

Integrated pest management: A brief review

¹ Vinoy Krishna, ² Rupa Upadhyay, ³ Ritu Pandey, ⁴ NityNishant, ^{*5} Rajneesh Dwevedi

^{1, 2, 5} Department of Science, Lady Irwin College (University of Delhi), New Delhi, India

³ Department of Botany, SGTB Khalsa College (University of Delhi), Delhi, India

⁴ Department of Home Science, Lady Irwin College (University of Delhi), New Delhi, India

Corresponding Author:

Rajneesh Dwevedi

Email: rajneesh.conservation@gmail.com

Abstract

Regulating agriculture in a highly populous nation like India presents twin challenges before the policy makers. Increasing productivity without damaging the environment is a target that would require management strategies to serve the twin goals. Pests are major nuisance responsible for huge crop wastage in India. The chemical pesticides on the other hand are responsible for toxicity of the vegetable and fruit produce, negatively impacting the environment as well. This paper deals with the Integrated pest management strategies that are used to make the agricultural practices more productive and environmentally sustainable at the same time.

Keywords: Pesticide, Pest management

1. Introduction

In a country like India, agriculture is a major source of livelihood. India is fortunate to have varied climatic conditions, which enable us to grow a large number of crops of economic importance. Indian agriculture in general has seen various phases like conventional agriculture, mixed agriculture and specialized or advanced agriculture. It has seen "Green Revolution" which changed the whole scenario of agricultural practices. With the result, India achieved not only self-sufficiency in food crops but started exporting the food commodities also. Introduction of high yielding varieties especially hybrids have on one side increased the production many times on the other hand it has resulted in drastic changes in existing pest scenario. In order to reduce yield losses due to pests, farmers go for calendar based chemical sprays instead of need based applications of pesticides, which leads to pesticide residue. It is a major constraint in export potential of vegetables. Sometimes farmers use excess amount of fertilizers and continue using banned pesticides, which also results into soil and air pollution. Indiscriminate use of pesticides has resulted on one hand in the development of resistance to pests and on the other hand posed problems of health to human beings and environmental contamination.

The use of agrochemicals in the form of pesticides is inseparable from modern agriculture. They provide the most effective solutions to control the insects, weeds, fungi, nematodes etc. Since vegetables are perishable in nature, more amounts of pesticides are sprayed.

In the decade of 1990s because of liberalized trade policy the world became a global market and multinational companies started playing a greater role in Indian seed industry. So it has become very important to study pest

problems and pest risk assessment in changing environment of cropping system and global market. Reliance on pesticides is not desirable in the present scenario of global agriculture. Hence in order to minimize the chemical residues and save our environment, there is a need to develop Integrated Pest Management approaches in vegetable crops.

After the development of concept of pest management, several phases came and it has evolved to IPM. According to Hffaker, (1980) ^[9], in Integrated Pest Management (IPM) several components of control methods are blended in a compatible manner so that the population of pests are maintained below the economic injury levels. It represents an ecologically sound approach to insect pest control (Metcalf and Luckman, 1975; Smith and Pimental, 1978) ^[22, 33]. IPM is a system approach, which is location and crop specific so knowledge of pest problems, their economic status, surveillance and forecasting the related issues are very important for the development of IPM in major vegetable crops like tomato, okra, egg plant, cucurbits, cole crops, root crops, beans etc. The major insects, pathogens and nematodes are to be managed by developing IPM strategies which may include various activities e.g. habitat, socio economic factor, soil tillage, crop husbandry (timely sowing, spacing, selection of healthy seeds, application of balanced doses of fertilizers, sanitary and hygiene, harvesting at right stage, timely irrigation, application of biopesticides and application of chemical pesticides only as per need) etc. There is a need to have well developed plant protection programmes.

Constrains in adoption of IPM

- Diminishing productivity
- Market pressures
- Small landholdings
- Easy availability of pesticides

Factors responsible for success of IPM programmes

- Habitat analysis
- Conservation of beneficial organisms
- Monitoring of pests and their natural enemies

Pest management under IPM aims at protecting the plants providing good plant health and natural defence mechanism. This paper highlights important pests and the IPM strategies used for some common vegetable crops against them. Table 1 shows some important pests of the common vegetable crops.

Management of Pests

The population is increasing every minute and to feed the country and the world is becoming a challenge. At the same time effect of climate change on agriculture, especially the poor and marginal farmers is also visible. Climate change will also affect availability of land, water and biodiversity. In return it will affect food security and may cause a changed pest scenario.

