al*., 2013). The method of sampling for was Tap and visual sampling (Qureshi and Stansely, 2007) and (1 minute for each plant).The average/mean of 10 plants/each treatment would be calculated by arithmetic means (Wakil *et al.,* 2009).

Shoot Fly maggot Infestation

The tomato field was infested by shoot Fly maggot in March, when crop was at flowering stage. The data of shoot Fly maggot was recorded at 21 March. The data was recorded by identified the infested shoot (Qureshi and Stansely, 2007). The mean/average of every treatment would be calculated by arithmetic means (Wakil *et al*., 2009).

Tomato fruit worm

The infestation data of fruit worm was recorded on the fruit, when tomato was reached at full fruiting stage. The data was recorded at 20 April. The method of sampling was the numbers of total fruits (TF) were recorded for each plant. The infested fruits (Presence of the hole in fruit made by fruit worm were counted from each plant. The infestation percentages of fruit borer damaged fruit were calculated by the following formula (Wakil *et al*., 2009).

Fruit Infestation Percentage = B/A ×100

B=Number of infested fruits

A=Total number of fruits (damaged+undamged fruits)

Statistical Analysis

The recorded data of Tomato fruit worm, Shoot Fly and Aphid were analyzed by using ANOVA to check the significance and non-significance of treatments. The means of Tomato fruit worm, Shoot Fly maggot and Aphid were compared (Mean±S.E) by Tukey HSD at P=0.05. Software Statistix 8.1 was used for statistical analysis.

RESULTS

Response of different exotic varieties of tomato toward Aphid

On the base of statistical analysis population of Aphid on each exotic varieties of tomato was varied significantly. The showed that the mean of aphid was from 14.633 (Floradel) to 1.133 (Ontario 7716). On the basis of statistical analysis the result showed that the exotic tomato variety Floradel (14.633) significantly was showed and other two Pakistani varieties local Pakistani (10.933) and Riogrande (10.433) non-significantly were showed high infestation. These three varieties are identified as more susceptible toward the infestation of Aphid. The lowest population /variety was recorded on exotic tomato varieties was Ontario 7716 (1.133), ZhongShuy 4 (1.567) and 8 A II (2.724). These three exotic varieties of tomato Ontario 7716, ZhongShuy 4 and 8 A II maximum resist against the aphid. There was no one variety that completely resist against aphid. The 2-3 varieties showed significantly highly resistance as compared to other varieties.

Response of different exotic varieties of tomato toward Shoot Fly maggot

Plants shoot infestation for shoot Fly maggot varied significantly for different treatments. Results showed the mean of infestation was start from (73.600) Allround to (6.900) Muchamiel. Fig. 7 showed significantly high infestation of Shoot Fly maggot was recorded in the exotic tomato varieties are Allround (73.600), Floradel (53.133) and ZhongShuy 5(33.300). These three treatments/varieties are identified as more susceptible toward the shoot Fly (Atherigona soccata) infestation**.** The table three and Fig. 7 showed that the lowest population was found in the treatments/varieties Muchamiel (6.900), Pusa Ruby (12.733) and Nunhem's Tuckqueen (13.433) of exotic tomato varieties. These three exotic tomato varieties were categorized as maximum resist against shoot Fly infestation. The present study was identified that none of the exotic tomato variety that completely resistant to the infestation of shoot fly maggot attack. The result showed that the exotic variety Allround (73.600) was more susceptible and the Muchamiel (6.900) showed maximum resist against shoot Fly maggot infestation. From all the treatments just 3 varieties showed significantly high resistance against shoot fly maggot.

