

SUNFLOWER DISEASE AND INSECT PESTS IN PAKISTAN: A REVIEW

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(Received 7 March, 2009; accepted 2 September, 2009)

ABSTRACT

Sun flower (*Helianthus annuus* L.) is one of the important oil seed crops and potentially fit in agricultural system and oil production sector of Pakistan. Various diseases, insects and nematodes attack damage the sunflower crop, results a wide range of loss in production and yield. Sunflower is susceptible to diseases of various kinds. The most serious diseases of sunflower are caused by fungi. The major diseases include rust, downy mildew, Verticillium wilt, Sclerotinia stalk and head rot, charcoal rot, blight and leaf spot. The severity of these diseases affects on crop yield. An account of important sunflower pests is discussed for brief understanding low yield of sunflower crop in Pakistan.

Key Words: Sunflower, oil crop diseases, fungi, nematodes, fungal pathogen, insect's damage

RÉSUMÉ

Le tournesol (*helianthus annuus* L.) est une des récoltes de graines oléagineuses importantes et potentiellement adaptée dans le système agricole et secteur de production de l'huile du Pakistan. Les diverses maladies, les insectes et les nématodes attaquent endommagent la récolte de tournesol, entraînant une perte dans la production et le rendement. Le tournesol est susceptible des maladies de diverses sortes. Les maladies les plus sérieuses du tournesol sont provoquées par des (champignons) mycètes. Les maladies principales incluent la rouille, rouille duvetuse, Verticillium wilt, putréfaction des tiges de sclérotinie, de charbon de bois, de rouille et la tache de feuille. La sévérité de ces des maladies affecte le rendement de récolte. Un inventaire des parasites importants de tournesol est discuté pour une brève compréhension du rendement bas de la récolte de tournesol au Pakistan.

Mots Clés: Tournesol, maladies des plantes oléagineuses, champignons, nématodes, microbes pathogènes fongiques, la destruction de l'insecte

INTRODUCTION

The Sunflower (*Helianthus annuus* L.) is one of the most important oil crops globally and is grown on over 22 million hectares worldwide, with a production of 26 million tonnes (Shirshikar, 2005; Skoric *et al.*, 2007). Sunflower (*H. annuus*) belongs to the family Asteraceae. *Helianthus annuus* var. macrocarpus, the giant sunflower, is cultivated for edible seed (Khan *et al.*, 2007). Sunflower is an important oil seed crop. As an oil seed crop, sunflower was introduced in Pakistan

during 1960 with the object of bridging the gap between production and consumption of edible oil in the country (Burney *et al.*, 1990).

Pakistan is deficit in vegetable oil production. We meet 28 percent of our requirements through indigenous sources. The balance of 72% is met through imports. The imported edible oil's budget is growing into billion of dollars; becoming a big drain on our foreign exchange reserves. Edible oil and oilseeds import cost of US\$ 1045 million during 2006-07. The edible oil requirement stood at 3.094 million tonnes in the same year.

This included 2.237 million tonnes from imported sources (oil and oilseeds). Local production remained at 0.857 million tonnes. Demand of edible oil is increasing at a rate of 5.4 percent annually. At this rate, our annual requirement would be 4.168 million tonnes after five years and if local production is not increased rapidly annual import bill will raise to 2.593 billion US\$ (Anonymus, 2008).

The agro-climatic condition of Pakistan is not conducive in general for palm oil cultivation. Sunflower and Soyabean were found to have the potential to raise the productivity of edible oil in Pakistan (Nasir, 2003). Over the years, sunflower has become an important crop for both farmers and consumers in Pakistan. Sunflower is a crop that fits well in the local cropping system and is considered the most important cash crop in all parts of the country. In all parts of Pakistan, the crop is grown in two seasons, spring and summer. The crop duration is such that it can be sandwiched between two cotton, rice or potato crops. It is a high yielding oil crop which gives high return to the farmers (Shah *et al.*, 2005). So it has a great potential to make the country self-sufficient in edible oil. It is needed to improve the yield potential of sunflower varieties/hybrids to increase sunflower production of the country (Haq *et al.*, 2006).