Approximately 18% of the agricultural produce is lost due to pests. The Integrated Pest Management (IPM) can be considered as a sustainable approach for the management of pests by using an amalgamation of various methods like cultural, biological, mechanical and chemical in a way that minimizes economic, health and environmental risks. Table 2 reviews various strategies undertaken to minimize the damage in vegetable crops due to pests.

Table 1: List of key pests affecting common vegetable crops

S. No.	Vegetable Crops	Diseases/ Insects/ Nematodes	Scientific name of causal organism	Plant Injury
1	Bean	Anthracnose disease	<i>Colletotrichum lindemuthianum</i>	Black sunken cankers with light colour centres with the raised border on immature pods.
		Ashy stem blight	<i>Macrophomina phaseolina</i>	Black, sunken canker on seedlings.
		Powdery mildew	<i>Erysiphe polygoni</i>	White powder formation on the leaves, later on the stem and pods.
		Rust	<i>Uromyces appendiculatus</i>	Minute dark brown and slightly raised spots on lower surface of leaves.
		Leaf spot	<i>Cercospora cruenta</i>	Irregular water soaked lesions on older leaves.
		Bacterial blight	<i>Xanthomonas phaseoli</i>	Water soaked spots on leaves and leaves turn to brown colour.
		French bean common mosaic		Mottling of leaves and various types of malformations. It is transmitted by mechanical sap inoculation.
		French bean yellow mosaic		Appearance of bright yellow patches inter-spaced with green areas on leaves.
		Aphids	<i>Aphis craccivora</i>	Sucking of sap from tender parts of plant resulting in twisting of leaves.
		Jassids	<i>Empoasca fabae</i>	Sucking of sap resulting in yellowing and curling of leaves.
		Pod borer	<i>Heliothis armigera</i>	Appearance of holes on the pods.
		Bean weevil	<i>Bruchus sp.</i>	Storage pest.
2	Cruciferous	Hairy caterpillars	<i>Spilosoma obliqua</i>	Skeletonization of leaves.
		Alternaria fungus	<i>Alternaria brassicae</i>	Concentric dark leaf spot.
		Bacterial soft rot	<i>Erwinia carotovora</i>	Soft, slimy and bad smelling rot on affected plants.
		Club root	<i>Plasmidiophora brassicae</i>	Formation of galls on affected roots giving club like appearance.
		Downy mildew	<i>Pernospora parasitica</i>	Appearance of yellowish, irregular lesions with white downy growth on leaves.
		Damping off	<i>Pythium aphanidermatum</i>	Rotting at collar region of seedlings.
		Black leg	<i>Phoma lingam</i>	Light brown lesions on stem followed by wilting of plant
		Cabbage yellows	<i>Fusarium sp.</i>	Yellowing and falling of leaves
		Cauliflower/ cabbage mosaic virus		Yellowing and falling of leaves
		Radish mosaic virus		Small circular to irregular chlorotic lesions on leaves.
		Turnip yellow mosaic virus		Growth of affected plant gets stunted
		Cabbage aphid	<i>Brevicoryne brassicae</i>	Sap of leaves sucked, growth checked.
3	Cucurbits	Diamond back moth	<i>Plutella xylostella</i>	Holes in the leaves, leaves turn brown and fall down
		Anthracnose fungus	<i>Colletotrichum lagenarium</i>	Formation of reddish brown spots on leaves
		Blight	<i>Alternaria cucumerina</i>	Formation of reddish brown spots on leaves and concentric rings
		Collar rot	<i>Rhizoctonia sp.</i>	Formation of dark brown lesion at collar region.
		Fusarium wilt	<i>Fusarium sp.</i>	Initially tip burning of leaves but ultimately whole plant dies.
		Powdery mildew	<i>Erysiphe sp.</i>	White powder formation on leaves, stem and other succulent parts of the plant
Downy mildew	<i>Pseudoperonospora cubensis</i>	Appearance of small water soaked lesions on leaves later greyish downy growth on lower surface of leaves		

