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MONITORING OF MAJOR PESTS ON CUCUMBER, SWEET PEPPER AND TOMATO UNDER NET-HOUSE CONDITIONS IN PUNJAB, INDIA

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ABSTRACT: Major insect, mite and nematode pests on cucumber, sweet pepper and tomato grown under net house were monitored in Punjab, India during 2008-09. The red spider mite (*Tetranychus urticae* Koch) was the predominant pest of cucumber. Leaf miner (*Liriomyza trifolii* Burgess) incidence was considerably low, and whitefly (*Bemisia tabaci* Gennadius) was noticed only during the early season. Thrips (*Scirtothrips dorsalis* Hood) and broad mite (*Polyphagotarsonemus latus* Banks) were serious pests on sweet pepper. The aphid (*Aphis gossypii* Glover) was the only insect found on tomato during early crop stages. The incidence of aphid was very low and whitefly was negligible. Tobacco caterpillar (*Spodoptera litura* Fabricius) damage was around 5 per cent on cucumber and tomato, and 23.75 per cent on sweet pepper during the later growth stages. The root-knot nematode (*Meloidogyne incognita* (Kofoid & White) Chitwood) population was not recorded at the time of transplanting in most net houses, but gradually increased over the growing season in all the three crops. In general, farmers applied prophylactic insecticide sprays to manage sucking insect pests in net houses.

Keywords*:* Net house, pest monitoring, vegetables

INTRODUCTION

Agriculture in India has changed significantly in recent years. For instance, the area under rice in India has declined by 1.09 million ha during 2000-2007 (Directorate of Economics and Statistics, 2007), while the area under vegetables has increased by 1.07 million ha during 2002-2006 (National Horticultural Board, 2006a). A similar trend is occurring in several Indian states, including Punjab. The area under vegetables increased to 152,100 ha in 2005-2006 from 54,612 ha in 1990-91 (National Horticultural Board, 2006b; Punjab Government, 2009). Egg plant (*Solanum melongena* L.), tomato (*Solanum lycopersicum* L.) and sweet pepper (*Capsicum*

annuum var. *grossum* L.) are important vegetables in Punjab. Pests, including insects, mites and nematodes, are the major factor limiting the vegetable production in the state.

Cultivation of vegetables under protective structures such as net houses has become popular in recent years (Kaur *et al*., 2004; Cheema *et al*., 2004; Singh *et al*., 2004). This enables, farmers to produce vegetables in the off-season, when fresh produce usually fetches higher price in the market. For instance, the plains of North India, especially Punjab, experience extreme weather during winter and summer, and tomato is available only for a short period (mid-April to May). The glut of tomato at this time causes prices to plummet, but by June the vegetable is scarce. Off-season tomato production in net houses increases the period of fruit availability (Cheema *et al*., 2004). Net house cultivation of sweet pepper is gaining importance in the lowlands of Northern India because farmers realize greater profits from earliness and total yield of the crop compared with open field conditions (Singh *et al*., 2004). Vegetable production under protected conditions is increasing due to high productivity and returns per unit area during the off-season.

The Punjab State Farmers' Commission (PSFC) subsidized and promoted the construction of net houses; since 2005, the commission has set up 200 net houses across the state (Kaur, 2008). However, the use of net houses for off-season vegetable production has been less effective due to construction issues and operational limitations (Sethi *et al*., 2009). Hence, damage from pests inside net houses is not significantly different from open field production, causing net house growers to use more pesticides. This study was carried out to record the occurrence of major pests on cucumber, sweet pepper, and tomato under net house production in farmers' fields.

MATERIALS AND METHODS

Pest surveillance was carried out on cucumber, sweet pepper and tomato in 15 net houses during September 2008–March 2009 in Moga, Ropar, and Sangrur districts of Punjab state, India. Five net houses with the 40-mesh size were designated for each crop and the major pests were monitored on the target crops at monthly intervals from transplanting to final harvest.

