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Allure of insect pest and diseases among three solanaceous crops viz. tomato, chilli and brinjal in Hamelmalo Agricultural College

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The experiment was conducted in the Hamelmalo Agricultural College, Eritrea, from January 2017 to May 2017. This was done to study the attraction of major insect pest and diseases in three solanaceous crops (tomato, chilli and brinjal) grown singly and with mix cropping pattern. In Eritrea, solanaceous crops are important vegetables grown in different areas of the country. Insect pest and diseases are the major biotic factors that limit the production of these vegetables in the country, these are recorded at the vegetative, flowering and fruiting stages for all three crops. The major insects pest, that is white fly, African boll worm, tomato fruit borer and leaf miner, were recorded on tomato followed by chilli and brinjal; whereas lace wing bug, leafhopper was attracted more on brinjal crops. Tomato and chilli were more susceptible for leaf curl virus and collar rot, while intensity of powdery mildew was maximum on tomato and minimum on chilli, whereas brinjal was least susceptible to any kind of diseases.

Key words: Tomato, Chilli, brinjal, incidence, severity, insect pest, diseases.

INTRODUCTION

Solanaceous crops, comprising tomato, chilli and brinjal, are important vegetables in Eritrea, grown in both high and lowland areas within the year. It has been reported in Eritrea that these solanaceous vegetables are highly susceptible to different kinds of pests and diseases, which limit the production, as crop losses 30 to 40%. With changes in the cropping systems and climate and by introduction of highly yielding varieties, different insects attack the solanaceous crops. The farmers use pesticides in cocktail form. Apart from direct damage, many insect pests are vectors for several viral diseases. Major insect pests of solanaceous crops, especially tomato, chilli and brinjal, are tomato fruit borer *Helicoverpa armigera,* tomato leaf miner and fruit borer *Tuta absoluta*, tobacco caterpillar *Spodoptera litura*, serpentine leaf miner *Liriomyza trifolii*, cotton whitefly *Bemisia tabaci*, Brinjal shoot and fruit borer *Leucinodes orbonalis*, Hadda beetle *Epilachna vigintioctopunctata*, Brinjal leaf roller *Eublemma olivacea*, Brinjal stem borer *Euzophera perticella*, Lacewing bug *Urentius hystericellus*, Chilli thrips *Scirtothrips dorsalis*, White grub *Holotrichia consanguinea*, and Red spider mite/yellow mite

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Polyphagotarsonemus latus. The major diseases of the solanaceous are Powdery mildew, Leaf curl virus, *Begomovirus* species, phomopsis collar rot *Phomopsis vexans*, blight and root knot nematode *Meloidogyne* species.

The estimated world production of tomato is about 89.8 million tons from an area of 3.17 million (Anon, 1998). Tomato is one of the most widely grown vegetables in the world, and in 2005, the European Union was the second largest producer after China (FAOSTAT, 2007). Tomato crops are particularly susceptible to more than 50 different species of the Begomovirus genus. Tomato yellow leaf curl disease and viral disease rout tomato in warm temperate regions of the world (Aron et al., 2008). Chilli is one of the vegetable and condiment crop in the world. India is the largest consumer and exporter of chilli in the world with a production of 1492 MT from an area of 775 thousand ha and productivity of 1.9 MT per ha. Brinjal, *Solanum melongena* L. is the most common, popular and principal vegetable crops grown in India and other parts of the world. The brinjal is mostly important in warm areas of Far East and grown extensively in India, Bangladesh, Pakistan and China.

The host selection of insects and diseases is based on the attractiveness of volatile chemicals emitted by plants. Particularly, female insects use olfactory stimuli to choose plants for ovipositon to ensure their food for the next generation. Proffit et al. (2011) found that the host plant odour elicited in mated tomato leaf miner *T. absoluta* females' upwind orientation flight as well as for egg laying. Gravid *T. absoluta* females discriminated between cultivated and wild tomato and among tomato cultivars according to their volatile profiles. Insects' pest and diseases are common among tomato, chilli and brinjal; while one of the solanaceous crop is more susceptible, others are resistant to the same insects and diseases. The present study was aimed to find out the most susceptible host among three solanaceous crops (tomato, chilli and brinjal) for insects and diseases in monoculture and mix culture. The aim was to determine when and how these crops could be grown in an integrated pest management (IPM) system, for sustainable crop protection to avoid excessive use of pesticides and residues that can be deleterious to humans, animals and the environment.