		Fruit rot	<i>Pythium aphanidermatum</i>	Water soaked lesions in stem later rotting of fruits having direct contact with soil.
		Bacterial angular leaf spot	<i>Pseudomonas lachrymans</i>	Appearance of water soaked, angular white to brown lesions on leaves, stems and fruits.
		Cucumber mosaic virus		Yellow mottling of leaves and stunting of affected plants. Aphids act as vector for the transmission of this virus
		Pumpkin yellow vein mosaic virus		Yellowing of veins and stunting of affected plants. White fly acts as a vector for the transmission of this virus
		Cucurbit phyllody		Transformation of floral parts in to green leafy structures, stunted plant growth without the capacity to bear fruits.
		Aphids	<i>Aphis gossypii</i>	Sucking of sap from foliage and transmission of viral disease.
		Jassids	<i>Empoasca sp.</i>	Sucking of sap from foliage.
		Red pumpkin beetle	<i>Aulacophora foveicollis</i>	Holes in the cotyledonary leaves.
		Epilachna (Hadda) beetle	<i>Epilachna vigintioctopunctata</i>	Lace like appearance on the leaves ultimately falling of leaves.
Fruit fly	<i>Dacus cucurbitae</i>	Puncturing of tender fruits.		
4	Okra	Damping off	<i>Pythium sp.</i>	Rotting at collar region of seedlings
		Powdery mildew	<i>Erysiphe sp.</i>	White powder formation on both the surfaces of leaves
		Fusarium wilt	<i>Fusarium sp.</i>	Slight yellowing and wilting of foliage
		Leaf blight	<i>Cercospora abelmoschi</i>	Small to sooty black, angular spots on both the surfaces of leaves.
		Yellow vein mosaic virus		Yellowing of veins, infected plants remain stunted and bear very few, yellow coloured fruits
		Jassids	<i>Amrasca sp.</i>	Sucking of sap from foliage
		White fly	<i>Bemisia tabaci</i>	Sap of the tender parts of plants is sucked; it acts as a vector for the transmission of virus also.
		Root knot nematode	<i>Meloidogyne spp.</i>	Knot like swelling on roots, affected plants remains stunted and weak
5	Solanaceous	Early blight	<i>Alternaria solani</i>	Dark and leathery spots on leaves
		Powdery mildew	<i>Erysiphe sp.</i>	White powder formation on leaves
		Fruit rot	<i>Phytophthora spp.</i>	Brown spots at the point of contact between fruit and soil
		Damping off	<i>Rhizoctonia solani</i>	Rotting at collar region of seedlings.
		Fusarium wilt	<i>Fusarium sp.</i>	Slight yellowing and wilting of foliage.
		Phomopsis blight	<i>Phomopsis vexans</i>	Small circular spots on leaves, affected leaves turn yellowish and die.
		Leaf curl virus		Curling and crowding of leaves.
		Tobacco mosaic virus		Mottling of leaves.
		Mycoplasma		Formation of little leaf, stunting of plant growth, plants give rosette like appearance
		Epilachna (Hadda) beetle	<i>Epilachna vigintioctopunctata</i>	Translucent like appearance of leaves
		Jassids	<i>Amrasca sp.</i>	Sucking of sap from foliage, plants become pale and ultimately bronze. Responsible for the transmission of little leaf disease.
		Fruit borer	<i>Heliothis armigera</i>	Circular holes are formed in fruits
		White fly	<i>Bemisia tabaci</i>	Sap of the tender parts of plants is sucked, It leads to yellowing and curling of leaves, it acts as a vector for the transmission of virus also.
Root knot nematodes	<i>Meloidogyne sp.</i>	Knot like swelling on roots, affected plants remains stunted and weak.		

Table 2: IPM strategies used in common vegetable crops

S. No.	Vegetables	Pests	Strategies	Reference
1	Brinjal	<i>Henosepilachna vigintioctopunctata</i>	<i>Pediobius foveolatus</i>	Jayanthi and Jessudasan 2000.
		Shoot and fruits borer	Inter-cropping- two rows of coriander	Dhandapani <i>et al</i> 2003.
		<i>L. Orbonalis</i>	Natural enemies - <i>Peristomerus testaceus</i> , <i>Eriborus argentiopilosus</i> , <i>Bracon chinensis</i>	Dhandapani <i>et al</i> 2003.
		Grubs of leaf beetle and adults of weevils	Neem Azal F 1ml/ lit	Kumar and Babu 1999.
		<i>Borers</i>	Neem cake 4 times during crop growth	Sreenivasamurthy <i>et al</i> 2002
		<i>Henosepilachna vigintioctopunctata</i>	Plant extract- <i>Annona squamosal</i> , <i>Agemone Americana</i> , <i>Calotropis gigantea</i>	Bannerji <i>et al.</i> 1985
		Root knot nematode	Trap crops- <i>Ipomea batata</i> <i>Tagetes cta</i>	Sheela <i>et al</i> 2002.
2	Crucifers	Diamond back moth	Mustard as trap crop	Srinivasan & Moorthy, 1992.
		Diamond back moth	Biocontrol agent- <i>Apanteles plutellae</i>	Annon 1995.
		"	Microbials- actinomycetes, bacteria, fungi etc.	Annon 1995.

