Chapter - I

Introduction

INTRODUCTION

The fruits and vegetables have a good contribution to balanced diet of human beings for providing energy rich food content and vital protective nutrients like vitamins and minerals and enrich health from the most nutritive menu and tone up the energy and vigour of man. Comparatively vegetables are one of the cheapest sources of natural nutritive foods.

India is a vast country with varied soil and agroclimatic conditions and is able to grow a wide variety of fruits and vegetables. It has the distinction of being the largest producer of fruits and the second largest producer of vegetables (next only to China) in the world. The annual growth rate of these commodities has been of the order of 1.66 and 3.96 respectively (Chadha, 1995). Compared to many other countries present yield per unit area of most of the vegetables is very low in India.

Among the vegetables, tomato, *Lycopersicon esculentum* Miller (Solanaceae) is one of the most important "protective foods" both because of its special nutritive value and wide spread production. It is the world's largest consumable vegetable crop next to potato and sweet potato but it tops the list of canned vegetables. It has originated in Peruvian and Mexican regions and has been used as food by the inhabitants of central and south America since pre-historic times. Perhaps it has been introduced in India by the Portuguese though there is no definite record of when and how it came to India. Tomato is cultivated in India over 2,90,279 ha with a total production of 46,03,446 MT (Chadha, 1995). Major tomato growing states in India are Bihar, Karnataka, Madhya Pradesh, Orissa, Punjab, Uttar Pradesh and West Bengal. At present yield per unit area is very low in India 9.78 t/ha only, while in Netherlands it is 248 t/ha (Kale *et al.*, 1993). A more realistic high yield from field production in temperate region is 39 t/ha, whereas, the average for the world is 21.12 t/ha with tropical regions recording around 14 t/ha (Choudhury, 1979). In India on an average, under field condition, a normal tomato crop yields 16-25 t/ha while the hybrids often produce 60-80 t/ha (Tiwari and Choudhury, 1993).

Tomato fruits are rich in vitamin content, most important being vitamin C followed by Vitamin A, B and B_2 (Nath, 1976). It is the rich source of vitamin A and C, minerals and organic acids (Gould, 1971). Tomato fruits are abundantly rich in vitamins, minerals and organic acids and contain 3-5% total sugars, 15-30 mg/100gm ascorbic acid, 7.5–10.5 mg/100ml

titratable acid, 2.4 gm/100gm dry fruit weight of minerals and 25-50mg/100gm of lycopene (Aykroyd, 1963; Kalloo, 1989).

The fruits are consumed raw, cooked or stewed. Large quantities of tomato fruits are used to produce soup, salad, pickles, ketchup, puree, sauces and used as ingredient for all vegetable preparation. It has a medicinal value as pulp and juices are promoter of gastric secretion and blood purifier. It is also considered to be intestinal antiseptic.

It is relatively a warm season crop and requires relatively long season to produce a profitable crop. The plant can not withstand severe frost, hot, high rainfall and water logging. The crop grows well at an average temperature of 21-23^{0}C but commercially it may be grown at temperature ranging 18-27^{0}C. The best soil for tomato is rich loam with a pH of 6.0-7.0, a little sand in the upper layer and a good clay in the sub-soil (Choudhury, 1990).

The unique geographical distribution, soil characteristic, agro-ecological situation and socio-economic background of terai region constitute a congenial environment for vegetable cultivation on commercial scale. Continuous cropping, monoculture, irrigation and high yielding varieties among other components of new agricultural technology often increase the vulnerability of crops to pest attack and favour multiplication and carry over of insect-pests. Moreover, presence of alternate host plants like other solanaceous crops and weeds make certain pests to emerge as devastating ones. The pests not only affect the health of the plants but also affect the quality and productivity of the crop, which turn into considerable economic loss of the crop. The annual crop loss in India have been estimated to be 10-30 per cent of the total production and in terms of money it is estimated around Rs. 6000 crores. Insect-pests constitute the major limiting factors in the successful production of tomato in the region under studies.

