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Eco-friendly strategies for insect-pest management in commercial vegetable production system in Uttarakhand, Himalayas

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Introduction

India is the second largest producer of vegetable after China. The vegetable cultivation in India is taken up by the farmers in both open fields as well as protected cultivation systems. The area under vegetable production was 8.9 million hectares during 2011-12 with a total production of 155.9 million tonnes with mean productivity of 17.4 tonnes/hectare (Anonymous 2013). However, the productivity of vegetables per unit area in India is less than the world's average vegetable productivity. Huge loss in vegetable production occurs due to insect pest damage and various disease pathogens. The loss due to insect pest accounts to 30 percent in vegetable crops and these insect-pests include white grubs, beetles, aphids, fruit borers, cut worms, grasshoppers, leaf hoppers, mealy bug, termites and a very wide variety of other insect pests. The most effective and popular way to control insect pests under protected cultivation system is use of chemical insecticides. Due to indiscriminate use of chemical pesticides, insects are bound to develop resistance, resulting in pest resurgence of minor pests with high level of residual toxicity in direct consumables besides other environmental hazards.

The most alarming state developed by these harmful pesticides is the contamination of air, water and soil resulting in health hazards with appearance of new diseases among human beings (Carson, 2007), harmful effect upon human life, wild life and other flora and fauna. With growing awareness among public regarding the adverse effects of pesticides on human health, air, water and soil resources as well as development of resistance and resurgence among the insect-pests have necessitated the need to look for eco-friendly, safer and effective methods of pest control.

Why insect-pests in vegetable crops are difficult to manage?

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- **Multiple generations:** Insect pests have short life cycle with faster rate of multiplication and they complete more than two generations in a year. For example whitefly can complete 11 generation/year, where as in Punjab mite is believed to complete 32 generation in a year. Likewise aphids complete more than two generations in the hilly regions of Uttarakhand.
- **Unlimited food supply**: Due to year around cultivation, insects have access to sufficient food. So, there is no dearth period for them. In the absence of host plants most of the polyphagous pests search for alternative hosts.
- **Lack of natural enemies**: Number of natural enemies is considerably abundant in open environment for checking the pest population but in an enclosed structure, where most of the vegetables are cultivated; these natural enemies are hard to exist. In addition, the indiscriminate use of pesticides is harmful to non-target organisms, thus, killing the natural enemies of pest in agricultural fields.
- **Congenial environmental conditions**: The manipulated environmental conditions inside protected structure favour faster reproduction and multiplication of insect-pests.

Several techniques have been devised for the management of insect-pests which are quite safe to environment and selectively kill insect-pest. Few of them are discussed as follow:

A) Ecological Management: The manipulation of the cultural practices like planting time, seed rate, plant spacing, tillage, plant diversity, crop rotation and nutrient management for reduction or avoiding pest damage to crops is known as cultural control. Since these manipulations are based on habitat management and requires a thorough understanding of different components of the ecosystem in which the pest thrives, this approach has also been known as ecological management or environmental control. The purpose of cultural control practices is to make the environment less favourable for the pest and facilitate the augmentation of population of natural enemies. Some of the Ecological management practices are:

i) Plant diversity: The plant diversity can be maintained in such a way that it can reduce the incidence of insect-pest on main crop. Ram and Singh (2010) studied the effect of intercropping of spices, cereals and root crops on the incidence of tomato fruit borer, *H. armigera* in tomato. The results obtained from study indicated that the incidence of *H. armigera* was found minimum when tomato was intercropped with coriander. The effect

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of inter-cultivation of four cruciferous cultivars viz. *Brassica juncea*. PBR-91, *B. napus* var GSL-1, *B. napus* var. PGSH-51 and *Eruca sativa* var. TMLC-2 on incidence of *H. armigera* on tomato were studied after burying them in soil. When two rows of crucifers were buried simultaneously (six day after sowing), *B. napus* var. GSL-1 was the most effective in reducing the oviposition on tomato (1.37 eggs/plant against 2.73 in control).

ii) **Mulching:** Mulching is often recommended to reduce weeds, diseases, insects, and conserve soil moisture. Plastic mulch is outstanding for preventing weeds while organic mulch lowers soil temperatures. Natural organic mulches like rice straw conserve soil moisture and add to the organic matter of the soil. Many vegetable crops have shown significant increase in earliness, yield and fruit quality when grown with plastic mulches and under low tunnels. Bhullar and Dhatt (2011) studied the effect of some cultural practices like training system and various types of mulching on the incidence of *Tetranychus urticae* Koch on brinjal grown under both open field and net house conditions. Mite incidence was more in open field conditions than in net house, while in net house crop, incidence of mites was less on crop grown with training system and black polythene mulch.

