Chapter - VI

Summary

SUMMARY

Tomato (*Lycopersicon esculentum* Mill.), a principal vegetable crop is grown well in terai region of West Bengal because of its unique soil-characteristic, agro-ecological situation and socio-economic background. Wide spread expansion in tomato cultivation and a considerable earning of the farmers of this economically backward region have been witnessed following a breakthrough in production technology after introduction of hybrids having higher yield potential with better keeping quality over a decade. Like other agricultural crops, tomato also suffers from damages by various insect and non-insect pests of which aphid (*Aphis gossypii* Glover), white fly (*Bemisia tabaci* Genn.), leaf miner (*Liriomyza trifolii* Burgess) and fruit borer (*Helicoverpa armigera* Hubner) can be considered as major ones in the region. Through out the span of tomato crop, from early seedling to harvesting, the plants are attacked either by one pest or others, resulting in remarkable loss of crop. Since the fruits of tomato are plucked frequently, at a close interval and are consumed after little cooking or uncooked salad, it is therefore, very difficult to control the pests through the use of conventional toxic, board spectrum synthetic pesticides. Because there is every possibility of retaining toxic residues in the fruits. All these pose a serious problem in pest management of tomato. The farmers, because of having poor scientific knowledge, non-availability of befitting, plant protection technology and lack of awareness on pesticides related health and environmental hazard alternative pest-management strategy of tomato crop for the region is required to be evolved. With this background attempts were made to explore:

- **Study of fluctuation of pest population and interaction with biotic and abiotic environmental factors and crop-phenology with a view to identify favourable weather parameters, peak period of pest infestation and vulnerable stages of crop growth with an ultimate objective to manipulate them through asynchronization of peak period of pest activity and vulnerable stage of crop growth.**
- **Study of bio-ecology of the important pest species with an objective to assess the pest structure at different environmental conditions and its relation with field level fluctuation of population.**

- **Assessment of crop loss caused by the pest complex with an objective to take decision appropriately for protection measure.**
- **Evaluation of varieties/hybrids commonly grown in the region with respect to pest interaction and effect on yield of crop for selecting varieties / hybrids tolerant to prevailing pest complex.**
- **Evaluation of pesticides under field conditions (synthetic and of biological origin) with a view to identify the pesticides more efficacious to pests and safer to health as well as environment.**

The investigation was carried out in the instructional farm and laboratory, Department of Agricultural Entomology, Bidhan Chandra Krishi Viswavidyalaya, North Bengal Campus, Pundibari, Cooch Behar, West Bengal, India, during the period from 1996-1999.

1. Seasonal incidence of insect-pests and their natural enemies of tomato and their interaction with crop-phenology

The causative relationship between weather parameters and pest-population as well as between crop phenology and pest-population build up was worked out with a view to asynchronise the vulnerable stage of tomato crop from peak period of incidence of pest species through adjustment of planting time. The initial attack of the two sucking pests, aphid and white fly was initiated on crops after two weeks of transplanting and the population was always at a low level on the first crop planted on November, 24 and the last one planted on February, 24. The highest level of attack occurred on the second and third crops planted on December, 24 and January 24, and at about the time of mid March. These pests were more active during early period of crop growth *i.e.* during the establishment stage (before fruiting) of crop growth. Population of both the pest species were found negatively correlated with temperature, r.h. and rainfall but showed positive correlation with daily sunshine hour. The level of infestation of the two internal feeders namely, leaf miner and fruit borer, increased gradually with the progress of crop growing season and became the highest on the last crop planted on February, 24. The leaf miner fed within the leaf. With the advancement of crop age leaf became thicker, provided better food and shelter for the larvae, hence favoured higher incidence of leaf miner in later

stage of crop growth. Thus, a higher level of infestation was maintained from late March to late May. Since fruit borer occurs in the fruits, irrespective of planting time its incidence was always restricted to later stage of crop growth. However, it was most active from middle of February to May. Significant variation was observed in the levels of infestation of the crops planted at different times due to differences in weather conditions. Both the internal feeders showed positive correlation with temperature, r.h. and total rainfall. The two other minor pests attacking tomato plants namely tingid bug and hadda beetle, were more active on the fourth crop. The prevailing weather conditions during the period of this crop-growing season favoured these two pests. However, they had no specificity in preference for crop growth stage.

Interaction between important weather parameters and pest population as well as between crop phenology and insect population showed that low temperature and moderate humidity coupled with early growth stage providing succulent plants as prevailed during normal crop growing season (first crop), favoured incidence of aphid and white fly. With the advancement of season vis-a-vis crop growth, temperature and r.h. became higher, leaves became mature and thick and appearance of fruits synchronised with the peak incidence of leaf miner and fruit borer, resulting in non-replenishable loss of crop.

Among the natural enemies *Menochilus sexmaculata, Coccinella septempunctata* and different species of spider were the most prominent. The natural enemy population was not only dependent on the climatic conditions but also with the level of pest population. *Menochilus* and spider population were found through out the growing period of all the crops, but the *Coccinella* population was restricted only to the later part of the crop-growing period, onward from the first week of February to the third week of March.

