# INTEGRATED PEST MANAGEMENT IN SUNFLOWER: AN INDIAN SCENARIO

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**Abstract**

In the Indian subcontinent the sunflower (*Helianthus annuus* L.) crop is fast expanding to different agroecological niches and cropping systems due to its wide adaptability. Among biological constraints in the sunflower production, pests dominate the scenario. A diverse assemblage of both beneficial and harmful insect species is associated with the sunflower ecosystem. Though more than fifty insect species have been reported on sunflower, cutworms (*Agrotis* spp.), sucking pests, leaf and plant hoppers (*Amrasca biguttula biguttula* Ishida, *Empoasca* spp.), thrips (*Thrips palmi*), whitefly (*Bemisia tabaci* Gennadius), defoliators (*Spilosoma obliqua* Walker*, Spodoptera litura* Fabricius*,* and *Plusia orichalcea* Fab.), and capitulum borer (*Helicoverpa armigera* Hubner) are major pests of economic concern. Among insect pests of sunflower, *H. armigera* is a highly polyphagous and destructive pest pest with more than 180 host plants including important crop plants such as oilseeds, pulses, cotton, vegetables, etc. Various pest species damage different parts of the sunflower plant at different phenological stages. Soil insects damage roots and emerging seedlings. Defoliators and sucking pests cause losses in food reserves. Inflorescence pests destroy floral parts and developing seeds and cause direct damage. Storage pests damage endosperm and embryo of seeds thereby preventing their proper germination and also depress the quality and quantity of oil content. The information on major pests, their management, i.e., bioecology, extent of damage and integrated pest management (IPM) strategies consisting of cultural practices, resistant sources, biocontrol agents, biopesticides, seed treatment and chemical control through insecticides, socioeconomic and ecological aspects of IPM have been discussed.

## Introduction

Sunflower (*Helianthus annuus* L.) is one of the edible oilseed crops making rapid strides in the oilseeds scenario of the Indian subcontinent due to its wide adaptability to different agroecological niches and cropping systems. Among biological constraints in sunflower production, insect pests are of major concern. In the Indian subcontinent, though more than fifty insect species have been reported on sunflower, cutworms (*Agrotis* spp.), sucking pests, leaf and plant hoppers (*Amrasca biguttula biguttula* Ishida, *Empoasca* spp.), thrips (*Thrips palmi* Karny), whitefly (*Bemisia tabaci* Gennadius), defoliators (*Spilosoma obliqua* Walker*, Spodoptera litura* Fabricius*,* and *Plusia orichalcea* Fab.) and capitulum borer

(*Helicoverpa armigera* Hubner) are major pests of economic concern (Basappa, 1998). Various pest species damage different parts of the sunflower plant at different phenological stages. The information generated by various research workers on major pests, their management, i.e., bioecology, extent of damage and integrated pest management (IPM) strategies consisting of cultural practices, biopesticides, seed treatment and chemical control through insecticides, will be discussed as follows.

**Results and Discussion**

***Seedling Pests.*** During the seedling stage several pests attack sunflower, among them cutworms, *Agrotis ypsilon* Rott, *Agrotis flammetra* Schiffer Mueller and the tenebrionid *Gonocephalum* spp. which cuts the emerging seedlings (Rangarajan et al., 1975; Sandhu et al., 1973). As a result of severity of seedling pests, sometimes the plant stand of sunflower crop is reduced up to 30 percent (Basappa and Bhat, 1998). Seedling pests can be effectively managed by growing sunflower on slopes of ridges (6-8 cm high). Monocrotophos bait prepared in rice bran is quite effective if spread in the field during evening hours. Drenching of endosulfan (0.05%) around seedlings gives good protection against the pests.

***Soil Insect Pests.*** Among soil insect pests, termites (*Odontotermes obesus* (Rambur), *O. guptai* and *Eurymotermes paradoxalis* Roonwal and Bose) attack sunflower (Sandhu et al., 1973). Termites can be managed by destroying the queen either by digging it out or dropping aluminium phosphide, 2 tablets per termitarium of 1 m diameter, or pouring chlorpiryphos 20 EC diluted @ 60 ml/18 l of water on the termitarium. Field sanitation and use of fully decomposed FYM mixed with wood ash reduces termite activity (Basappa and Rajagopal, 1993).