Response of different exotic varieties of tomato toward Tomato fruit worm

The Tomato fruit worm infestation/variety was recorded on different exotic tomato varieties was varied from each other. The Fig. 8 showed that the means of infestation of tomato fruit worm on different exotic varieties started from (37.964%) Muchamiel to (12.889%) Cromco. The Fig. 8 showed that the highest population of fruit worm was recorded in the exotic varieties of tomato is 37.964% (Muchamiel), 35.847% (Nunhem's Tuckqueen) and 33.572% (Balady) respectively. The results of 37.964% (Muchamiel) were significantly and the others two varieties 35.847% (Nunhem's Tuckqueen), 33.572% (Balady) did not show significance difference at Tukey HSD, P<0.05. Therefore, these three varieties are evaluated as susceptible for Fruit worm attack/infestation. The other three varieties (12.889%) Cromco, (14.278%) Dwarf Moneymaker and (15.482%) F4T5 ISL had response the resistance against fruit worm significantly showed in Fig. 3.These three varieties were categorized as resistance varieties against Tomato fruit worm. The results showed there was no one variety that resist against that insect pest. The observed resistant variety against fruit worm was Cromco, Dwarf Moneymaker and F4T5 (ISL).

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 12, December 2022

Response of different exotic varieties of tomato toward all of three insect pests Aphid, Shoot Fly and Tomato fruit worm

The present results showed that there was none of the variety that was susceptible or completely resist for the entire preliminary studied insect pest (Tomato fruit worm, shoot fly and aphid). Some earlier researchers also studied that there was none of the variety that resist or susceptible for all insect pests (Khanam *et al*., 2003). The mean data of the treatments against of the preliminary studied insect pests that was discussed in previous chapters those results showed that some of the varieties had complete resist or susceptible for two insect pests instead for all the three insects pests. However, the same results also showed that some varieties that were resist against one insect pest also susceptible for other insect pest. The comparison between the previous discussed first three resistance and susceptible varieties against three insect pests (Tomato fruit worm, shoot fly and aphid) showed in table 2. That comparison showed that the variety (F4T5 ISL) also resist against 2 insect pests (tomato fruit worm and aphid). However, the variety ZhongShuy 4 was resistance against Aphid and susceptible for Shoot fly maggot. The variety Muchamiel resistance against Shoot fly maggot and susceptible for fruit worm. On the other hand the variety Floradel susceptible for two insect pests (aphid and tomato fruit worm). All the treatments showed significantly that there was no one variety against all the insect pests.

DISCUSSION

The means of the all data in previous chapters showed that none of the variety was completely resistant to the attack of the insect pests (tomato Fruit worm, Shoot fly maggot and Aphid). The earlier researchers also studied that none of the variety was completely resistant against all insect pests (Khanam *et al*., 2003).

There are many number of physical plant characters that make the plant susceptible or resistant for the insects feeding, oviposition, shelter, development and reproduction (Rafiq *et al*., 2008). These physical plant factors are Trichome density, thickness of the leaves, hard fruit skin, hard pulp of fruit and mesocarp. Trichomes make the plant unsusceptible for insect pest attack. The varieties that were resist against the Shoot fly maggot and Aphid may be had dense trichome. The phenols and acidity of tomato fruits also important role against tomato Fruit worm attack (Selvanarayanan and Narayanasamy, 2006). The varieties that were showed resistance to tomato fruit worm may be the fruits of those plants had phenols and high amount of acidity that contribute the host plant resistant against tomato Fruit worm.

There are also some biotic resistances mechanisms present in the plant that used as resistance against pest attack. These biotic resistance mechanisms are Antixenosis, Antibiosis and tolerance. Antixenosis refer to the response of insects to the characteristics of the host plant which make unattractive to the insect for feeding, oviposition or shelter. Example: Hairs on leaves. Antibiosis refers to the adverse effect of the host plant on the biology, development and reproduction of the insects. Examples: DIMBOA in corn. Tolerance refers to ability of the host plant to withstand an insect population sufficient to damage severely the susceptible plants. Example: Vegetation aggression in crops. There may be one, two or all mechanisms was present in resistance varieties from the above biotic resistance mechanisms that enable the plants was resist against insect pests. Response of different exotic varieties of tomato toward Insect Pests in Arid climate was conducted to control the major insect pests of tomato that were environmentally safe, easily managed and cheap. Similar work and studied has been documented by (Khanam *et al*., 2003), who worked on the evaluation of genotypic susceptibility tomato varieties different from those in present study. Thus we expect similar mechanisms to be prevailing in these genotypes. We have thus identified different levels of resistance in various exotic tomato genotypes in arid climatic conditions.