2. Biology of important insect-pests of tomato.

The studies on bio-ecology of three major insect-pests namely, white fly, leaf miner and fruit borer under laboratory conditions showed that duration of different life stages of these three pests varied significantly with different times of crop growing period. White fly was found biologically more active during October-November. Span of all the developmental stages were

prolonged during December-January and shorter during October-November. Duration of life cycle was longer (40 days) in December-January while shorter during October-November (19.57 days). Duration of life cycle of leaf miner was longer (22.22 days) during February-March and shorter (15.68 days) during relatively warmer part (April) of the crop growing period. Duration of different developmental stages and hence the life cycle of fruit borer, was the shortest (31.43 days) during April-May and longest (43.36 days) during February-March and average being 38.52 days on tomato fruits covering the entire crop growing period.

Duration of different life stages as well as life cycle of the above mentioned pests had significantly negative correlation with temperature and r.h. indicating that the pests were biologically more active during the warmer part of the crop growing season which corroborated the higher level of infestation during the period in the fields.

3. Assessment of crop loss of tomato caused by important insect-pests

The studies on extent of damage caused by the important pests and estimation of loss in yield of tomato was undertaken on the first and the fourth crops and on two representative tomato varieties—one open pollinated (Pusa Ruby) and another hybrid (Abinash-II). The composition of the important pest species was almost the same on the two varieties but differed in the level of population in two crops, the varieties and in case of four different treatments such as untreated control, plants treated with a fungicide (Dithane M-45) alone, an insecticide (malathion) alone and the two in combination. A relatively low level of population of all the pest species was observed on the first crop compared to that on the fourth, and also on insecticide alone and combined insecticidal and fungicidal treated plants than on the untreated control. The open pollinated variety always witnessed less pest attack than the hybrid. However, loss in yield of tomato can be avoided from protective use of insecticides to an extent of 10.63% and 11.09% in winter and 23.69% and 26.66% in spring-summer crop for the open pollinated (Pusa Ruby) and hybrid (Abinash-II) respectively. Lower extent of loss from winter crop appeared to be due to low temperature and r.h., which restrict normal activities of pest species.

4. Evaluation of tomato varieties against insect-pests, natural enemies and yield

The varieties evaluated, were neither resistant to any pest species nor multiple tolerant/less susceptible to the pest complex. One variety while found more susceptible to any pest species observed less susceptible to another. In general, among the seven varieties and hybrids tried against insect-pests and considered for yield, revealed that the six hybrids were more susceptible to pest complex than the high yielding open pollinated variety. Pusa Ruby was relatively more susceptible to the sucking pests *viz.* aphid (0.29/leaf) and white fly (0.54/plant) while it was less susceptible to the internal feeders *viz.* leaf miner (1.51%) and fruit borer (7.00% and 5.61% in number and weight). Among the hybrids Abinash-II suffered from the highest leaf miner infestation (4.80%) but tolerant to white fly (0.24/plant). The hybrid Rasika was more susceptible to internal feeders than the sucking ones. The hybrid Arjuna and Rupali were found moderately tolerant to all pests as a whole. Pusa Ruby was indeterminate type having longer fruiting period, but due to smaller size and weight to fruit (38.19gm) and yield was the lowest (45.23 t/ha) among all the varieties tested. Considering the overall performance, with respect to yield and pest-reaction, Arjuna (84.34 t/ha) was found better among the commonly grown varieties in terai region because of moderate pest incidence and higher yield potentiality.

5. Management of insect-pest complex of tomato through pesticides

Pesticides is an important tool in present day pest management programme. Seven pesticides of different origin (synthetic and biological) were evaluated in the field against the key pest of tomato *viz.* leaf miner and fruit borer attacked the last planted crop. The pesticides trialled were malathion and DDVP (synthetic) and Azadirachtin, *Bacillus thuringiensis, Beauveria bassiana,* NPV, Avermectin (of biological origin). Avermectin @ 0.01% and HaNPV @ 250 LE/ha were found equally or even more effective than synthetic pesticides. Although better suppression of leaf miner infestation (44.39%) and yield of tomato (60.26 t/ha) were obtained from DDVP @ 0.05%, however, avermectin and HaNPV performed better against fruit borer (49.95% and 52.03% bored fruit in number and weight for avermectin and 49.39% and 50.99% bored fruit in number and weight for

HaNPV respectively). It therefore, confirms that avermectin and HaNPV were equally effective against the key pests as compared to usually recommended synthetic pesticides DDVP. Considering the performance of all the seven pesticides pest management and their impact on health and environment, the use of the two recommended insecticides (malathion and DDVP) needs to be reviewed. Malathion and DDVP are harmful to the activities of natural enemies of crop pest. While avermectin, a microbial toxin and HaNPV, a viral pathogen were not only more effective against the pest complex of tomato and produced relatively higher yield but also have no adverse effect on health, environment and natural enemies of crop pests and thereby compatible with IPM of tomato as a curative measure.

From the critical analysis of the results under present investigation it can be concluded that insect-pests are one of the important limiting factors of tomato cultivation in terai region of West Bengal. Crop loss due to pests is more during spring-summer season during winter. Hybrids suffer more than the open pollinated varieties. None of the varieties found resistant or multiple tolerant to the pest complex of tomato. However, Arjuna among the commonly grown varieties, was found better because of moderate pest incidence and higher yield potentiality. None of the pesticides evaluated could control the pest complex satisfactorily. However, among the biologically originated pesticides avermectin and HaNPV were found equally or even more efficacious than the two recommended synthetic pesticides. An early harvest of mature fruits minimizes borer attack during peak period of incidence coupled with raising of tolerant variety like Arjuna along with need based application of avermectin and HaNPV can be recommended for IPM programme for the tomato crop in terai region.