The crop, tomato is prone to a number of diseases and is attacked by a number of insect-pests. Pests damage the crop either directly by feeding on some parts of the plants or by dessemination of harmful organisms from diseased to healthy plants. Among the different insect-pests of tomato, the fruit borer (*Helicoverpa armigera* Hubner), white fly (*Bemisia tabaci* Genn.), aphid (*Aphis gossypii* Glover), hadda beetle (*Henosepilachna vigintioctopunctata* Fabr.), jassid (*Amrasca biguttula biguttula* Ishida), leaf miner (*Liriomyza trifolii* Burgess), tobacco caterpillar (*Spodoptera litura*) etc.

are important. Besides this lacewing bug or tingid bug (*Urentius hystricellus* Richter), termites, grasshoppers, flea beetles also attack tomato plants. Among the non-insect pests mites and nematodes are also important. In terai region of West Bengal, aphid, white fly, leaf miner and fruit borer are the most important. (Anon, 2000). In addition, tingid bug and hadda beetle sporadically appear as minor pests.

Aphids suck the sap from the leaves, tender part of stems etc and are more prevalent during pre-flowering stages of crop growth (Cruz and Bernardo, 1971) and caused curling, fading and shedding of leaves. Another sap sucking pest, the white fly acts as a vector of Gemini virus, which is pathogenic to the young plant (Quiros *et al.*, 1995), spreading devastating leaf curl disease and causes yield loss upto 93% (Singh, 1989). However, both aphid and white fly populations decline with the advent of rainy season (Singh, 1984).

Among the different ornamental plants, weeds, field crops, tomato and marigold are found to be the preferred host for survival of the leaf miner through out the year and the infestation rate was higher during monsoon and summer than the winter (Kapadia, 1994) and cause 22.5% reduction in yield during kharif season in Rahuri, (Pawar *et al.*, 1996). Leaf miner attacked the leaves of middle and bottom canopy as compared to the top canopy (Srinivasan *et al.*, 1995) and more infestation was found at low plant height (Zenhder and Trumble, 1984). The insect was first detected to infest tomato plants in south India in 1992. By 1995, the leaf miner reached the pest status and is apprehended to become major and the devastating one in future (Srinivasan *et al.*, 1995).

The fruit borer although the main pest of legumes but may attack a large number of plants including cotton, tomato etc. This polyphagous species is a key pest as it attack the cashable part of the plant *i.e.* fruit and make the fruits unfit for human consumption causing considerable crop loss (Kashyap, 1983) even upto 40-50% in Tamil Nadu (Srinivasan, 1959) and in Bangalore (Khaderkhan *et al.*, 1997). The percentage of fruit damage is always higher in late planted crop (Ogunwolu, 1989) and the yield also declines progressively with the late plantings as disease and fruit borer infestation become more (Sharma *et al.*, 1997). The infestation become more by the end of March (Lal and Lal, 1996). Unusual rains during late winter, high humidity and ambient temperature favoured the pest population build up as reported by Sinha and Chakrabarti (1983).

Lal (1991) reported that high yielding varieties and hybrids need more pesticides as they are more susceptible to insect-pest attack. Kashyap and Verma (1986) recorded 42-55% damage of tomato fruits in susceptible varieties while it is only 1.7-2.9% in resistant variety.

Efforts to prevent pest damage have resulted in the ever-increasing use of pesticides. From the time of advent of chemical pesticides since 1950, the farmers all over the world adopted it as a potential weapon to fight against the pests in their field. Eye-catching performance of such pesticides lured the farmers to use these miracle compounds in large quantity to safeguard their crops from the attack of insect-pests. Among the pest attacking tomato, fruit borer, *Helicoverpa armigera*, is regarded to be the most important insect-pests causing yield losses directly as the pest attack is confined to cashable part of the crop *i.e.* fruits. Fruit borer develops resistance to DDT and synthetic pyrethroids and to a lesser extent to endosulfan and monocrotophos (King and Sawicki,1990). Aldicarb, carbaryl and dimethoate has also been reported as the agents of pest resurgence (Eveleens, 1983). Recent reports reveal that this pest can not be managed to the desired level by the use of available insecticides (Patil, 1993).