Commercially available sunflower varieties contain from 39 to 49% oil in the seed. The oil accounts for 80% of the value of the sunflower crop, as contrasted with soybean which derives most of its value from the meal. Sunflower oil is generally considered a premium oil because of its light colour, high level of unsaturated fatty acids and lack of linolenic acid, bland flavor and high smoke points. The primary fatty acids in the oil are oleic and linoleic (typically 90% unsaturated fatty acids), with the remainder consisting of palmitic and stearic saturated fatty acids.

Low yield of sunflower may be attributed to several reasons such as occasional adverse climatic conditions, poor agronomic methods of cultivation, non-availability of improved seed and prevalence of diseases and damage caused by pests. Sunflower is attacked by many diseases, which reduce the yield and quality significantly under optimal conditions (Mirza and Beg, 1983).

More than 90 sunflower diseases have been reported world wide (Bai *et al.*, 1985). Sunflower plants are attacked by a number of infection microorganisms mostly Fungi, Bacteria and Nematodes which reduces yield and quality (Ara *et al.*, 1996; Bhutta *et al.*, 1997; Amin and Youssef, 1997). The severity of losses induced by plant pathogens is often related to the crop growth stage at the time of disease onset and intensification. Occasionally, when the disease begins at an advanced stage of crop development, crop yield is not impaired (Zadoks, 1985).

The most serious diseases of sunflower are caused by fungi. The major diseases include rust, downy mildew, Verticillium wilt, Sclerotinia stalk and head rot, phoma black stem, charcoal rot and leaf spot. The severity of these diseases affects on crop yield. There is a dire need to raise production through disease control.

The present work is a review of Sunflower disease research findings from Pakistan and a brief understanding of diseases.

CHARCOAL ROT

Sunflower plants suffer from charcoal rot disease caused by *Macrophomina phaseolina* (Jalaluddin, 2008). *M. phaseolina* has a wide host range and is responsible for causing losses on more than 500 cultivated and wild plant species (Khan, 2007). Charcoal rot of sunflower was reported for the first time from Faisalabad (Mirza, 1984) and later from other areas of Punja (Sindh and NWFP provinces) as a threat to sunflower (Mirza and Beg, 1983; Steven *et al.*, 1987). *Macrophomina phaseolina* survives as free sclerotia in the soil or embedded in the host crop and in dry soil for long period (Sinclair, 1982).

Ahmad (1988) reviewed research on different sunflower rots in Pakistan. Six rots including, charcoal rot, head rot, stalk rot, collar rot, black rot and bacterial rot are known to exist. Among these, charcoal is considered the most prevalent. Ataga and Akueshi (1986) observed that *M. phaseolina* grew well on the seeds, increased the free fatty acid, oil content and caused discoloration of the oil. However, the relation of sunflower borne pathogen and oil quantity and quality is not well understood. *M. phaseolina* is

reported as the most destructive on sunflower crop and major in yield in Pakistan (Mirza and Beg, 1983; Mirza, 1984).

Symptoms. Early symptoms of the disease are not visible, but sudden wilting of plants, usually after pollination, is the most common symptom. The diseased plants mature early and show brown to dark brown spots appear on stem from which the disease gets the name 'charcoal rot', if the affected stem is split, black microsclerotia are found in the pith. The plants become weak, dry and show light gray or ashy black discoloration of stems. Poorly filled heads can be seen and drying of stalks occurs, which also become normally discolored. Pith disintegrates and vascular fibers appear shredded, covered with small bodies of disease causing fungi.

SCLEROTINIA STALK WILT AND HEAD ROT

Sclerotinia sclerotiorum is causative agent of stalk and head rot in sunflower (Mirza and Yasmin, 1984; Bhutta *et al.*, 1995). This disease is found throughout the world where sunflower is grown. *Sclerotinia sclerotiorum* seedling, stalk and head rots are hazard to sunflower all over the world (Mesterhazy and Gulya, 1988). Sunflower diseases especially head rot followed by charcoal rot are the serious threat to sunflower growers in Pakistan (Mehdi and Mehdi, 1988; Khan *et al.*, 1999). So far no commercial sunflower cultivar has been reported with resistance against *M. phaseolina* (Gul *et al.*, 1989; Ahmed and Burney, 1990; Hafeez and Ahmad, 1997; Khan, 2007).

