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Study of protected v/s open field conditions on insect-pest incidence to minimize insecticide application for quality production of high value horticultural crops

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ABSTRACT

An experiment comprised of three crops like tomato (Naveen variety), capsicum (Bharat variety) and strawberry (Chandler variety) on insect-pest incidence under open field and polyhouse conditions, was conducted at Centre for Protected Cultivation Technology (CPCT), IARI, New Delhi, during 2006-2010 (four seasons). The result reveled that the minimum incidence of insect-pest, plant mortality from affected insect vectors and spraying of insecticide were observed under polyhouse condition as compared to open field condition. However, un-marketable (insect affected) fruits were almost nil under polyhouse condition as compared to open fild condition. The marketable fruits (free from insect-pest) production (kg/plant) and net income (Rs./plant) were found maximum under polyhouse as compared to open field condition in all crops during all the seasons. The reduction in yield and economic loss were found very high under open field crops in comparison of polyhouse cultivation in all seasons. It was concluded that cultivation of highly insect-pest susceptible vegetable and fruits crops inside polyhouse is beneficial. Cultivation under polyhouse was thus observed to be a better technique of IPM.

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INTRODUCTION

Integrated pest management (IPM) approach, is the best combination of various pest control options such as cultural practices, biological control agents, and use of chemical spray. Integrated pest management through conventional techniques has often been found to be difficult under intensive and exploitative practices of vegetable production. This system was developed out of the need for the sustainable crop production strategy against the background of increasing pesticide use and deleterious effect of residues on the environment.

Greenhouse (polyhouse) is a framed or inflated structure covered with a transparent or translucent materials, in which crop could be grown under the condition of at least partially controlled environment and which is large enough to permit a person to carry out cultural operations. Polyhouses protect the growing crops against the insect- pest and diseases (biotic stress) and thus improve the fruit quality and increase the production and productivity per unit area/unit time. Thus, polyhouses could be considered to fit into the role of IPM, which provides an acceptable and affordable basis for pest control.

In the case of open field cultivation, more often, farmers apply insecticides after the devastation by the pest, thus losing the crop yield as well as money spent on insecticide application. Therefore, timely application of insecticides is essential with appropriate selection of chemicals, especially when resistance to insecticide is low. Insecticide application should be done only when population of the insect has reached the threshold level, which may cause economic loss. In contrast, polyhouse cultivation is inherently free from these problems.

Vegetable cultivation plays an important role fitting into the traditional cropping system to make it more remunerative.

Small and marginal farmers can earn more from limited holding by intensive vegetable cultivation. After the green revolution period, India has achieved sustainable growth in vegetable production and ranks next to China in overall production. But the vegetables are highly susceptible to insects (white fly, mites, aphid and house fly, fruit fly, borers, cutworm, hoppers and beetle) attack, which causes loss in 30 - 40 per cent vegetables yield (Satparthy *et al.,* 1998 and Singh, 1998).

Tomato, capsicum and strawberry are the most important, high value, commercial vegetable and fruit crops. The demand in the country is increasing day by day with increasing population. These vegetable and fruits are consumed not only in fresh form but are also used as processed products such as soup, ketchup, squash, pickles, chatani, jam, ice-cream etc. These crops have very good export potential witch may fetch enough foreign exchange. However, very limited information (Singh *et al.,* 2001 and Pant *et al.,* 2001) is available on cultivation of these crops under polyhouse condition. Therefore, an attempt has been made in the present study to find out the suitability of tomato, capsicum and strawberry cultivation under polyhouse condition that minimizes insect vector and insecticide as compared to open field cultivation.

About one dozen insect-pests attacking in tomato, capsicum and strawberry crops, are most serious, capable of causing 60 - 70 per cent damage to the fruits of Solonaseous vegetable crops (Lal, 1964). The foliage pest namely, jassids, beetles, mites, white fly and aphid can be easily controlled with pesticides, of course with their usual adverse effect. But it is difficult to control the borer and birds even with insecticides. The desirabity of controlling these insect-pests under adopting pest management techniques thus be emphasized. The work carried out at the CPCT, IARI, New Delhi (INDIA) for 4 years on the management of these pests, polyhouse condition is reported in this article.