Fig 1: Mulching

B) Mechanical Control: The reduction or suppression of insect pest population by means of manual devices is referred to as mechanical control. Mechanical control includes collection and destruction of insect-pests, use of preventative barriers and trapping of insect-pests.

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i) **Trellis system:** Trellis system is effective method to control insect-pests. Incidence of insect pest is less in trellis system because of more penetration of light and easy pest monitoring as compared to traditional methods.

Fig 2: Trellis system

ii) **Protected cultivation:** Insect-pests are known to cause direct damage to vegetable crops as well as indirect damage by acting as vectors of various plant diseases. Polyhouse act as a physical barrier for spread of the pest and consequently for plant disease. It is evident that incidence of insect-pests per plant was higher under open field as compared to properly managed polyhouse which necessitates more number of spraying of insecticide under open field conditions. The economic benefits are much higher under protected cultivation as compared to open conditions.

Fig 3: Protected cultivation (Green house)

iii) **Sticky barriers or traps**: Small flying insect pests are attracted to unique yellow colour and adhered to the non-drying glue coating the trap. By catching the winged

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adults with yellow sticky traps before they reach the plants, the build-up of pests is delayed and existing insect populations is also reduced. Yellow sticky traps are a non toxic way to control and monitor insects like whiteflies, aphids, Onion fly, cabbage white butterfly, fruit flies, thrips, cucumber beetles, fungus gnats, leafhoppers, froghoppers, moths, flea beetles, leaf miners etc. As an integral part of integrated pest management program, they can be used in greenhouses, orchards, flowers and vegetable gardens for reducing initial insect load.

Fig 4: Sticky barriers or traps

iv) **Lure and kill**: Various insects are trapped and killed by using pheromone traps which are difficult to manage by other means. For instance, fruit fly lays eggs in fruit tissue, so that control of fruit fly is difficult and control measures directed towards adult flies. Some of the commonly used lure for attracting the adult fruit flies are Cue-lure, methyl eugenol and molasses. Chaudhary and Patel (2008) used two methods of fruit fly control, *viz*., aqueous sprays of poison bait and installation of lure traps as male annihilation technique, individual and in combination in pumpkin field. The combined use of cue-lure baited traps and sprays of poison bait with protein hydrolysate reduced the fruit infestation significantly over their individual treatments during different stages of pumpkin fruit growth as well as resulted in better marketable fruit yield per unit area.

C) Host Plant Resistance: Plants with constitutive insect resistance possess genetically inherited qualities that results in a plant of one cultivar being less damaged than a susceptible

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plant lacking these qualities. Although insect resistant plants have been recognized for many years as a sound and safe approach to crop protection, it is only during the last two decades that insect-plant interaction have been extensively investigated from the behavioural, ecological and physiological points of view. A number of plant characteristics are known to render the cultivars less suitable or unsuitable for feeding, oviposition and development of insect-pest. Broadly, these characteristics can be classified into two categories: biophysical and biochemical. Sultani *et al.* (2011) studied the morphological and biochemical bases of resistance in okra genotypes against shoot and fruit borer, *E. vittella*. Resistant genotypes (HB-03-29-7B and HBT-1-19-1-1-2) exhibited adverse effect on various biological parameters of *E. vittella* and varied significantly in trichome density. Moreover, length and thickness of fruit pericarp varied significantly. Amongst phyto-chemicals; total sugars, total phenols, phosphorus and tannin contents of resistant genotypes showed adverse effects on larval survival, pupal weight and adult emergence. Such resistant varieties can be successfully used as an eco-friendly technique for insect-pest management.

D) Use of Biopesticides and Bioagents: Biopesticides are assumed to be safe as compared to conventional insecticides. These are classified in to different categories based on their source of origin. Botanical and microbial based biopesticides are registered in India for different crops and the consumption of biopesticides is increasing year by year. In vegetable crops, such biopesticides can be used on need based without their adverse effects on non-target organisms. Bioagents are living organisms which prey on other harmful insects and keep their population below economic threshold level. The conservation and augmentation of bioagents is needed for their successful use in insect-pest management. Various state biocontrol laboratories are involved in the production of these bioagents for inoculative and inudative releases.

Conclusion

The increasing awareness of consumers towards pesticide residue free produce necessitated the need for non-chemical methods of insect-pest control. Amongst these, cultural practices are basic and eco-friendly ways to minimize the insect-pest population. The various kinds of traps can be used for monitoring and suppression of initial pest population. Further, selection of insect resistant varieties and need based use of biopesticides which are selective and eco-friendly can be used in eco-friendly pest management programmes.

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Future Prospects

Eco-freindly insect-pest management requires the manipulation of local natural resources for conservation and augmentation of natural enemies which can be achieved by successful participation of farmers in training and adoption of such techniques on large scale. Government initiatives are also required for inoculative and inundative releases of various bio-agents on large scale from time to time.

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