Symptoms. Diseases appear in different phases as root rot, stem rot, and head rot. Water-soaked lesions appear on the taproot and fibrous roots. The disease is also characterised by sudden wilting of leaves. Gray to brown lesions appears at the base or other parts of the stem. The plant wilts and dries up. Stems shred in to vascular strands and become straw colored on drying. In head rot, white mycelium growth of the fungus is observed. White, fluffy mycelium of the pathogen can also be found inside or outside infected tissues under moist conditions. Sclerotia can survive in soil for many years, with or without

crop residue. Such heads fall off and have no seeds.

ALTERNARIA BLIGHT

Alternaria blight is one of the most prevalent and serious diseases of sunflower and could become epiphytotic (Mirza and Beg, 1983). Many workers have reported *Alternaria* blight as one of the serious disease in Pakistan (Ghafoor and Khan, 1974; Mirza and Ahmad 1982; Mirza and Yasmin, 1983; Ahmad 1988; Bhutta *et al.*, 1993). *Alternaria* spp. was first described as a sunflower pathogen (Sackston, 1978) and since then it has been found in most parts of the world and destructive in some years. *A. helianthi*, the leaf, stem and head spotting pathogen, appears to be the most threatening (Sackston, 1978). *Alternaria* leaf spots have been reported to reduce the seed and oil yield by 27 to 80 percent and 17 to 33 percent respectively (Reddy and Gupta, 1977; Balasubrahmanyam and Kolte, 1980). The damage due to the disease is the number of seed per head, followed by yield. It also affects the quality of seeds by adversely affecting the seed germination vigor of the seedlings. In Pakistan, these diseases are also reported; as major limiting factors in sunflower production (Mirza and Beg, 1983; Blinda *et al.*, 1993; Bhutta *et al.*, 1995).

Symptoms. The symptoms first appear in the form of dark-brown to black, circular to oval-shaped spots on the lower leaves. The spots are surrounded by necrotic chlorotic zones with gray white necrotic center marked with concentric rings. The disease spreads gradually to the middle and upper leaves. Late in the season, elongated spots are found on petioles, stems, and ray-florets resulting in leaf blight and sometimes cause rotting of stem and heads. High humidity favours the pathogens.

SEPTORIA LEAF SPOTS

Septoria leaf blight of sunflower, caused by *Septoria helianthi*, is widely distributed throughout the world with reports from Europe, Asia, Africa, Australia, North and South America (Frandsen, 1948; Kubenkova, 1980; Liu and Lu, 1988; Petrov and Arsenijevic, 1996; Rashid and

Platford, 1992 and 1994; Yang *et al.*, 1988). Septoria leaf spot on sunflower was first observed by Henry and Gilbert (1924) and subsequently reported from many countries of the world including India and from Pakistan with a different climatic zone (Siddique and Yasmeen, 1982). The pathogen has also been reported in Pakistan on sunflower (Akhtar and Mirza, 1988). *S. helianthi* has been recorded in various parts of the world causing reduction in yield. Its 30-60% incidence also has been reported from Pakistan (Mirza, 1984).

Symptoms. On average, 5-8% plants show leaf spot symptoms. Plants show small irregular spots on lower leaves which gradually spread to upper leaves. The spots mostly start from the margins of leaves, coalesce resulting in the development of yellow to dark brown irregular blotches. Small angular to more or less circular or sometimes diamond shaped, brown to dark brown spots develop on upper leaf surface and lighter gray brown on lower leaf surface. In these spots many small pycnidia are develop on both surfaces of leaves under moist conditions. A spot coalesce and leaves wither and dry first on lower and gradually spread to upper leaves (Hamid and Jalaluddin, 2007).