Such consequences forced to think over the pest management with new dimension. It gave birth to new idea of "Integrated Pest Management" (IPM) which assesses the existing situation and utilizes all the available pest control methods in a compatible manner to keep the pest population below economic threshold level and above maintenance threshold level of natural enemies. The global importance of IPM was recognised in 1992 when it was assigned a crucial role in agenda 21 (Chapter 14 Section 1) of the action plan of the UN Conference on Environment and Development (UNCED).

The use of bio-control agents in the IPM has been gaining momentum since their introduction. The potential use of insect pathogens like *Bacillus thuringiensis* (Bacteria), *Metarrhizium anisoptiae* and *Beauveria bassiana* (Fungi) and nuclear polyhedrosis viruses (NPV) in pest control has been documented by various workers (Tanada, 1956; Steinhaus, 1957; Aizawa, 1963; Igonffo, 1965 and Hemipel, 1967). This approach represents an ideal form of pest control as the pathogens provide long and short term pest suppression with less disruption in ecological balance (Pramanik, 1996). Besides the microbial control measures, some environment friendly biopesticides such as neem derivatives are applied against lepidopteran larvae as they disrupt the growth of these larvae and act as antifeedant agents (Mustafee, 1997).

Besides these, several cultural practices like regulated irrigation, use of resistant varieties, stimulation of different fertility level, time of sowing and harvesting, knowledge about environmental condition, age of plant also play very important role in the judicious pest management strategy.

A good number of works have already been worked in different parts of the country and abroad on different aspects of the pest constraints and their management of tomato. The constantly charging dynamic nature of agroecosystem results in equally dynamic changes in pests and the problems they pose. Hence, pest management programme developed once can not be an everlasting solution to the pest problems of a crop. With the rapid advancement of science and technology and constantly changing dynamic nature of agriculture, pest management strategy is likely to go on changing from time to time.

In terai region of West Bengal different vegetables are cultivated in large scale because of its unique soil-characteristic, agro-ecological situation and socio-economic background. But the fact is that the technologies at this moment available to the farmers are not ecologically sound. The vegetables that are cultivated are brinjal, chilli and cucumber all the year round; cauliflower, cabbage, leafy vegetables, tomato, potato in rabi and vendi in summer and rainy season. Because of high benefit to cost ratio of these crops grown in this region farmers mostly grow these crops as cash crops. As a result no proper crop rotation is followed. Even tomato, brinjal, chilli; cucumber are growing year after year on the same plot of land because of limited holding of irrigated land or upland of individual farmer. Therefore, injudicious application of fertilizers and improper crop-rotation practices are common phenomenon. Even to the farmers, there is large gap in modern plant protection methodologies, so that, they can achieve maximum productivity avoiding minimum losses due to frequent outbreak of pests and diseases. The insecticides and fungicides of different groups are applied at a closer interval, fruits are plucked even after a day of spraying, pesticides are applied regularly in a schedule, whether pest and disease appear or not, as a prophylactic measure. All these affect the crop plants as well as beneficial micro-organisms present in the soil and other parasites and predators along with the target ones. Moreover, toxic residues invariably deposited in fruits and other plant parts, which are consumed even before safe waiting period. Whether the amount deposited beyond tolerant limit is yet to determine.

In order to overcome the problem of toxic residue hazards through the use of broad spectrum synthetic pesticides on the perishable crop like,

tomato it is necessary to evolve a safe pest management strategy, particularly in areas like terai region of West Bengal where no work, even preliminary investigation has yet been carried out. Therefore, a through study on incidence of pest and disease in relation to prevailing weather conditions, assessment of loss caused by them, role of varieties in perspective of new seed policy and use of safer pesticides which will be compatible with other methods of control with an ultimate objective to formulate future IPM programme under rapid changing agricultural situation and production system in terai region of West Bengal is the basic need at present day.

In view of the objectives delineated above, programmes have been drawn accordingly and the investigation has been carried out during the period from 1996 to 1999 in a holistic approach as follows :

- **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.**

It is expected further that the adaptable outcome of the present investigation will lead to formulation of a pest management strategy for tomato crop in terai region which will be environmentally sound, technically feasible, economically viable and also safer to human health and non-target organisms. This strategy can also be followed in other regions and even on other vegetable crops having similar problems in pest management.