***Sucking Pests.*** Leaf and plant hoppers (*Amrasca biguttula biguttula* Ishida, *Empoasca* spp., *Cicadulina zeal* China), thrips (*Scirtothrips dorsalis* Hood, *Thrips tabaci* (Lindeman)*, T. palmi* and whitefly (*Bemisia tabaci* Gennadius) attack sunflower. Among sucking pests, *A. biguttula biguttula* appears in serious form causing crop losses up to 46 percent. The incidence would start from the seedling stage and prevail right through the entire plant life. Stunted growth of plants, cupped and crinkled leaves and burnt appearance of leaf margins are symptoms of damage. Low RH and high daily maximum temperature were found to have significant positive correlation with its population.

In the sunflower ecosystem several species of coccinellids, viz., *Brumus suturalis* Fab., *Chilocorus nigritus* F., *Coccinella septumpunctata* L., *Menochilus sexmaculata* F., and *Scymnus nubilus* Mulls. keep a good check on sucking pests like thrips, aphids and leafhopper nymphs (Sandhu et al., 1973 and Goel and Kumar, 1990). Some germplasm lines showed promise against leafhopper (Entry no. KBSH-8, BSH-1, EC-61039, 75268M, 77195, 110737, 35811), whiteflies (EC-93442) and thrips (EC-101287 and EC-68414) either by supporting comparatively lesser populations or not expressing cupping symptoms compared to susceptible ones. Mixed cropping of sunflower with cotton resulted in comparatively lower thrips and leafhopper infestation on the former. Spray phosphamidon (0.03%) or dimethoate (0.03%) or monocrotophos (0.05%) may be used against the sucking pests. Neem seed kernel extract 2% is effective against leafhoppers. Thrips are suspected to be a vector of sunflower necrosis disease. Imidacloprid @ 5, 7.5 and 10 g/kg of seed was found most effective with the least sucking pests and lowest necrosis disease (Basappa, 1999).

***Defoliators.*** The sunflower crop is damaged at different phenological stages by several defoliators which include *Spilosoma obliqua* Walker*, Spodoptera litura* Fabricius*, Spodoptera exigua* Hub., *Estigmene lactinea* Fab., *Euproctis fraterna* Fab., *Euproctis virguncula* Wlk. *P. ricini* Fab.*, Plusia signata* Fab. and *Plusia orichalcea* Fab. The loss in seed yield due to defoliators in a rainfed Kharif crop was up to 268 kg/ha. If the defoliators attack is before flower initiation it would affect food partitioning between stem, leaves and roots and if it is later it would affect growth of both vegetative parts and inflorescence. *Pilosoma obliqua* is highly polyphagous and occurs all over India, and is often reported to cause colossal damage to sunflower. *Spodoptera* may also assume injurious levels similar to *S. obliqua.* Adults of *Zygogramma bicolorata* Pallister which were released as biocontrol agents for the control of *Parthenium* weed were observed feeding on sunflower plants in an isolated field. Beetles were also found in low numbers on other plant species like *Amaranthus* spp., cultivated sunflower *Helianthus annuus* and wild sunflower *H. tuberosus* L.*,* but feeding was negligible though there was a high population and severe defoliation of *Parthenium* in the vicinity (Basappa, 1997a).

Defoliators on sunflower can be effectively managed by following various IPM tactics. Both *Spodoptera obliqua* and *S. litura* lay eggs in masses on the undersides of leaves and early instar larvae feed gregariously on leaves and give them the "esh-like" appearance which can be easily located, collected and destroyed by scouting across the field. Both of them pupate in plant debris as well as soil, hence summer ploughing will expose the pupal stage to predators. In nature, several parasitoids, predators and microbial agents occur on *S. obliqua* and *S. litura*. *P. orichalcea* and *Trichoplusia. ni* (Hubner) usually begin to attack the vegetative phase of the crop. Five parasitoids: *Apanteles ruficrus* Haliday*, A. africanus*, *Euplectrus ceylonensis* (Howard)*, Campoletis chloridae* Uchida and *Exorista xanthaspis* Wiedemann were found parasitising *T. orichalcea* larvae (Men and Thakre, 1998). The pupation takes place on the plant itself so plant debris should be destroyed to suppress this pest. If there is outbreak of these defoliators, methyl parathion 2% dust @ 25 kg/ha may be dusted or endosulfan 0.05% or dichlorvos 0.05% or fenitrothion 0.05% @ 650-700 liters of spray solution/ha may be applied.