CONCLUSION

To assess the varieties that contribute to find the host plant resistance target varieties as compared to the other available pest management strategies to improve it is very long term process and objective of integrated pest management program (IPM). In general the present study concluded that the exotic tomato varieties Ontario 7716, Muchamiel and Cromco showed most resistant against Aphid, shoot Fly maggot and Tomato fruit worm respectively. The most susceptible exotic varieties were Floradel, West Virginia 63, Allround and Muchamiel for Aphid, Shoot Fly maggot and Fruit worm respectively. The score of these varieties were better than the Pakistani local varieties. Further broad and extensive work is needed on the improvement, finding and characterization of the resistant mechanisms and physical plant factors against these major insect pests. Finally this work will provide opportunity to breeders to develop or insert those exotic traits that responsible for the resistance mechanisms in tomato plants to develop the more accurate resistant varieties for the control or management of these serious and economically injurious pests.

REFERENCES

[1] A.Radzevicius, R., Karkleliene, P., Vskelis, C., Bobinas, R., Bobinaite and S., Sakalauskiene, 2009. Tomato (*Lycopersicon esculentum* Mill.) fruit quality and physiological parameters. At different ripening stages of Lithuanian cultivars. Agronomy Research **7** (Special issue II), 712–718, 2009.

[2] Ahamd, M., and M. A., Saleem, 2004. Comparative efficacy of ten conventional and new chemistry insecticides against Army worm, *Spodoptera litura* (Fabricus) (Lepidoptera: Noctuidae) under laboratory condition. Pak. Entomology, **26(2)**: 1-4.

[3] Amjad U., I. A., Khan, M., Inayatullah, A. R., Saljoqi and M., Shah 2013. Appraisal of Different Tomato Genotypes against Tomato Fruit Worm (*Helicoverpa armigera* Hub.) Infestation., Pakistan J. Zool., vol. **45(1)**, pp. 113-119, 2013.

[4] F.A.O., 2007. FAO Statistics, Food and agriculture of United Nations. Available from http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567#ancor. Accessed on October 01, 2009.

[5] Leuschner, K., Taneja, S. L., and Sharma, H.C., 1985. The role of host-plant resistance in pest management in sorghum in India. Insect Sci. Applic., **6**: 453-460.

[6] Marcic, N.K., Gasperlin, L., Abram, V., Budic, M., Vidrih, R. 2011. Quality parameters and total phenolic content in tomato fruits regarding cultivar and microclimatic conditions. Turk J Agric For **35**, 185-194.

[7] Mirza, I., 2007. Tomato paste plant to be set up at Killa Saifullah. Available at http://www.pakissan.com/ English/ news/ news Detail.php? Newsid = 15041 (accessed on 31 August, 2007).