Aphid

For each observation, 20 fully expanded leaves in sweet pepper were selected at random across all plants in each net house and given an aphid (*Aphis gossypii* Glover) infestation score using the trinomial sampling scale: 0, no aphids present; 1, 1-10 aphids; and 2, 11 or more aphids (Kohler and St. Clair, 2005). Aphid counts in tomato and cucumber crops were recorded from three leaves (one each from top, middle, and bottom strata) in a plant.

Whitefly

For each observation, the number of whitefly (*Bemisia tabaci* Gennadius) adults was recorded from three selected leaves (one each from top, middle, and bottom strata) in a plant.

Thrips

Thrips (*Scirtothrips dorsalis* Hood) infestation was visually rated based on damage symptoms, using a scale from 0 (no symptoms) to 5 (plants with no leaves and only stem remaining) (Kumar *et al*., 1996).

Leaf miner and tobacco caterpillar

Leaf miner (*Liriomyza trifolii* Burgess*)* damage was estimated as percent mined leaves (number of mined leaves x 100/total number of leaves). Similarly, tobacco caterpillar (*Spodoptera litura* Fabricius) damage was estimated as percent damaged plants in each plot.

Mites

Broad mite (*Polyphagotarsonemus latus* Banks) and red spider mite (*Tetranychus urticae* Koch) damage were assessed using a scale of 0 (no symptom on any leaf) to 5 (heavy necrosis of growing points and defoliation of infested plants for broad mite and severe necrosis and defoliation for red spider mite) (AVRDC, 1997).

Except for aphids on sweet pepper, all the insect counts and damage scoring were done on 10 randomly selected plants in each plot.

Root-knot nematode

Soil samples were taken at monthly intervals from 5-10 spots chosen at random in a zig-zag manner from planting to final harvest in each net house. These samples were processed by Cobb's decantation and sieving method and were observed for root-knot nematode *Meloidogyne incognita* (Kofoid & White) Chitwood populations.

Besides surveying the pests on the target crops under net-house conditions, the general pesticide use in the net-house production systems was also recorded.

RESULTS AND DISCUSSION

The net house cultivation has been adopted by growers with the objective of preventing damage by insect pests. However, many growers still face the problems of insect pests especially sucking pests, inside net houses.

Cucumber

Pest Status

Cucumber is grown during September to January under net-house conditions in Punjab. The red spider mite was the predominant pest of cucumber under net house conditions in Punjab. The mean damage rating was higher in October (1.21), followed by November (0.82) (Fig. 1). The leaf miner incidence was considerably lower, as the infested leaves accounted to only 0.71 percent in October and there was no subsequent incidence of leaf miner. Whitefly incidence was noticed early in the season soon after transplanting the crop. It was 0.19 whitefly adults per leaf in September and increased to 0.26 adults per leaf in October. However, it was not observed during the later growth stages (Fig. 1). Although tobacco caterpillar was present, the damage was lower, recording 4.48 percent and 5.40 percent incidences in October and November, respectively (Fig. 4). The root-knot nematode population was not recorded in the soil samples collected at the time of transplanting in September. However, it gradually increased in

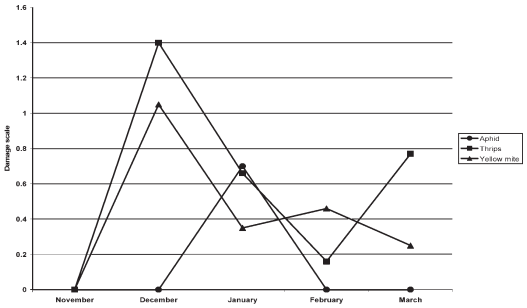

Fig. 1 : Incidence of whitefly, leaf miner and red spider mite on cucumber

October (70 larvae/250 ml soil sample) and attained a maximum of 153 larvae/250 ml soil sample in November. The population was slightly reduced (125 larvae/250 ml soil sample) in December (Fig. 5).

Pesticide Spray Status

Some farmers fumigated net houses with dichlorvas (Nuvan® 76 SL) at the rate of 1 ml/l during sowing of cucumber. In general, farmers gave two prophylactic sprays of thiamethoxam (Actara® 25 WG) at the rate of 60-100 g per acre or imidacloprid (Confidor® 17.8 SL) at the rate of 0.60 ml/l to control sucking pests such as aphid and whitefly in net houses. Dicofol 18.5 EC was applied at the rate of 3.3 ml/l by some farmers to control red spider mite infestation. For root-knot nematode, farmers applied phorate (Thimet® 10 G) before sowing.