***Inflorescence Pests.*** Among insect pests of sunflower, capitulum borer, *Helicoverpa armigera* is the most serious and destructive pest. The minor inflorescence lepidopteran pests are *Chloredia obsolata* Hbn., *Pericalia ricini* L., and *Heliothus peltigera* Denis and Schiffermuller. *Helicoverpa armigera* is a highly polyphagous pest with more than 180 host plants including important crop plants such as oilseeds, pulses, cotton, vegetables, etc., and the pest is prevalent throughout Africa, Asia and Australia (Basappa, 1997b). It causes direct damage to receptacle, ovaries, and developing seeds and the resulting loss in seed would be over 50 percent. This pest has developed resistance to most of the commonly used insecticides in the cotton ecosystem and therefore it is imperative to protect sunflower from this dreaded pest by following different IPM tactics.

There is enough scope for ecofriendly pest management approaches against *H. armigera*. Altogether 77 parasitoids and 33 predators have been reported in different crops (Manjunath et al., 1985). In sunflower, predators such as *Chrysoperla carnea* Stephens, *Menochilus sexmaculata* and parasitoids such as *Bracon* spp., *Campoletis* spp., and *Trichogramma* spp. have been found to be predominant. Predators like *C. carnea* and the coccinellid beetle complex are predominant key mortality factors of this pest. Diseases such as NPV and muscardine (white and green) have often been noticed in the field populations. A significant

reduction in pest density is achieved with a spray of NPV@250 LE/ha. NPV@250 LE/ha with UV protectants gave better protection than local NPV without UV protectants. Three sprays of NPV@500 LE/ha brought down pest populations completely and recorded the highest yield. Coverage of capitulum and upper plant parts thoroughly with NPV+Bt would give better results. Only 6.66% head damage was noticed when the sunflower crop was sprayed with NPV @ 250 LE/ha + Endosulfan 35 EC @ 1 ml/l water twice with an interval of 15 days beginning with flowering stage (Sajjanar et al*.,* 1999). Cultural practices are important components of IPM. Sunflower is recommended to be grown as an intercrop with redgram, groundnut, ragi and soybean. Sunflower grown with redgram brought down the borer population on sunflower by a small margin compared to other cropping systems. Accessions like KBSH -6, 7, 8, 9, TNSU-3, HA-263, 291B, 296, 460, EC-109281, 107285, and BRS-3 were found superior. Sunflower line BRS-3 was found to contain in its seeds an anti-nutritional factor (proteinase inhibitor) which on incorporation in a semi-synthetic diet caused antibiosis in *H. armigera* (Bhat et al., 1996). Populations can be monitored by sex pheromone traps. Many botanicals of 'neem' origin have been evaluated against *H. armigera* on other crops but on sunflower there is very little information (Basappa, 1996). Application of neem seed kernel extract and neem-based pesticides will not only reduce damage due to *Helicoverpa* but also helps in conserving the activity of natural enemies as well as honey bees (Basappa, 1998). Many insecticides have been screened for their efficacy, among them phosalone (0.05%), endosulfan (0.05%), fenvalerate (0.005%), decamethrin 90 (0.002%), monocrotophos (0.05%), cypermethrin (0.005%) spray @ 650-700 l/ha, methyl parathion (2%), quinalphos (1.5%) and endosulfan (4%) dust @ 25 kg/ha may be used against the head borer and were found to be most effective among the insecticides screened by several workers. Honeybees play a very important role as pollinators which are essential to bring about cross-pollination in sunflower (Bhat and Basappa, 1998). Spraying in the evening hours and use of insecticides such as endosulfan and phosalone would safeguard bees.

***Stem Borer.*** Larvae of cerambycid *Oberea* spp. tunnel in the stems of sunflower and cause damage. The plants get dried up, turn black and have a sickly appearance. Damage is greater in plants grown in deep black soil (94.72%) than sandy soils (70.64%) (Veda and Shaw, 1994).

***Storage Pests.*** Sunflower seeds are also susceptible to most of the storage pests infesting other stored commodities. Merchant grain beetle *Oryzaephilus mercator* L.*, Corcyra cephalonica* Stainton*, Tribolium castaneum* (Herbst) and *T. confusum* Park were found causing damage to sunflower seeds.

***Non-Insect Pests.*** Non-insect pests such as rabbits, parakeets, doves, house sparrows, crows, rats, etc., have been reported to cause severe damage on sunflower (Basappa, 1995). Doves, field rats, crow, rabbit and striped squirrel also damage germinating seedlings or pick up sown seeds (Sandhu et al*,* 1973). Among birds the rose-ringed parakeet *Psittacula krameri* Scopoli is the major bird pest of the sunflower crop, causing 10-40% damage and in isolated areas maybe more than 90%. In recent times use of reflective ribbon or bird scaring ribbon has been found effective (Syam Sunder Rao, 1999).