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 12, December 2022

[8] Stewart, A.J., Bozzonet, S., Mullen, W., Jenkins, G.I., Lean, M.E.J., Croizer, A., 2000. Occurrence of flavonols in tomatoes and tomato-based products. J Agric Food Chem **48**: 2663-2669.
[9] Wajid A., M.S., Jilani, N., Naeem, K., Waseem, J., Khan, M., J., Ahmad and Ghazanfarullah, 2012. Evaluation of different hybrids of tomato under the climatic conditions of Peshawar. Sarhad J., Agric. Vol.**28,** No.2, 2012.
[10] Shaheen, N., 2008. Is organic forming suitable solution for Pakistan. SDPI Res. News Bull., **15**: 78-81.
[11] Ashfaq, M., Sajjad, M., Ane, M. N. U., and Rana, N., 2012. Morphological and chemical characteristics of tomato foliage as mechanisms of resistance to *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) larvae. Afr. J. Biotech., **11**: 7744-7750.
[12] Srinivasan, R., and Uthamasamy, S., 2005. Does host plant chemistry influence feeding and ovipositional behavior of fruit borer in tomato. J. Veg. Sci., **11**: 107116.
[13] Selvanarayanan, V., And Narayanasamy, P., 2006a. Assessment of tomato germplasm for resistance to fruit borer *Helicoverpa armigera* Hubner. J. Veg. Sci., **12**: 71-79.
[14] Selvanarayanan, V., And Narayanasamy, P., 2006b. Factors of resistance in tomato accessions against the fruit worm, *Helicoverpa armigera* (Hubner). Crop Protect. **25**: 1075-1079.
[15] Mohammad, S., M.Ashfaq, A.Sahil and S.Akhtar, 2011. Screening of tomato genotypes for Resistance to tomato fruit borer (*Helicoverpa armigera* Hubner) in Pakistan. Pak. J. Agri Sci., Vol. **48**(1), 59-62; 2011.
[16] Wakil, W., M. Ashfaq, M.U., Ghazanfar, M. Afzal and T. Riasat. 2009. Integrated management of *Helicoverpa armigera* in chickpea in rain fed areas of Punjab, Pakistan. Phytoparasitica **37**:415-420.
[17] Ignacimuthu, S., 2007. Insect pest management; meeting report. Curr. Sci., **92**: 1336-1337 FAO Agricultural Statistics of Pakistan 2014-15. Govt. of Pakistan, Ministry of Food Agriculture and Livestock, Food, Agri. and Livestock Div. (Economic Wing) Islamabad. p. 8485.
[18] Rafiq, M., A. Ghaffar and M. Arshad. 2008. Population dynamics of whitefly (Bemisia tabaci) on Cultivated crop hosts and their role in regulating its carry-over to cotton. Int. J. Agric. Biol. **9**:68-70.
a. Khanam, U.K.S., M. Hossain, N. Ahmad, M.M., Uddin and M.S. Hussain. 2003. Varietal Screening of tomato to tomato fruit borer, *Helicoverpa armigera* (Hub.) and associated
b. Tomato plant characters. Pak. J. Biol. Sci. **6**: 413-412.
c. Hoffmann, H., Hardie, D. And Burt, J., 2007. Tomato pests in the home garden and their control. Dept. Agric. Aust. Garden Note, **34**: 82-88.
d. Inayatullah, M., 2007. Biological Control of tomato fruit worm (*Helicoverpa armigera*)
e. Using egg parasitoid *Trichogramma chilonis* (Trichogrammatidae: Hymenoptera) and
f. *Chrysoperla carnea* (Chrysopidae: Neuroptera). First Annual Technical Report, HEC
g. Funded Project, pp. 99.
[19] Ashfaq, M., Sajjad, M., Ane, M. N. U. And Rana, N., 2012. Morphological and chemical Characteristics of tomato foliage as mechanisms of resistance to *Helicoverpa armigera* (Hubner) (Lepidoptera: Noctuidae) larvae. Afr. J. Biotech., **11**: 7744-7750.
[20] Lange, W. H., & Bronson, L. (1981). Insect pests of tomatoes. *Annual review of entomology*, *26*(1), 345-371.
[21] Mohamed, A. A. N., Ismail, M. R., & Rahman, M. H. (2010). In vitro response from cotyledon and hypocotyls explants in tomato by inducing 6-benzylaminopurine. *African Journal of Biotechnology*, *9*(30), 4802-4807.
[22] Sajjad, M., Ashfaq, M., Suhail, A., & Akhtar, S. (2011). Screening of tomato genotypes for resistance to tomato fruit borer (Helicoverpa armiger Hubner) in Pakistan. *Pakistan Journal of Agricultural Sciences*, *48*(1), 59-62.
[23] Ali, W., Jilani, M. S., Naeem, N., W**aseem, K., Khan, J., & Ahmad, M. J. (2012).** Evaluation of different hybrids of tomato under the climatic conditions of Peshawar. *Sarhad Journal of Agriculture*, *28*(2).
[24] Talekar, N. S., Opena, R. T., & Hanson, P. (2006). Helicoverpa armigera management: a review of AVRDC's research on host plant resistance in tomato. *Crop Protection*, *25*(5), 461-467.
[25] Selvanarayanan, V., & Narayanasamy, P. (2006). Factors of resistance in tomato accessions against the fruit worm, Helicoverpa armigera (Hubner). *Crop Protection*, *25*(10), 1075-1079.
[26] Dhandapani, S., Jin, J., Sridhar, V., Chua, N. H., & Jang, I. C. (2019). CYP79D73 participates in biosynthesis of floral scent compound 2-phenylethanol in Plumeria rubra. *Plant Physiology*, *180*(1), 171-184.
[27] Latif, M., Mumtaz, N., Davey, M. R., & Power, J. B. (1993). Plant regeneration from protoplasts isolated from cell suspension cultures of the wild tomato, Lycopersicon chilense Dun. *Plant cell, tissue and organ culture*, *32*(3), 311-317.
[28] Rashid, M. A., & Singh, D. P. (2000). *A manual on vegetable seed production in Bangladesh*. AVRDC-USAID-Bangladesh Project, Horticulture Research Centre, Bangladesh Agricultural Research Institute.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 12, December 2022