Sweet pepper

Pest Status

Most of the net houses were empty during the peak summer months (June to August) and the crops were transplanted in September. Thrips were the predominant pests of sweet pepper under net house conditions in Punjab. The damage rating was higher in December (1.40) and gradually declined to 0.16 in February through January (0.66). However, the damage rating again increased in March (0.77) (Fig. 2). Broad

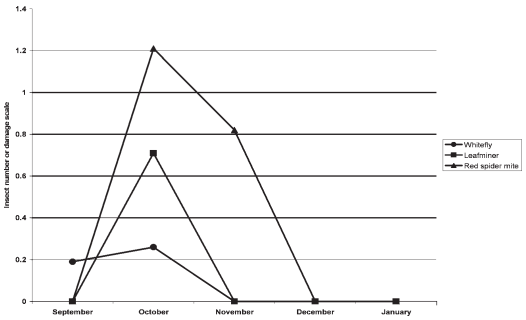

Fig. 2 : Incidence of aphid, thrips and yellow mite on sweet pepper.

mite was another serious pest on sweet pepper. The damage rating was higher in December (1.05) and sharply declined in January (0.35), February (0.46), and March (0.25). Slight infestation rating (0.70) of aphid occurred in January. Tobacco caterpillar occurred in higher incidences during the later growth stages, with 23.75 percent

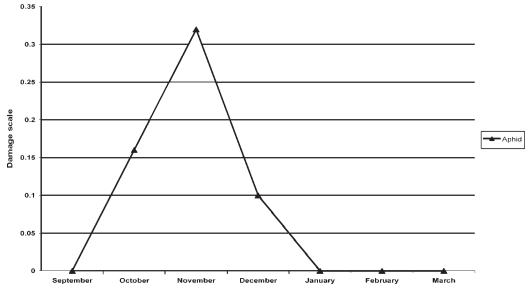

Fig. 3 : Incidence of aphid on tomato

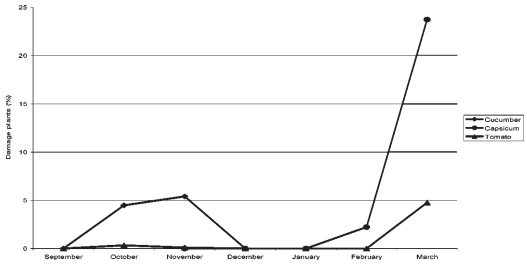

Fig. 4 : Infested plants of tobacco caterpillar in cucumber, capsicum and tomato

damage in March (Fig. 4). The root-knot nematode also gradually increased in later stages recording 74, 135, and 233 larvae/250 ml soil sample in January, February and March, respectively (Fig. 5).

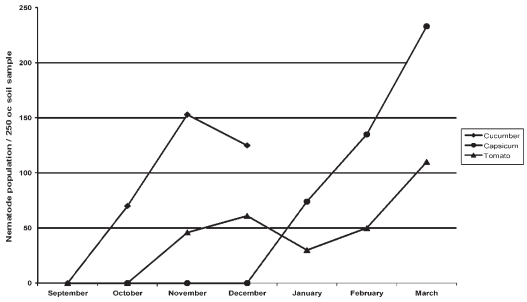

Fig. 5 : Incidence of root knot nematode on cucumber, capsicum and tomato crops.

Pesticide Spray Status

Three to four sprays of imidacloprid (Confidor® 17.8 SL) at the rate of 0.50-0.85 ml/l were given by farmers to control sucking pests such as aphid, whitefly, thrips, and mites. Some farmers also drenched the net house soil with chlorpyriphos 20 EC at the rate of 2 l/acre, two days prior to transplanting.