		"	<i>Streptomyces avermetilis</i>	Murugan and Ramchandran, 2000.
		Lepidopteran pests	<i>Bacillus thuringiensis</i> based formulations	Malathi <i>et al</i> 1999.
		Diamond back moth and leaf webber	Intercropping- one row of tomato	Srinivasan and Veeresh 1986
3	Cucurbits	Leaf miner	Parasitoid- <i>Hemipterus varicornis</i>	Moorthy and Kumar, 2002
		Leaf miner	Neem seed kernel extract 5%	Annon, 2001.
		Fruit fly	Predators- <i>C. carnea</i> , <i>Opius compensates</i> <i>O. incies</i>	Annon, 2001.
		White fly	Yellow sticky traps smeared with castor oil	Geetha <i>et al.</i> , 2002.
		Pumpkin beetle	Microbial treatments- <i>B. bassiana</i>	Annon, 2001
		<i>Dacus cucurbitae</i>	Traps containing methyl eugenol (1ml/lit)+ vinegar/ gur+ malathion (1ml/ lit) with stirring of soil	Raghunath and Gokulapalam, 1999.
4	Okra	<i>Amrascabigitula</i>	Parasitoids- <i>Erythelnuemposcae</i> and <i>Stethyminuempascae</i>	Dhandapani <i>et al</i> 2003
		<i>Erias sp.</i>	<i>Bracon hebetor</i> and <i>Rogas testaceus</i> ,	Dhandapani <i>et al</i> 2004
		<i>Aphis gossypii</i>	<i>Aphelinus flavipes</i>	Dhandapani <i>et al</i> 2005
		White fly	Microbial spray- <i>Beauveria bassiana</i>	Dhandapani <i>et al</i> 2006
		<i>E. vitelli</i>	Microbial spray- <i>Bacillus thuringiensis</i>	Pandey <i>et al</i> 1999.
		Leaf hopper	Botanical insecticide- <i>Parthenium hysterophorus</i> 3%	Dhandapani <i>et al</i> 2003
			Botanical insecticide- <i>Nicotine sulphate</i>	Dhandapani <i>et al</i> 2003
	Combination of rhizome extract of <i>Acorus calamus</i> 3%, leaf extract of <i>Ocimum basilicum</i> 3% and <i>Daturastrumarium</i> 3%	Pawar <i>et al</i> 2001		
5	Onion	Sucking type insects	Predators- Coccinellids, Syrphids, spiders and <i>C. carnea</i>	Singh, 1997.
		Thrips	Barrier cropping- 2 rows of maize	Annon, 2001; Srinivas and Lawande, 2002
6	Tomato	Early blight	Isolates of <i>Bacillus cereus</i> + plastic rowmulches	Ploper <i>et al</i> 1992
		Fruit borer	Trap crop- Marigold one row for every 14 rows of tomato	Srinivasan <i>et al</i> 1993.
		Various pests	Neem+ Pongamia pinnate cakes	Kumar and Krishnamoorthy, 2002.
		<i>Aleurodicus disperses</i>	Predators- Hitiduid, coccinellid, <i>Scymnus coccivora</i>	Dhandapani <i>et al</i> 2003.
		<i>Spodotalitura</i>	Neem extract	Joshi <i>et al</i> 1993.

Conclusions

India is one of the largest vegetable producers in the world. However a lot of losses occur at pre-harvest as well as post-harvest stages of crop produce. At pre-harvest stage, generally the damage takes place due to attack by pests. There is a need to look for options to reduce these losses especially when there is so much talk about food security and food safety. Integrated pest management is one of these options wherein it is important to involve farmers to make IPM a successful strategy in Indian perspectives. Success. They should not only play an important role at field level but at training and development of resistant varieties also. The indigenous knowledge possessed by them should be tapped.