MATERIALS AND METHODS

Cultivation preparatory

Prior to sowing and transplantations of the crops, the land was ploughed using a tractor once and twice with oxen, in order to make the soil tilt and to remove the different kind of weeds. Levelling was done with human labour and the field was laid out as per the design. All three solanaceous crops, chilli (Treatment 1), tomato (Treatment 2), and brinjal (Treatment 7) were grown separately as well as mixing with tomato+chilli (Treatment 3), tomato+chilli+brinjal (Treatment 4), tomato+brinjal (Treatment 5), and chilli+brinjal (Treatment 6) with three replications.

Seed sowing and transplantation

The popular variety of tomato was Segravati and local variety of chilli and brinjal were selected. Sowing seeds were taken up by adopting standard seedbed 2×2 m^2 for tomato, chilli and brinjal in the college nursery on 25 January 2017. The raised seedlings were transplanted in 3×3 m^2 experimental plots on 1st March, 2017.

Agronomic practices and irrigation

The all-agronomic practices were adopted to grow the good and healthy crops. The farmyard manure and other required fertilizers were applied per standard recommendation. Frequent irrigations were given to the crop during the season. First irrigation was done after transplant. Manual weeding was done at 15, 30, 45 and 60 days after transplantation.

Sampling of insect and diseases

While sampling the specimen, factors such as host condition, growth stage, insect pest, disease development, etc., were taken into consideration. Representative samples, based on visual symptoms of the disease were drawn from each crop at random per methods described by Sukhatme (1954) and Yates (1960). At least five plants per plot were covered for sampling. Sampling was done along the diagonals of the fields at regular intervals (fortnightly). The sampling sites were approximately equidistant from each other along the sampling pathway. At each site, a specified number of plants at specified distance on the row were carefully examined and sampled.

The parameters, which were given particular emphasis, were the intensity and prevalence of insect pest and diseases. For survey, methodologies given by James (1971, 1974) and Weeks et al. (2000) were followed.

The formula used for calculation of the disease incidence and severity are as follows:

Incidence (%) = (No. Of infected plant/Total plant assessed) × 100

Severity (%) = (Sum of all disease rating / Number of plants assesed × Maximum grade) × 100

Statistical data analyses

The collected data were subjected to statistical analysis, using the GENSTAT software.

RESULTS AND DISCUSSION

Report on common insect pest in three solanaceous crops: Tomato, chilli and brinjal

The tomato, chilli and brinjal are highly susceptible for different kinds of insect pest and diseases. Observations were made from germination to harvesting stage of the crops. Observations were made for occurrence of insect pest and diseases on all three crops. There were different

Table 1. Common insect pest on different three solanaceous crop.

S/N	Common name	Scientific name	Host plant	Status
1	White fly	*Bemisa tabaci*	Tomato ,chili and brinjal	Major
2	Jassid	*Empoasca denastans*	Tomato, chili, and brinjal	Major for brinjal
3	African boll worm	*Helicoverpa armigera*	Chili and tomato	Tomato
4	Tomato fruit borer	*Tuta absoluta*	Tomato	Major
5	Lace wing bug	*Urenticus orbonelis*	Brinjal	Minor
6	Aphid	*Myzus persicae*	Chili	Minor
7	Thrips	*Thrips tabaci*	Chili	Minor
8	Grasshopper	*Hieroglyphus haman*	Brinjal	Minor
9	Leaf minor	Leaf minor	Brinjal	Minor
10	Red spider mite	*Liriomyza trifolii*	Brinjal	Minor

Table 2. Insect pest population on different host.

Treatment/population/observation	*Tuta absoluta*			African bollworm			Whitefly			Jassids		
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
Chili	0.00	0.00	0.00	7.00	6.67	3.00	0.33	0.67	0.67	4.00	2.67	0.00
Tomato	3.00	6.00	2.33	9.00	14.33	4.00	3.00	6.00	2.33	4.00	2.33	5.67
Tomato+Chili	1.33	3.33	1.00	6.00	4.00	3.00	2.33	3.33	1.00	3.00	1.67	0.00
Tomato+Chilli+Brinjal	1.00	1.33	0.33	5.33	4.33	5.00	1.00	1.33	1.33	3.67	2.00	2.00
Tomato+Brinjal	1.00	1.00	0.33	7.00	6.00	3.33	1.00	0.33	0.33	2.00	2.33	3.00
Chili+Brinjal	0.00	0.00	0.00	7.00	4.00	6.00	0.00	0.00	0.00	4.33	2.00	1.00
Brinjal	0.00	0.00	0.00	0.00	8.00	8.00	0.00	0.00	0.00	4.33	2.00	4.00
L.S.D at 5%	1.29	1.33	0.67	1.78	2.40	1.53	1.33	1.26	1.03	4.12	2.88	6.15