Tomato

Pest Status

Aphid was the only insect found on tomato during early crop stages under net house conditions in Punjab. The damage began in

October (0.16 aphids/leaf) and doubled in November (0.32 aphids/leaf); subsequently, it declined to 0.10 aphids/leaf in December (Fig. 3). The incidence of whitefly was nil. Slight infestation of tobacco caterpillar was noticed in October (0.34%) and November (0.10%), and it was completely absent from December to February, before causing the maximum damage (4.76%) in March (Fig. 4). The root-knot nematode population averaged about 30 to 61 larvae/250 ml soil sample during November to February. However, it suddenly increased to 110 larvae/250 ml soil sample in March (Fig. 5).

Pesticide Spray Status

One to four sprays of different insecticides such as imidacloprid (Confidor® 17.8 SL) at the rate of 0.80-1.25 ml/l, thiamethoxam (Actara® 25 WG) at the rate of 50-100 g/acre, dimethoate (Rogor® 30 EC) at the rate of 2.0-7.0 ml/l, and acetamiprid (Pride® 20 SP) at the rate of 30 g/acre were used by farmers for the control of sucking pests such as aphid and whitefly. Some farmers also sprayed one spray of endosulfan (Thiodan® 35 EC) at the rate of 160 ml/acre or chlorpyriphos 20 EC at the rate of 3.30 ml/l to control tobacco caterpillar infestation. Some farmers drenched soil with chlorpyriphos 20 EC at the rate of 2 l/acre, two days prior to transplanting.

There are no monitoring studies on the occurrence of pests on vegetables grown in net house conditions in Punjab. However, some literature has shown the occurrence of certain pests while growing tomato and sweet pepper inside net houses. Cheema *et al*. (2004) recorded tomato fruit damage by tobacco caterpillar ranging from 3.00 to 9.64 percent in net houses in Ludhiana, Punjab. They also observed slight incidences of whitefly and aphid, but not leaf miner, thrips, and mite. Our study also confirmed the occurrence of aphid and whitefly on tomato. Slight incidence of tobacco caterpillar (0.14–0.63 larvae/plant) was recorded in sweet pepper and the fruit damage ranged between 2.08–8.55 percent. Lower incidences of broad mite (0.08-0.27/plant), whitefly (0.42-0.60/leaf), and aphids (0.32-1.46/leaf) also were reported (Singh *et al*., 2004).

It is assumed that the major entry point for aphid, whitefly, thrips, and mites is through the nylon net. Most net houses were built with 40-mesh netting (Sidhu and Dhatt, 2007; Sethi *et al*., 2009). The 40-mesh or coarser mesh nets failed to exclude 100 percent of the thrips, whitefly, and aphid in several countries (Talekar *et al*., 2003; Harmanto, 2006). The most promising way to prevent the entry of small-sized insects and mites in net houses is to use nets with finer mesh. Nets with 50-mesh or 60-mesh nets to exclude thrips, whitefly, and aphids have been suggested (Polston and Lapidot, 2007; Shahak *et al*., 2008; Palada and Wu, 2009). Although coarser mesh nets (32-mesh, 40-mesh) do not allow the entry of bigger insects like tobacco caterpillar, about 5 percent damage in cucumber and tomato, and a maximum of 23.75 percent damage in sweet pepper were noticed. The infestation of tobacco caterpillar inside net houses has also been reported in Taiwan. Female moths of this pest lay eggs in small batches on the top of the net house, and when the tiny larvae hatch, they drop through the holes onto the crop inside the net house (Talekar *et al*., 2003). Poorly designed or constructed net houses may be unstable during strong winds or storms; netting can tear, allowing the insects to enter the net house. There is a need for better quality nets and improved stitching methods to keep net houses intact for a longer period of time. Growers must be educated to monitor the integrity of the netting at regular intervals. The door is another possible entry point for pests. Most net houses have only one door, which allows easy entry of insects when growers open the door or when gaps develop between the door panel and soil surface. Sometimes these doors are kept halfway or fully open while farmers are inside. Double doors, arranged at right angles to each other with two sliding panels, could reduce the entry of pests through doors (Talekar *et al*., 2003).