The natural mortality factors and the role-played by each factor at different locations in different seasons should be well studied. Since vegetables are short duration crops, they require a well-studied programme. It requires a lot of studies on the bio-ecology and methods of mass production of important natural enemies. The need of the hour is to realize the potential of indigenous biocontrol agents and parasitoids and predators. Intensified conservation methods should be adopted for parasitoids and predators. Traditional knowledge in regard to botanical pesticides should be researched and utilized. Therefore, it is essential that all the concerted efforts are made by integrating various approaches to manage pest successfully. By giving focused

attention through adopting the techniques of IPM, sustainable vegetable crop production can be achieved.

References

1. Annon, Yearly report of Asian Vegetable Research and Development (AVRDC). Management of insects and plant diseases. Taiwan, 1995, 109-116.
2. Anon. Integrated pest management package for cucurbitaceous crops. Bhattarcharya, S. and Madhi M. (Eds.). Offset Press, Directorate of Extension, Ministry of Agriculture, Government of India, New Delhi, India. 2001.
3. Banerji R, Misra G, Nigam SK. Role of indigenous plant material in pest management. Pesticides, 1985, 32-37
4. Chadha KL, Singh AK, Patel VB. (Eds.). Recent Initiatives in Horticulture. The Horticultural Society of India. Malhotra publishing house, New Delhi. 2008.
5. Chandler D, Bailey AS, Tatchell GM, Davidson G, Greaves J, Grant WP. The development, regulation and use of biopesticides for integrated pest management. Philosophical Transactions of the Royal Society, 2011; 366:1987-1998. doi:10.1098/rstb.2010.0390
6. Dhandapani N, Shelkar UR, Murugan M. Bio-intensive pest management (BIPM) in major vegetable crops: An Indian perspective. Food, Agriculture & Environment, 2003; 1(2):333-339.
7. Fageria MS, Choudhary BR, Dhaka RS. Vegetable Crops (Production Technology: 2), Kalyani Publishers, New Delhi. 2012.
8. Geetha B, Swamiappan M, Kempuchetty N. Predators for the biological control of the spiraling whitefly *Aleurodicus dispersus*