insects and diseases reported during the observation. The major insect and diseases were documented and reported in Tables 1 and 3. During the cropping process, the major insect pest was recorded, which are, white fly, *Helicoverpa armigera*, *T. absoluta*, and jassid; whereas minor insect pest were lacewing bug, grasshopper, thrips, red spider mite and aphids. The major insect pest that causes significant damage in crops, their population after regular interval and further studies, were recorded in the present study.

Population of tomato leaf miner and fruit borer (*T. absoluta*)

T. absoluta tomato leaf miner and fruit borer is one of the most recently invasive pests in African countries. *T. absoluta* was observed in different treatments and found that the population of the *T. absoluta* were significantly on tomato crop, whereas on chilli and brinjal the population was either very low or zero (Table 2). In the first observation, it was found that the highest population was 0.3 larvae/plant on treatment two, while the zero population was on treatments one and six. In the present experiment, pest appeared throughout the observation. However, maximum numbers were recorded on treatment two at time of second observation and lowest in third observation in treatments 1, 6, and 7, respectively. In the third observation, the populations of *T. absoluta* decrease in all treatment even with maximum number on treatment two. Sheata et al. (2016) also reported *T. absoluta* on other cultivated solanaceous plants such as eggplant (*S. melongena*), potato (*S. tuberosum*), pepper (*C. annuum*), sweet pepper (*Solanum muricatum* L.), tobacco (*Nicotiana tabacum*) and other non-cultivated Solanaceae (*Solanum nigrum, Solanum elaeagnifolium*). The present result shows that tomato is highly preferable for *T. absoluta* compared to other solanaceous crops, such as, chilli and brinjal. Shehata et al. (2016), opine that the rate of infestation of different host plants and the biology of *T. absoluta* showed that the insect can discriminate between different host plants and it is more preferential to tomato followed by eggplant, potato and pepper (chilli); this is in line with the present study.

Population of whitefly at different host

Whitefly is one of the major insect pests of solanaceous crops, which damage the crop by direct sucking of

Table 3. Incidence of diseases on different hosts.

S/N	Name of diseases	Symptom	Host plant	Major/minor
1	Powdery mildew	Powder like structure on leaf surface holding conidia	Tomato and Chili	Major
2	Collar rot	Rotting of stem at collar region	Tomato and Chili	Major
3	Leaf curl virus	Curling of leaves and chlorosis, white fly present as a vector	Tomato and Chili	Major
4	Early blight	Concentric ring on leaves	Tomato, Brinjal and Chili	Minor
5	Late blight	Curling of leaves from margins and faded are on centre of the leaves	Tomato and Chili	Minor

phloem juice and transmitting number of viral diseases; leading to the death of plants. In the present study, population of whitefly was monitored and it was found that the population of white flies significantly affected all treatments (Table 2). In the first and second observation treatments, the second has maximum population; however in brinjal crop, infestation level was zero in the first observation but it was minimum on treatments three and six in the second observation. According to Fekri et al. (2013), whitefly *Bemisia tabaci* is one of the most important pests of tomato and this insect exists as an economic pest in most places of the world (Byrne and Houk, 1990; Gerling, 1990). Third observation was made after 45 days and it was found that the population of whitefly in all three crops decreases and maximum population was recorded on brinjal treatment seven; whereas the lowest was on treatments one and two. In the first observation, population of whitefly is maximum on tomato crops, which indicate that they prefer tomato at the vegetative stage than other solanaceous. However, in the third observation, population of whitefly decreases in all the treatments, indicating they prefer the seedling and vegetative stages of crops. Thrips, whiteflies, aphids and mites are the major sucking pests that contributes to decrease in crop yield (Hosmani, 1993), but in the present study all the pest was significantly low in population. Whiteflies are series vector of different viral diseases; they transfer virus from infected plants to healthy plants; leading to high infestation of diseases in a short time. The whitefly sucks the plant sap (Schuster et al., 1996), reducing the quality and quantity of the sap (Mound, 1965b). This pest also transmits various viral diseases (Dickson et al., 1956; Duffus, 1987; Bedford et al., 1994).