In the present survey, the lower incidence of sucking pests in the net houses may not be the outcome of the protective structures, but rather the result of prophylactic pesticide applications. Since the growers are aware that

even low densities of whitefly, aphid, and thrips cannot easily be ignored due to their roles as vectors in transmitting viral diseases of cucumber, sweet pepper and tomato, they use pesticides to keep the pests in check. However, it has become clear that red spider mite, leaf miner, and whitefly on cucumber; thrips, broad mite, and aphid on sweet pepper; and aphid and whitefly on tomato are the small-sized pests that could occur inside net houses in Punjab. Although the bigger sized hole in the coarser nylon net is assumed to be the major entry point for these sucking insects, it cannot be ruled out that the change in the microclimate inside the net-houses may also have contributed to their occurrences. For instance, Sethi and Dubey (2010) reported that the air temperature inside the conventional net-house was about 2.5°C to 3°C higher as compared to the open field conditions during winter months (December 01 to February 20) in Punjab. However, it was 8°C to 9°C higher in polyethylene (PE) covered (UV stabilized and 200 microns thickness) greenhouse as compared to the open field. It has already been shown that the whitefly (*B. tabaci*) developmental time greatly reduced with rise in temperatures. The adult to adult generation time of *B. tabaci* (biotype B) on sweet pepper was 49 days at 17°C, whereas it was only 18 days at 33°C (Muniz and Nombela, 2001). Stavrinides *et al*. (2010) proved that the leaf temperature in vineyards increased by 0.8°C for every 1.0°C increase in ambient air temperature, and peak population densities of Pacific spider mite, *T. pacificus*, increased significantly with increasing frequency of leaf temperatures above 31°C. According to Sethi and Dubey (2010), plant temperature for eggplant in the open field was 20°C to 23°C as compared to 22°C to 25°C inside the conventional net-house during spring season in Punjab. Whereas, it was around 28°C to 29°C inside the PE covered greenhouse. Thus, the changes in the microclimate of the plants grown inside the net-house could also contribute towards the high incidences of insect pests, especially sucking insects.

None to negligible root-knot nematode (RKN) population incidence was recorded at the beginning of the growing season in most of the net houses surveyed. However, the population increased substantially during the season. This may be due to the presence of nematodes in inactive stages, such as eggs in the soil during the absence of host crops, as most of the net houses surveyed were empty during the hot summer months (June–July). Nematode populations decreased during December and January, but began increasing from the end of February onward, as this survey documents. Sweet pepper was affected more severely by root-knot nematodes than cucumber or tomato. Although this seems to contrast with the findings of Sharma *et al*. (2007), who reported that sweet pepper was least damaged by nematodes while tomato and cucumber were the most severely affected, cucumber was monitored only up to December until its final harvest, whereas tomato and sweet pepper were monitored until March in our study. Hence, cucumber may have recorded more RKN population if it was grown during the spring season (February – March) due to increasing temperature.

Root-knot nematode was not reported earlier in net house production systems. However, we found significantly high populations in cucumber, sweet pepper, and tomato in the current study. Once established, nematodes are very difficult to control because they may persist in the soil for a longer period inside the net houses. Precautionary measures should be taken well in advance to prevent the entry of nematodes inside the net house, since plant parasitic nematodes (*Meloidogyne* spp.), are the most destructive and difficult to control in protective cultivation systems (Sharma *et al*., 2007). They may enter the net house through infected nursery seedlings, irrigation water, farm implements used in infested fields, etc.

This study reports the occurrence of small-sized sucking pests such as aphid, leaf miner, thrips, whitefly, mites and bigger lepidopterans

such as tobacco caterpillar, besides root-knot nematode on cucumber, sweet pepper, and tomato inside net houses in the Punjab state, India. The size of the nylon net used to construct the net houses may be the major factor responsible for primary pest entry, although holes in torn nets, negligence on the part of growers to keep doors closed, and seedlings produced in open/infested soils may serve as secondary entry points. Net house structures should be improved with high quality nets and better methods of construction. Besides, the microclimate with high temperature and humidity inside net houses also provides a congenial environment for faster multiplication of pests like thrips, aphids, whitefly and mites. Growers need to be educated in managing the net houses properly to realize the full potential of net houses for producing safer vegetables. In addition, proper integrated pest management (IPM) strategies should be in place to manage pests like tobacco caterpillar inside the net houses.

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