MATERIALS AND METHODS

Trials were conducted at CPCT, IARI, New Delhi during 2006 - 2007, 2007 -2008, 2008 - 2009 and 2009- 2010 (four season) under open field and polyhouse conditions. The crops included were tomato (Naveen variety), Capsicum (Bharat variety) and Strawberry (Chandler variety). Nursery was raised in first week of October and transplanting was done after 20 - 30 days of seedlings. The tomato, capsicum and strawberry were transplanted in November first week at the spacing of 60x60cm, 60x30 cm and 30x20 cm, respectively in both conditions. Experiment was carried out in Randomized Block Design with three replications and 10 plots of sizes 2.4 x 1.8m, 2.4 x 1.2m, 1.2X1m were used for tomato, capsicum and strawberry, in each replication under 23 x 22 and 15 x 5m^2 size of polyhouse, respectively. Soil was sandy loam having pH range 6 - 7.5. Irrigation was given by flood technique. Manuring (300 q/ha) as done using FYM before 15 days of planting for all crops. A basal dose of phosphorus and potash was given at 200 and 250 kg/ha, respectively for tomato and capsicum and at 20 and 25 kg/ha, respectively for strawberry. Nitrogen application was done as top dressing (3 - 4 times) after transplanting at the rate of 300 kg/ha for tomato and capsicum and 15 kg/ha for strawberry. Necessary cultural operations were provided to the crops; 100-micron thick black polyethylene was used for mulching in case of strawberry crop in both conditions. Data were recorded on insect-pest affected plants per plot per replication throughout the growth phase to fruiting phase in each crop. Some of the IPM methods like late planting, training-pruning, cleaning and spray of insecticide were given under both conditions. Identification of causal disease and insect-pest incidence and damage were recorded under laboratory condition

RESULTS AND DISCUSSION

All the crops like tomato, capsicum and strawberry showed varying incidence of insect-pest on plant growing environment under open field and polyhouse conditions. Data pertaining to the parameter under study have been presented in Tables 1, 2 and 3 during 2006-2010 (four seasons).

The overall view of the result with respect to the performance of different high value vegetable and fruits crops with regard to the damage from fruits borer, jassids, beetle mites, aphid and white fly and their insect free marketable fruits yields under open and polyhouse conditions were brought to the light in the following points.

Insect-pest incidence:

The incidence of insect –pest per plant was found minimum under polyhous condition and in maximum in open field condition of tomato, capsicum and strawberry (Table 2). The open field crop has no barriers of insect-pest entry, so attack in open field crop is quite possible according to environmental conditions. However, polyhouse has physical barrier of insect –pest.

Plants mortality:

The plant mortality was observed as 2.20, 2.50 and 2.020 per cent, respectively for tomato capsicum and strawberry under polyhouse as compared to 45.50, 42.70 and 35.80 per cent under open field cultivation during all seasons of experimentation. Higher plant mortality in open field condition was due to maximum insect pest entry (Table 2). These insect - pest damage plant in various ways which could be described as:

– The insect vectors like white fly (*Bemisia tabaci*, Thrips (*Scrtothrips dorsalis*) and Mites (*Polyphagotarsonemus latus*) transmit virus and increase leaf curl and mosaic viral diseases in plants showing downward

curling of the leaves and excessive branching. This leads to stunted growth of plant in several cases and plants remain unfruitful.

– These insect vectors suck the sap from the ventral surface of the leaves and exudation of honeydew of the pests favour the development of sooty mould that inhibits photosynthesis in plants.

– Grubs and nymphs of these and others insects-pest like, aphid (*Peach green aphid*), beetle (*Epilachana vigintioctopunctata*), and mealy bug (*Ferrisia virgata*) cause tremendous damage to plant, scrap green tissue of the leaves and feed on leaves, secrete honeydew on which sooty mould develops, which hinders the photosynthetic activity of the plant. Young nymphs puncture the epidermis of the succulent spots of the plant, inject their toxic saliva and start sucking the cell sap and thereby devitalise the plant. Various disease causing fungi and bacteria also enter the plant body through these injuries, and thereby increase the plant mortality, under open field condition, However, under polyhouse condition, for there is an inherent barrier for the insect pest entry, so there is no effect of disease on plant. Similar findings were obtained by Singh (1998) and Sathpaphty *et al.* (1998).

Un-marketable fruits:

Percentage of un-marketable or poor quality fruits obtained was almost nil under polyhouse condition whereas in open field condition, it was 42.50, 35.50 and 32.30 per cent, respectively for tomato, capsicum and strawberry (Table 1). This was because of maximum insect pest entry of the fruit borer in tomato; beetle, weevil and maggot in capsicum and strawberry under field conditions. Besides, the fruits were highly affected by birds under open field condition. However, polyhouse completely checked these type of insect-pest and birds entries. A similar observation has been reported by Hazara and Some (1999) and Sharma and Yamdagni (2000).