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 12, December 2022

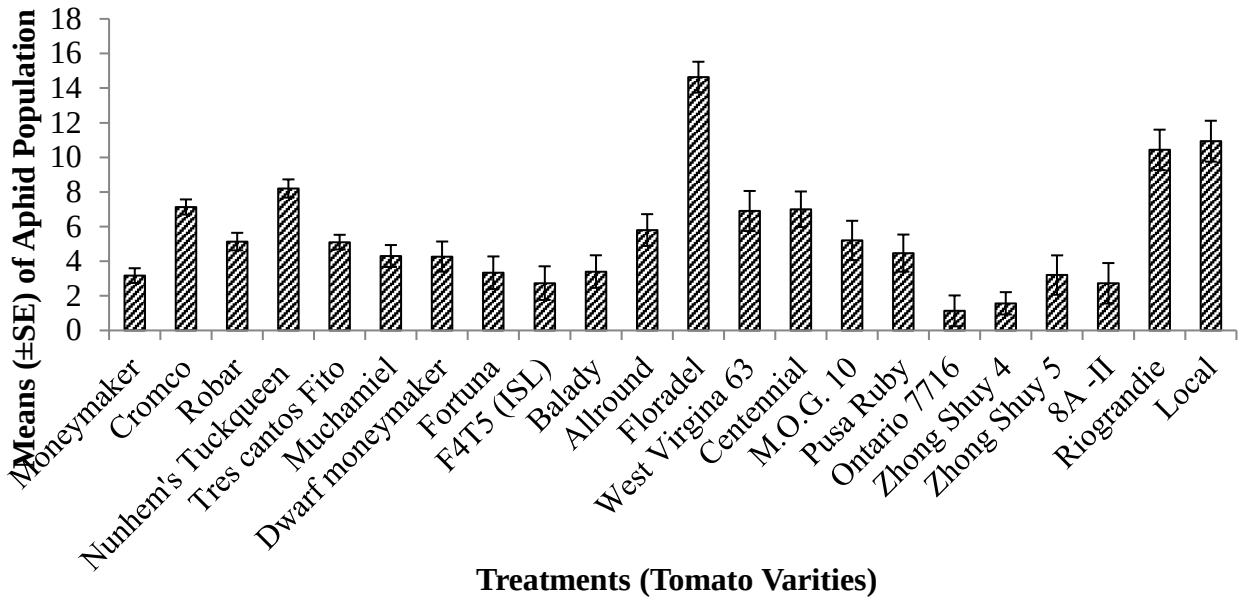

Fig. 6: Means for 22 tomato varieties for aphid population mostly showed non-significant results but the varieties Floradel, Ontario, Riograndie and local are highly significant values.