RHIZOPUS HEAD ROT

Three species of *Rhizopus* cause head rot of sunflower (*Helianthus annuus*) around the world: *R. oryzae* Went & Prinsen Geerligs (synanamorphs *R. nodosus* Namyslowski and *R. arrhizus* A. Fischer), *R. microsporus* Tiegh., and *R. stolonifer* (Ehrenb.:Fr.) Vuill. (synanamorph *R. nigricans* Ehrenb.). Head feeding by larvae of several insect species is correlated with the severity of *Rhizopus* head rot (Klisiewicz, 1979; Rogers *et al.*, 1978). *M. phaseolina* (charcoal rot) and *Rhizopus* spp. (head rot) were reported as most destructive on sunflower crop in Pakistan (Mirza and Beg, 1983).

Symptoms. The head turns brown and become soft, gray mycelial growth develop later. Brown irregular water soaked spots appears at back of head. These spots enlarge, turn brown, and become soft and pulpy. Heads clearly look

abnormal. Wet weather following flowering favors disease development, particularly if the heads are damaged by hail, birds, or insects. There is no control, although varieties with upright heads are more frequently infected than varieties with bending heads.

VERTICILLIUM WILT

Verticillium wilt is caused by a persistent soilborne and seedborne fungus, *Verticillium dahliae* that remains in the soil for several years. Verticillium wilt may be a serious disease on lighter soils with a history of sunflower cropping. Infection occurs when soilborne microsclerotia germinate and penetrate sunflower roots. The fungus grows into the plant's vascular system, producing numerous microsclerotia that spread throughout the entire vascular system and all parts of the plant.

Symptoms. Verticillium wilt symptoms can be on individual plants or groups of plants in a field. Disease symptoms first appear on older plants, generally after the six-leaf stage. Prominent yellow, inter-veinal patches appear on leaves, which are gradually enlarged and coalesce, while leaf centers turn brown and necrotic, having mottled appearance. Affected leaves rapidly become dry and die. Symptoms usually are not observed until flowering but under severe conditions they may occur as early as the six-leaf stage. Severely diseased plants may contain masses of tiny black fruiting bodies (microsclerotia) inside the stalk. These microsclerotia look like finely ground pepper. When highly magnified, the microsclerotia are irregular to club-shaped (0.1 mm or less in length). Affected stems have black streaky patches on them, and roots are also affected. Plants show stunting, small flower heads and destruction of root system.

RUST

Sunflower rust, incited by *Puccinia helianthi* Schwein., is a major disease in sunflower (*Helianthus annuus* L.) growing areas of the world (Quresh and Jan, 1993). Rust disease has been reported in Pakistan; however, information on

incidence and distribution of disease in various agro-ecological zones is not comprehensive. Oil yield losses in sunflower caused by rust infection are greatly influenced by the growth stage of the plant when infection occurred and by the intensity of infection (Siddiqui and Brown, 1997).

Symptoms. Small, chestnut brown or orange to black powdery, scattered pustules appears on lower leaves first. But can spread to all leaves and even living parts of the head. The leaves become dry pre-maturely, affecting yield and seed quality. The leaves may turn yellow but rarely fall on the plants. The first pycnial and aecial infections usually occur on volunteer seedlings, growing among the debris of the previous crop. The inoculum from the affected crop is spread by wind.

DOWNY MILDEW

Downy mildew disease of sunflower has been considered as a potentially destructive disease. This disease had spread to all sunflower growing countries mainly through seeds (Viranyi, 1990). Downy mildew is a serious obstacle in sunflower cultivation due to its systemic nature of infection. Sunflower downy mildew caused by *Plasmopara halstedii*, is a one of major disease of sunflower (Rahim *et al.*, 2002). *Plasmopara halstedii* (Farl.) Berl and de Toni is the most destructive one. *P. halstedii* is a soil-borne pathogen, its oospores serving as primary inoculum for young sunflower seedlings. The disease has been distributed mainly by seed to all sunflower growing countries (Leppik, 1966; Viranyi, 1990). Powdery mildew has also been reported in Pakistan (Mirza, 1984).