Marketable fruits:

The marketable fruit yield was found more 3.75, 2.30 and 0.300 kg/plant under polyhouse condition compared to open field condition 1.55, 1.12 and 0.110 kg/plant in respect of tomato, capsicum and strawberry, respectively during all the seasons. This too was due to maximum incidence of insect

Table 1: Schedules of insecticide application and crop period under open and polyhouse condition

Crops	Four season pooled practices, during 2006-10				
	Crops periods		Insecticide spray	Number and date of spraying	
	Open side	Polyhouse side	@ 0.2,0.5 -1ml/litre of water	Open field	Polyhouse
Tomato	First week of November to first week of May (180days)	First week of November to firs week of June (210 days)	Neemgourd Neemgold Malathion Endosulphan, Phosphomidon Rogor Monocrotophas	12 November, 28November, 24 December, 11 January, 17 February 20 march, 12 April and 22 April (Total sprays = 8)	25 November, 15 January, 23 February and 20 April, (Total sprays = 4)
Capsicum	First week of November to Firs week of May (180days)	First week of November to firs week of June (210 days)	Neemgourd Neemgold Malathion Endosulphan, Phosphomidon Rogor Monocrotophas Dicofol	12 November, 28 November, 24December, 11 January, 27January, 17 February, 28 February 20 March, and 15 April (Total sprays = 9)	25 November, 15 January, 23 February and 20April (Total sprays = 4)
Strawberry	First week of November to First week of March (115 days)	First week of November to Second week of April (160 days)	Neemgourd Neemgold Malathion Endosulphan, Phosphomidon Rogor Monocrotophas Dicofol	25 November, 24 December 19 January, 17 February, (Total sprays = 4)	25 November and 15 February (Total sprays = 2)

Table 2 : Name and Incidence of insect- pest on high value vegetable and fruits crops under open field and polyhouse conditions

Crops	Four season pooled practices, during 2006-2010				
	Name of Insect-pest	Incidence of Insects - pests per plant and No. of Insecticide sprain with IPM practices			
		Open field condition	Polyhouse condition	No. of spray of insecticide in open field condition	No. of spray of insecticide in polyhouse condition
Tomato	White fly (*Bemisia tabac*i)	20.50	0.66	8	3
	Aphid (*Aphis gossyp*ii)	25.60	0.83		
	Beetle (*Epilachana vigintioctopunctata*)	17.40	0.33		
	Mealy bug (*Ferrisia virgata*)	15.50	0.00		
	Fruit borer (*Helicoverpa armigera*)	5.60	0.00		
	Birds (crow, peacock etc.)	**	0.00		
Capsicum	White fly (*Bemisia tabac*i)	25.50	0.33	9	3
	Aphid (*Aphis gossyp*ii)	35.30	0.66		
	Mites (*Polyphagotarsonemus latus*)	25.60	0.33		
	Thrips (*Scirtothrips dorsalis*)	11.30	0.83		
	Beetle (*Longitarsus nigripennis*)	15.50	0.33		
	Paper maggot (*Spilographa electa*)	5.50	0.00		
Strawberry	Aphid (*Myzas ascalonicus*)	25.20	0.66	6	2
	Mites (*Steneotarsonemus fragariae*)	15.50	0.33		
	Beetle (*Harpalus rufipes*)	11.50	0.66		
	Thrips (*Thrips atratus*)	5.40	0.33		
	Leaf Roller (*Ctenopsenstis obliquana*)	3.70	0.00		
	Birds (crow, peacock etc.)	**	0.00		

**- Although no exact count of birds was made, however, there was distinct damage in the field.

Table 3 : Effect of insect- pest incidence on high value vegetable and fruits crops under open field and polyhouse condition

Name of the experimental crops	Four years pooled data during 2006 - 2010									
	Open field condition				Polyhouse condition				Yield loss (%) in open field compared to polyhouse condition	Economic loss (%) in open field compared to polyhouse condition
	% of plant mortality- or incidence of disease (%)	% of un-marketable fruits	Marketable yield (Kg/plant)	Net income (Rs./ plant)	% of plant mortality- or incidence of disease (%)	% of un-marketable fruits	Marketable yield (kg/plant)	Net income (Rs./ plant)		
Tomato	45.50	42.50	1.55	4.75	2.2	0.00	3.75	15.75	58.66	69.84
SD (±)	± 0.910	± 0.425	± 0.007	± 0.047	± 0.015	± 0.00	± 0.037	± 0.315	±7.18	± 2.096
Capsicum	42.70	35.50	1.12	4.10	2.5	0.00	2.30	16.53	51.30	75.19
SD (±)	± 0.854	± 0.710	± 0.005	± 0.033	± 0.033	± 0.00	± 0.037	± 0.093	±1.530	± 2.556
Strawberry	35.80	32.30	0.110	1.40	2.02	0.00	0.300	7.0	63.00	80.00
SD (±)	± 0.646	± 0.404	± 0.001	± 0.007	± 0.002	± 0.00	± 0.003	± 0.049	±1.89	± 2.800