- on vegetables. In proceedings International Conference on Vegetables Bangalore, India. 2002, 261.
9. Hffaker CB. (Eds.). New Technology of pest control. John Wiley & Sons, New York. 1980.
 10. Hokkanen HMT. Trap Cropping in Pest Management. Annual Review of Entomology. 1991; 36:119-138.
 11. Jacobsen BJ, Larson B, Zidack NK, Ansley J, Eckhoff JLA, Bergman J. Integrated management of *Cercospora* leaf spot. Sugarbeet Research Ext. Rep, 2002; 33:235-240.
 12. Jacobsen BJ, Zidack NK, Larson BJ. The Role of Bacillus-Based Biological Control Agents in Integrated Pest Management Systems: Plant Diseases. Phytopathology, 2004; 94 (11):1272-1275.
 13. Jayanthi S, Alexander Jessudasan RW. Role of *Pedobius foveolatus* (Hymenoptera: Eulophidae) in the biocontrol of the brinjal spotted leaf beetle: *Henosepilachna vigintiotopunctata* (Coleoptera: Coccinellidae). Pestology, 2000; 24(5):33-36.
 14. Joshi BG, Sriprakash K, Murthy PNS. Efficacy of neem seed kernel suspension, neem seed bitter, pongamia cake water extract, *Bacillus thuringiensis* Berliner, nuclear polyhedrosis virus alone and in combination against tobacco caterpillar, *Spodoptera litura* F. in nurseries. In Chari, M.S. and Ramaprasad, G. (Eds). Botanical pesticides in integrated pest management. Proceedings Symposium on botanical pesticides in IPM. Rajmundry, India. 1993, 154-158.
 15. Krishna Kumar NK, Krishnamoorthy PN. Advances in the use of botanicals for the IPM of major vegetable pests. In Conference on Vegetables. Bangalore, India. 2002, 233.
 16. Krishna Moorthy PN, Srinivasan K. Pest management in leguminous vegetables. In annual report, IIHR, Bangalore. 1988.
 17. Krishnamoorthy PN, Krishna Kumar NK. Advances in the use of botanicals for the IPM of major vegetable pests. In International Conference on Vegetables Bangalore, India. 2002, 233.
 18. Krishnamoorti A, Mani M. Feasibility of managing *H. armigera* on tomato through parasitoid. In: National Workshop on *Heliothis* management. TNAU, Coimbatore. 1988.
 19. Kumar SP, Babu S. Evaluation of anti feedant properties of neem azal against certain leaf feeders of brinjal. Pestology, 1999; 22(10):62-64.
 20. Larson B. Integrated management of *Cercospora* leaf spot. (M. S. thesis), Montana State University, Bozeman. 2004.
 21. Malathi S, Sriramulu M, Babu TR. Evaluation of certain ecofriendly insecticides against lepidopteraous pests of cabbage. Indian J. Ent. 1999; 61(2):127-133.
 22. Metcalf RL, Luckman WH. Introduction to insect pest management. Wiley, New York. 1975.
 23. Murugan M, Ramachandran K. Bioefficacy of vertimec 1.8 EC against diamondback moth, *Plutella xylostella* (L.) on cabbage. Pestology, 2000; 24(1):12-14.
 24. Pandey NK, Ojha PK, Upadhyay KD. Studies on the bioefficacy of *B. thuringiensis* formulations against *E. vitella* Fabr. Under laboratory conditions. RAU. J. Res. 1999; 9(1):57-61.
 25. Pawar DB, Warade SD, More TA. Efficacy of different plant extracts against leaf hopper (*Amrasca devastans* Dist.) and fruit borer (*E. vitella*) of Okra. In Proceedings of the second National Symposium on Integrated Pest Management (IPM) in Horticultural Crops: New Molecules, Biopesticides and Environment. Bangalore, India. 2001, 66.
 26. Ploper LD, Backman PA, Stevens C, Khan VA, Rodriquez-Kabana R. Effects of soil mulch, row cover, and biological and chemical foliar treatments on early blight of tomato. Biol. Cult. Tests. 1992; 7:38.
 27. Praveen PM, Dhandapani N, Kennedy JS. Efficacy of *Bacillus thuringiensis* (Berliner) formulations for the management of tomato fruit borer, *Helicoverpa armigera* (Hubner). Pestology, 2001; 25:58-61.
 28. Ramesh A, Battu GS, Bath DS. Management of insect pests of cauliflower with biopesticides. Indian J. Ecol. 2000; 27(2):156-162.
 29. Regunath P, Gokulapalam C. IPDM in bittergourd– experiences in participatory approaches. In Proceedings of Hort. India, India. 1999, 277- 279.
 30. Sheela MS, Nisha MS, Mohandas C. Impact of trap cropping and crop rotation for the management of root-knot nematode in vegetables. In International Conference on Vegetables Bangalore, India. 2002, 245.
 31. Shelton AM, Badenes- Parez FR. Concepts And Applications Of Trap Cropping In Pest Management. Annual Review of Entomology, 2006; 51:285-308. doi: 10.1146/annurev.ento.51.110104.150959
 32. Singh SP. Biological control in India. In Upadhyay, R.K., Mukharjii, K.G. and Rajak, R.K. (Eds.), IPM systems in agriculture: Biocontrol in emerging biotechnology Aditya books private Ltd., New Delhi, India. 1997, 2.
 33. Smith EH, Pimental D. Pest control strategies. Academic Press, New York. 1978.
 34. Sreenivasamurthy D, Krishna Moorthy PN, Raja ME, Shivanna. Economic assessment of pest management in brinjal and cabbage using neem products. In International Conference on Vegetables. Bangalore, India. 2002, 243.
 35. Srinivas PS, Lawande KE. Barrier cropping - a new method for the management of thrips in onion. In proceedings International conference on vegetables Bangalore, India. 2002, 237.
 36. Srinivasan K, Veeresh K. The development and comparison of visual damage threshold for chemical control of *Plutella xylostella* and *Crocidolomia binotalis* on cabbage in India. Insect Sci. 1986, 547- 557.
 37. Srinivasan K, Krishnamoorthy PN, Prasad R. Evaluation of different trap crops for the management of fruit borer, *H. armigera* on tomato. In: Abs. Golden Jubilee Symp. Horticultural Research: Changing Scenario Bangalore, India. 1993, 259.
 38. Tewari GC, Sandana HR. *Eriborus argentiopilosus* (Caweras) a new parasite of *L. orbonalis*. Entomon, 1987; 12(3):227-228.
 39. Verma JP, Varma A. Farming systems and integrated pest management. Malhotra publishing house, New Delhi. 1992.
 40. Weinberger K, Srinivasan R. Farmers' management of cabbage and cauliflower pests in India and their approaches to crop protection. Journal of Asia-Pacific Entomology. 2009; 12(4):253-259.
 41. Wright S, Miller SA. Evaluation of *Bacillus*, *Brevi bacillus* and *Paeni bacillus* spp. for management of tomato diseases. Biol. Cult. Tests, 2001; 16:PT75.