Symptoms. *P. halstedii* may induce disease symptoms of various kinds depending on age of tissue, level of inoculum, environmental conditions and cultivar reaction. The main symptoms include damping-off of seedlings; systemic infection of stem leaves and flower/seed head, which is the most typical and important; cotyledon-limited systemic infection (Ljubich and Gulya, 1988); localised below-ground infection of roots and/or hypocotyl; localised leaf infections causing angular leaf spotting. The downy mildew fungus attacks sunflowers as both

seedlings and mature plants, causing white cottony growths in the young plants, and large, clublike roots and stunted growth in the older ones.

Symptoms. Typical symptoms occur in seedling stage. Infested seedlings die, but those that and carrying systemic downy mildew infection are stunted and the leaves show characteristic green and chlorotic mottling along the main veins and over the lamella. Local foliar lesion symptoms are characterised by small angular greenish yellow spots on leaves. In the affected plants flower heads are erect. Under moist conditions, a white downy growth composed of sporangiophores and sporangia of the fungus appears on the lower leaf surface corresponding to chlorotic areas above.

SEED BORNE DISEASES

Sunflower seeds, which are consumed as raw, roasted or salted, contain 32 to 45% edible oil, which is a rich source of polyunsaturated fatty acid. Several seed-borne fungi including species of *Alternaria*, *Aspergillus*, *Cladosporium*, *Curvularia*, *Drechslera*, *Fusarium* and *Penicillium* have been reported from sunflower seeds (Reddy, 1989; Kaur *et al.*, 1990; Shahnaz and Ghaffar, 1991). Moreover, seed-borne fungi decrease protein, carbohydrate, cholesterol contents, iodine values and increase acid quantity (Singh and Prasad, 1986; Sexana and Karan, 1991; Ahmad *et al.*, 1994). Low quality with reduced and discolored oil contents of sunflower seeds are reported to be caused by species of *Rhizopus* (Zad, 1979; Singh and Prasad, 1977). Damages of seeds, such as seed death, seedling and plant abnormalities or decreased seed vigor caused by seed-borne pathogens are not always recognised by users.

Shahnaz and Ghaffar (1991) reported 5 *Fusarium* spp., with predominant occurrence of *F. moniliforme* and *F. solani*. But, *Fusarium oxysporum* and *F. solani* which were isolated from seeds are aggressive pathogens of sunflower as compared to *F. moniliforme* and *F. pallidoroseum* (Bhutta *et al.*, 1997). *Acremonium fusidioides*, *Arthrotrrys oligospora*, *Aspergillus ochraceus*, *Bipolaris bisepata*, *Cephalophora tropica*,

Chaetomium spinosum, *Cladobotryum varium*, *Cladosporium cladosporioides*, *Emericella nidulans*, *Gonatobotrys simplex*, *Humicola grisea*, *Memnoniella echinata*, *Mucor mucedo*, *Myrothecium verrucaria*, *Phialophora verrucosa* and *Syncephalastrum racemosum* were found to be new seed-borne fungal species on sunflower in Pakistan (Sharfun-Naharet *et al.*, 2005).

OTHER FUNGAL DISEASES

Several other pathogens also attack the sunflower crop. *Phomopsis macdonaldii* capable of causing extensive internal stalk decay and premature opening of sunflower it seed yield losses are slight (Carson, 1991). In Pakistan, its incidence was reported in Punjab (Masirevic *et al.*, 1987). *Phomopsis helianthi*, causal agent of brown spot and stem canker of sunflower caused 20 percent loss on hybrids in Iran (Madjidieh, 1988). In Pakistan *Phoma bracea* is only reported in Punjab area in traces (Masirevic *et al.*, 1987). Root rot caused by *Rhizoctonia* and *Macrophomina* species, *Cercospora* leaf spots caused by *Cercospora helianthi* are also sometimes less as well more important fungal diseases. *Phialophora asteris* f.sp. *helianthi* has also been reported as wilting agent at flowering stage of sunflower (Mirza and Ahmad, 1999).