The average selling price of four years = Rs.5/kg tomato, Rs. 8.5/kg. capsicum and Rs.40/kg strawberry for marketable fruits.
The average cost of cultivation of four years = Rs. 1.5/ plant tomato and capsicum, but Rs..3/plant strawberry for open field condition.
The average cost of cultivation of four years = Rs. 3/ plant tomato and capsicum, but strawberry Rs. 5./plant for polyhouse condition

pest and birds under open field condition. However, cultivation under polyhouse also protects and checks the damage caused by insect pest and birds. A similar finding was given by Singh *et al.* (2001), Hazara and Some (1999) and Sharma and Yamdagni (2000).

Yield and economic loss:

Table 3 revels that there was a loss of 58.66, 51.30 and 63.00 per cent of fruit yield in tomato, capsicum and strawberry in open field condition compared to polyhouse condition, whereas in terms of economic loss there was 69.84, 75.19 and 80.00 per cent saving in yield which is due to its protective structure that checks the entry of insect-pest, leading to minimum mortality of plant and have less degradation of fruits quality and economic loss. Singh *et al.* (2001), Singh (1998) and Sathpaphty *et al.* (1998) also reported similar finding.

Table 4 : Effect of insect pest incidence on high value vegetables and fruit crop under open field and polyhouse conditions

Four year pooled data during 2006-2010

Crop	Insect pest	Open field condition						Polyhouse condition						Yield loss (%) in open field as compared to polyhouse condition	Economic loss (%) in open field as compared to polyhouse condition
		No. of insect pest / plant	No. of spraying of insecticide	Plant mortality (%)	Un marketable fruits (%)	Marketable yield (kg/ plant)	Net income (Rs/ plant)	No. of insect pest / Plant	No. of spraying of insecticide	Plant mortality (%)	Un marketable fruits (%)	Marketable yield (kg/ plant)	Net income (Rs/ plant)		
Tomato	White fly	20.50	8	45.5	42.50	1.55	4.75	0.66	3	2.20	0.00	3.75	15.75	58.66	69.84
	Aphid	25.60						0.83							
	Beetle	17.40						0.33							
	Mealy bug	15.50						0.00							
	Fruit borers	5.60						0.00							
	Birds	**						0.00							
Capsicum	White fly	25.50	9	42.70	35.50	1.12	4.10	0.33	3	2.50	0.00	2.30	16.53	51.30	75.19
	Aphid	35.30						0.66							
	Mites	25.60						0.33							
	Thrips	11.30						0.83							
	Beetle	15.50						0.33							
	Paper maggot	5.50						0.00							
Strawberry	Aphid	25.20	6	35.80	32.30	0.110	1.40	0.66	2	2.02	0.00	0.300	7.0	63.00	80.00
	Mites	15.50						0.33							
	Beetles	11.50						0.66							
	Thrips	5.40						0.33							
	Leaf Rollers	3.70						0.00							
	Birds	**						0.00							
Cucumber	Red pumpkin beetle	4.60	8	35.70	63.50	1.35	3.05	0.00	3	3.20	0.00	2.85	7.55	52.63	59.60
	Mites	25.30						0.66							
	White fly	18.40						0.33							
	Aphid	26.30						0.86							
	Fruit fly	2.70						0.00							
Summer Squash	Red pumpkin beetle	4.70	7	32.50	55.70	1.48	1.96	0.16	3	2.50	0.00	2.72	4.44	49.59	55.86
	Mites	25.50						0.66							
	White fly	15.40						0.66							
	Aphid	27.80						0.83							
	Fruit fly	3.70						0.00							
Okra	Whit fly	28.50	8	38.30	35.50	0.215	0.145	1.16		3.50	0.00	0.455	0.865	52.75	83.23
	Mites	24.70						0.83							
	Aphid	28.80						1.17	3						
	Leaf hopper	4.50						0.00							
	Shoot and fruit borer	6.60						0.00							

* Although no exact count of birds was made, however, there was distinct damage in the field.

It was concluded that cultivation of highly insect-pest susceptible vegetable and fruits crops inside polyhouse is highly beneficial.

Minimize insecticide:

The results showed that maximum application of insecticidal spray *i.e.* in total 8, 9 and 6 sprays were in tomato, capsicum and strawberry, respectively under open field. However, 3, 3 and 2 insecticides sprays were done in polyhouse condition during all the seasons (Table 2). Due to the fact that maximum incidence of insect-pests (above % of threshold level) under open field condition, so more number of sprayings of insecticides was done to achieve the higher production and at the same time polyhouse acts as physical barrier for the entry of the insects and hence IPM plays a key role under protected cultivation.

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