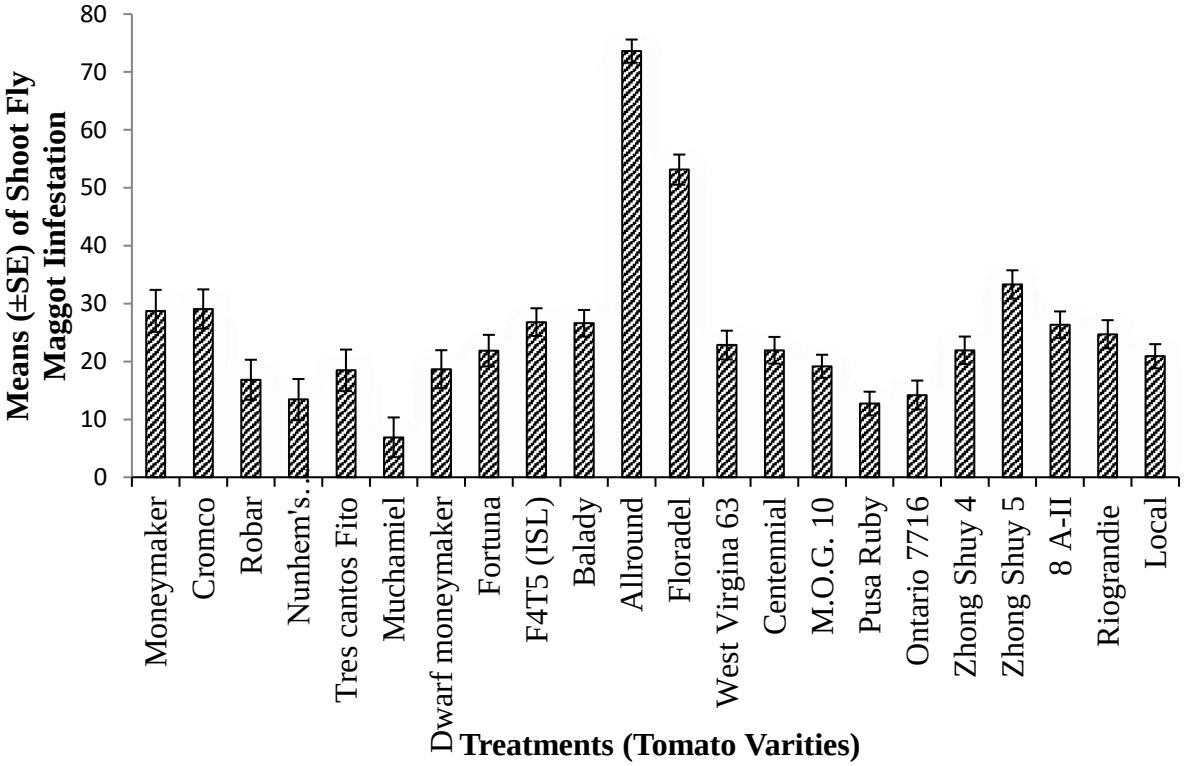

Fig. 7: Means for the tomato varieties with Standard error showed that the mostly varieties had non-significant results but the 4 varieties (Allround, Floradel, Zhong Shuy 5 and Muchamiel) showed high significant values against shoot fly maggot infestation.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 12, December 2022