ROOT KNOT NEMATODE

In Pakistan, the root-knot nematode problem is more damaging than in developed countries, because the country has tropical and sub-tropical regions, where the climate is suitable for nematode activity throughout the year (Khan and Ahmad, 2000).

Amongst root knot nematode, (*Meloidogyne incognita*) has proved to be a threat to sunflower crop. Root knot disease of sunflower is becoming one of the most serious calamities for the successful cultivation of sunflower crop. On account of alarming losses, it requires immediate and due attention to minimise its predation (Rehman *et al.*, 2006). According to an estimate root knot nematode cause 16.44% yield losses in infected sunflower plants followed by yellowing, stunting and killing of plants (Rehman *et al.*, 2006).

Meloidogyne incognita is the most widely distributed species as it was found in all the 34 districts of Punjab (Khan and Ahmad, 2000).

In the other parts of Pakistan, such as Karachi and Sindh too, *M. incognita* has also been found to dominate over the other species (Ahmad and Saeed, 1981).

INSECTS

The major hazards to sunflower seed production are insects. These insect pests serve as vector for virus and other diseases. Leaf curling, chlorosis and premature senescence of plants can be due to severe infestation on sunflower by *Empoasca abrupta* (Rogers, 1981). Sunflower acts as a host of several which ravage it both in the field as well as in the warehouses and inflict severe losses.

The pests ravaging this crop include Cutworms (*Agrotis* spp.), Green stink bug (*Nezara viridula* nnaeus), American bollworm (*Helicoverpa (Heliothis) armigera*), Cotton aphid (*Aphis gossypii* Glov), Potato aphid (*Iacrosiphum euphorbiae* Thos), and Cabbage semi-looper (*Plusia orichalcea* (Fabricius)). Others include ifflower caterpillar (*Perigea capensis* G), Head caterpillar (*Tathmopoda theoris* Mayr), Melon fly (*Dacus Cucurbitae* Coq.), whitefly (*Bemisia tabaci* Genadius), Yellow flower thrips (*ankliniella sulphurea* S.), several species of army worms, grasshoppers and termites, Brown bruchid (*Caryedon gonagabricus*), Sawtoothed beetle (*Oryzaephilus* spp.) (Aslam, 2000). Whiteflies, loopers and Jassids have also been recorded on different local genotypes of sunflower in Pakistan. (Rafiullah *et al.*, 1998).

The insect pests found in sunflower (cultivated and wild) also include *Agrotis* spp (Cut worm), *Odontotermes obesusi* (White ants), *Agapanthia dahlii* (Stem borer), and *Melanagromyza* spp. (Stem girdler), *Aphis gossypii* (Cottoii aphid). Others include *Agnus convolvoli* (Horn worm), *Empoasca* spp., *Su/eima helianthana* (Sunflower bud moth), *Helicoverpa* spp. (bull worm) *Spodoptera litura* (Tobacco caterpillar), and *Plusia ohchalcea* (Cabbage semilooper). Also included are *Homoeosoma electellum* (Sunflower moth), *Atezara viridula*

(Green stink bug) *Diacrisia obliquata* (Hairy caterpillar), *Myllocerus b/andus* (CoXXon green weevii), *Zygogramma exclamationis* (Sunflower beetle) and *Smicronyx* spp. (Sunflower seed weevil) (Aslam *et al.*, 2000; Ashfaq and Aslam, 2001). Butt (1989) discussed that major insect pests found on sunflower genotypes are *Amrasca devastans*, *Thrips tabaci*, *Bemisia tabaci*, Tingid bug and *Eutetranychus* spp. Kakakhel *et al.* (2000) reported that the insect pests attack on sunflower are *Bemisia tabaci*, *Empoasca* spp., *Thysanoplusia orichalcea*, *Diacretia obliqua*, *Nezara viridula*, *Helicoverpa armigera* and *Nysius inconspicuus* .). Sattar *et al.* (1984) also reported the insect pests of sunflower as whitefly, *Bemisia tabaci*, aphids *Aphis gossypii*, jassids (*Amrasca devastans*), bud moth (*Heliothis armigera*) and surface grass hopper (*Chrotogonus* spp.).

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