Population of African bollworm (Helicoverpa armigera)

The population of African bollworm (ABW) was recorded in all treatments; indicating they are not attracted on brinjal and chilli. At the vegetative stage, very few number of ABW were recorded as pests as more flowers and fruits were bore into, and later on the population increased to 6.0 larvae/plant on treatment two; meanwhile, the population was non-significant on the other crops. At the first observation, the pests damaged the leaves and flowers but at the fruiting stage, the fruits of tomato were scratched and damaged, while larvae were found in matured fruits. Tomato crop is prone to many insect pest infestations (Mailafiya et al., 2014), particularly, the devastating fruit borer *(H. armigera*), which is a major tomato pest, both in rainy and dry season in Nigeria and other tomato growing countries (Trenbath, 1993; Pino et al., 1994; Degri and Mailafiya, 2013).

Population of jassid (leafhopper)

The green leafhopper are jassids, belonging to Hemiptera order, Cicadelidae family. They are serious pests for solanaceous crop and commonly damage crops, from seedling to harvesting stage. In the present study, the population of jassids was recorded on every treatment and it was found that the population of jassid was significantly susceptible in all the treatments. In the first observation, the maximum population was found on treatments six and seven, 4.33 hopper/plant; whereas the maximum population in the second and third observations was 2.67 and 5.67 hopper/plant recorded on the first and second treatments, respectively.

Bharadiya and Patel (2005) found that the activity of the jassid, *Amrasca biguttula biguttula* was the maximum as at the third week of November, on brinjal crop (Jadhav et al., 2004). Jassids, *Amrasca biguttula* (Ishida) are some of the major insect pests of chilli. Adult jassids are slow flyers, while the nymphs suck the sap by moving from the down side of the leaf, resulting in wrinkles that appear on dorsal side of the leaf.

Table 4. Intensity of different disease at different host.

Treatment/population	*Collar rot*			Leaf curl virus			Powdery mildew		
	1st	2nd	3rd	1st	2nd	3rd	1st	2nd	3rd
Chili	26.31	55.50	55.50	0.00	58.90	73.33	58.90	56.66	0.00
Tomato	11.59	14.60	19.40	0.00	70.00	86.66	70.00	65.55	0.00
Tomato+ chili	9.70	18.90	20.10	0.00	66.70	84.44	63.37	58.89	0.00
Tomato+chilli+brinjal	13.00	24.60	24.70	0.00	54.40	70.00	70.00	55.55	0.00
Tomato+brinjal	17.96	13.90	13.90	0.00	65.50	66.66	73.30	51.11	0.00
Chili+brinjal	2.78	0.00	0.00	0.00	56.70	56.66	70.00	51.11	0.00
Brinjal	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
L.S.D at 5%	7.75	9.69	9.90	0.00	8.17	6.27	8.43	7.28	0.00

The present results indicated that all the treatments are susceptible to jassids.

Occurrence of diseases on different host

Some diseases were found as major and minor as shown in Table 3. Syed et al. (2016a) and Rao et al. (2016) also reported similar diseases as the present field trial, namely, leaf curl virus, powdery mildew, and collar rot. The major disease incidence of leaf curl and powdery mildew of tomato and chilli is caused by leaf curl virus and *Erysiphe* species, respectively. Whitefly, aphids and jassids were observed as the major vector for viral diseases. Wherever the insect pests occurred, there was also incidence of leaf curl disease because of the transmitted viruses. Hence, the present results are also in agreement with Syed et al. (2016). Syed et al. (2016a) found that *Alternaria* blights reported on potato, tomato, okra and chillies from Hamelmalo, Hagaz and Adiatiklezan sub regions; powdery mildews in chillies and okra were noticed from medium to high intensity as well as mosaic viral disease in tomato, cucumber and okra. Rao et al. (2016) found that different diseases such as early blight, late blight, powdery mildew, wilt affected chilli crops and tomatoes; blossom end rot and leaf curl in tomato; and damping off, leaf curl, bacterial leaf spot in chillies.