***Nematodes.*** Sunflower is a host for more than 30 species of plant parasitic nematodes. The root knot nematodes *Meloidogyne javanica* (Treub) Chitwood*,* and *M. incognita* (Kofoid and White) Chitwood*,* the reniform nematode *Rotylenchus zeae*; *P. penetrans, P. projectus* Jenkins*, P. brachyurus* (Godfrey) Filipjov and Schuurmans-Stekhoven*,* stubby root nematode *Trichodorus christei,* stunt nematode *Tylenchorhynchus dubius* Butschl. and spiral nematode

*Helicotylenchus multicinctus* Cobb. are important pathogens attacking sunflower in India. Cultural practices play a major role in the nematode management. Deep ploughing during summer exposes nematode larvae and eggs to high temperature resulting in 60-70% population reduction. Application of organic amendments like neem cake, karanj cake, and mahua cake@1g/kg soil brings down nematode populations. African marigolds, asparagus and crotalaria have been found to have antagonistic properties when grown as an intercrop; they particularly reduced population of reniform and root knot nematodes (Vara Prasad, 1999).

**Conclusions**

In the management of insect pests of sunflower ecofriendly approaches need to be followed. Since the sunflower crop attracts several species of beneficial insect fauna, hence attention needs to be focused on conservation of activity of promising biocontrol agents and pollinators by adopting ecofriendly approaches like use of biopesticides, mechanical methods and cultural practices, which play very important roles in reducing pest load without affecting beneficial insect fauna (Basappa and Sriharan, 1999). The following integrated pest management (IPM) approaches are suggested for pest populations below ETL: (1) summer ploughing which exposes resting stages of insects to predatory birds as well as to hot sun, (2) seed treatment with imidacloprid@5 g/kg seed keeps sucking pests below the threshold level up to 35-40 days after sowing without affecting natural enemies, (3) growing sunflower on slopes of ridges of 6-8 cm height would reduce damage due to cutworms, (4) termites can be effectively managed by killing the queen after digging termitarium, (5) remove alternate hosts which act as an initial source of infestation, (6) keep field bunds and crop weed free to avoid high pest load as weeds favor the pest build up on the main crop, (7) hand collection and destruction of egg masses, early and late instar larvae of *S. litura* and *S. obliqua,* (8) mixed cropping of sunflower with cotton will result in lower thrips and leafhopper infestation on sunflower whereas *H. armigera* will be low on sunflower in the sunflower+redgram intercropping system, (9) spray NSKE (5%) or other neem formulations against defoliators and capitulum borer, (10) use *Spodoptera* and *Helicoverpa* NPV@250 LE/ha in case there is an outbreak of pests. NPV can also be used in sequence with NSKE (5%) for effective management of these pests, and (11) need-based application of pesticides needs to be followed if there is outbreak of pests. IPM technology developed at the Directorate of Oilseeds Research has been demonstrated in farmers' fields in the traditional sunflower growing area. An IPM package involving sunflower KBSH-1 hybrid, seed treatment with thiram@3 g/kg seed, application of monocrotophos 0.05% against sucking pests and mechanical collection of egg masses and gregarious stage larvae of *S. obliqua* proved superior to the farmers practice of two rounds of spray with endosulfan (0.07%) and monocrotophos (0.05%). All the IPM packages were superior and economically viable with CB ration of 1:2.62 and spared natural enemies and pollinators than the farmers' practice.

There is a need for early detection, monitoring and management of insecticide resistance in major pests of sunflower like *H. armigera* and *S. litura* which have developed several fold resistance to the majority of common insecticides in the cotton ecosystem. Though several promising ecofriendly integrated pest management (IPM) components have been evaluated there is a need to develop locations specific IPM modules by involving promising biocontrol agents, botanicals, resistant varieties, and cultural practices as well as relatively safer

insecticides for biocontrol agents and pollinators. Though effective plant protection technologies have been developed, they are not demonstrated in the form of location-specific IPM modules due to lack of trained extension personnel and a strong extension program with a participatory approach (Basappa et al., 1999). Farmers need to be educated in monitoring pest populations and simple expert systems in pest management of sunflower. Thus development and provision of up-to-date knowledge is a key factor enabling farmers to implement an IPM program in sunflower for sustainable production.

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