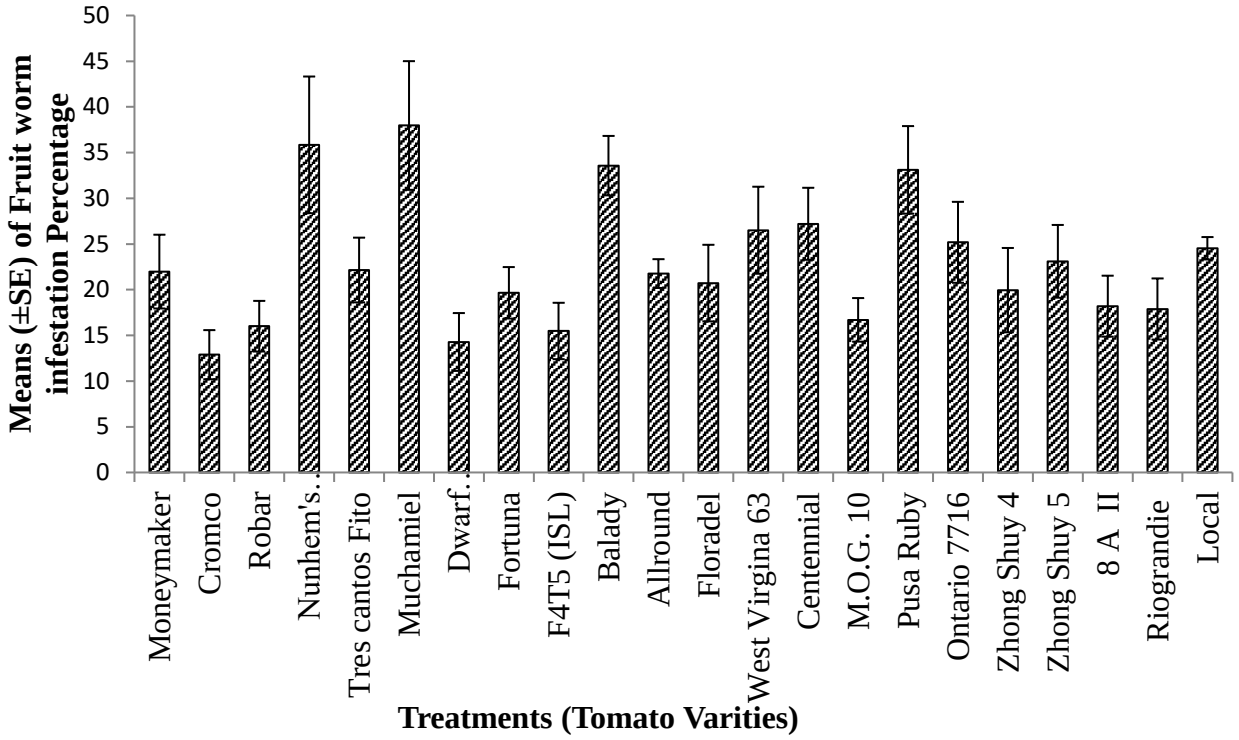

Fig. 8: Means for the fruit worm infestation percentage in tomato varieties with standard error showed that the mostly varieties have non-significant values but the varieties (Muchamiel and Cromco) are resistant varieties against tomato fruit worm with highly significant values.

Table1: Name and origin of exotic varieties of tomato used as a treatment imported from the genetic resources of Netherlands.

Sr. No.	Name of Variety	Origin
1	Moneymaker	The Netherlands
2	Cromco	The Netherlands
3	Robar	The Netherlands
4	Nunhem's Tuckqueen	The Netherlands
5	Tres Cantos Fito	Spain
6	Muchamiel	Spain
7	Dwarf Moneymaker	India
8	Fortuna	The Netherlands
9	F4T5 (ISL)	The Netherlands
10	Balady	Lebanon
11	Allround	The Netherlands
12	Floradel	USA
13	West Virginia 63	USA
14	Centennial	USA
15	M.O.G. 10	The Netherlands
16	Pusa Ruby	India
17	Ontario 7716	Canada
18	ZhongShuy 4	China
19	ZhongShuy 5	China
20	8 A-II	Syria
21	Riograndie	Pakistan
22	Local	Pakistan

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 12, December 2022

Table 2: Response of different exotic varieties of tomato toward all of three insect Pests Aphid, Shoot Fly maggot and Tomato fruit worm.

Resistance Varieties			
Insect pest	**Varieties name**		
Aphid	Ontario 7716***	ZhongShuy 4**	8 A-II
Shoot Fly maggot	Muchamiel***	Pusa Ruby**	Nunhem's
Fruit Borer	Cromco***	Dwarf Moneymaker**	F4T5 ISL
	Susceptible varieties		
Aphid	Floradel*	local Pakistani**	Riograndie
Shoot Fly maggot	Allround*	Floradel**	ZhongShuy 4
Fruit Borer	Muchamiel*	Nunhem's Tuckqueen**	Balady

***Highly resistant varieties
**Moderate varieties

*Highly susceptible varieties