Disease intensity of collar rot on different hosts

The data collected and analyzed for the parameters shows the host preference of collar rot on different crops and their combinations. From Table 4, it has been noted that there were significant differences in the collar rot incidence on different treatments at 15 days interval of data collection. Data has been collected for collar rot after 25 days of transplant. In all three observations, the maximum collar rot incidence was recorded in chilli (T3), that is, 26.31, 55.50 and 55.50, respectively and the lowest in Brinjal (T_7), that is, 0.00 (Table 4). The order of treatments for 1st observation of collar rot incidence was T1 > T_5 > T_4 > T2 > T3 > T6 > T7; while the order of treatments for the second and third observations was T1 > T_4 > T_3 > T2 > T5 > T6 > T7.

Disease intensity of leaf curl virus on different host

There was high percentage of disease incidence and severity of leaf curl virus during the second and third observations in different treatments due to white fly populations, which is high during this period. However, the first observation incidence and severity were zero in all treatments. Incidence and severity for leaf curl virus have significant difference among the treatments at second and third observations. The highest incidence was found in Tomato + Chilli (T3), which is 70.00 and 86.66 in the second and third observations, respectively; followed by T3, T5, and T6. In treatment seven (Brinjal), incidence and severity were recorded as zero. Same trends were observed in severity of leaf curl virus; the highest in Tomato+Chilli (T3) and lowest in T7 (brinjal). Rao et al. (2016) have reported similar results and Syed et al. (2016b) reported that tomato and chilli are susceptible for leaf curl virus in Hemalemalo region. The leaf curl virus was high due to whitefly populations during the peak seasons of the crop (Table 2).

Disease intensity of powdery mildew on different host

The disease incidence of powdery mildew observed during the experiment was highly severe at the first observation, which is 73.30 in treatment five; but during the second observation, the disease incidence was decreased. During the final observation, there was no incidence and severity. Powdery mildew was severe in all treatments except in T7 where there was significant difference among the treatments for intensity of powdery mildew. At the maturing stage of the crop it was heavy rainfall due to this powdery mildew incidence and severity

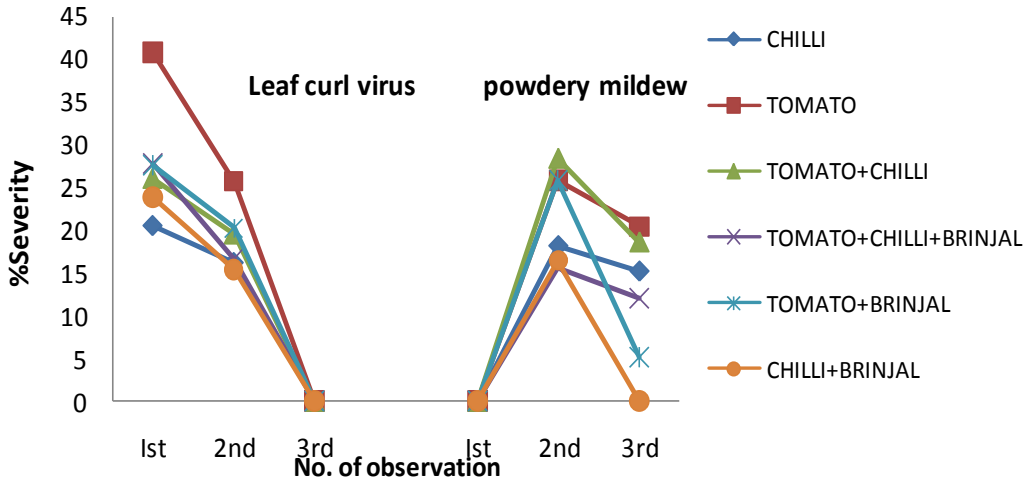

Figure 1. % severities of leaf curl virus and powdery mildew on different host.

recorded zero. Powdery mildew incidence was the highest in T5, 73.30, followed by T2, T4, T6, T3 and T1; in the first observation and second observation the highest incidence was recorded in T2, 65.55, and the lowest in T7. Severity of powdery mildew was higher in T2 as 40.74 and 25.65 in first and second observations, respectively; followed by T4, T5, T3, T6, T1 and T7. Syed et al. (2016b) also reported the same findings that powdery mildew is severe on chilli and tomato, while there is no powdery mildew on brinjal. This has been reported in Anseba region. Powdery mildew was severe before rainfall because it is considered as dry land area disease. This is because this spore do not only require high humidity like other fungus, but holds more than 52% water content as well as high lipid content coating on spore (Figure 1).

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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