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SOYBEAN DISEASES IN PAKISTAN - *A REVIEW*

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ABSTRACT

Soybean diseases have been intensively studied in soybean-growing countries. In Pakistan, research on diseases and their control is limited so far. Different diseases damage the crops and result negligible and sometimes 100 percent loss in out put. Oil seed crops are subjected to various mechanical, physiological and biological stresses in all stages of growth and in all natural environments, which interfere with their normal growth and development. Weather, toxicants, pollutants, insects, viruses, fungi, nematodes, bacteria and weeds are primary hazards to the production. An account of the most important diseases of soybean crop in Pakistan was discussed.

Key-words: Soybean, plant diseases, pathogens, fungi, nematodes, viruses, control.

INTRODUCTION

Soybean, a native of Asia, is an important legume, a primary source of vegetable oil and protein. Soybean products become more important in formulating new, low cost, nutritionally balanced and high quality protein food and beverages for human consumption. Soybean had been known the world over as unmatched amongst oil seeds for its nutritive qualities, and is acknowledged as the Protein King for its highest protein content besides having an abundance of mineral salts and Vitamin A, B, & D. In Pakistan the consumption of edible oil has been reckoned to be 1.09 million tons in 2000-2001 of which 29% was produced locally and the remaining 71% was imported (Badar, 2002). Oil seed crops are subject to various mechanical, physiological and biological stresses in all stages of growth and in all natural enviroments that interfere with their normal growth and development. Weather, toxicants, pollutants, insects, viruses, fungi, nematodes, bacteria and seeds are primary hazards to the production. Overall, all diseases are injurious in some areas, in some years and on some plant parts. All parts of plant are subject to diseases and one or more diseases can occur on virtually every plant and in every field. Qualitative estimated world loss by these infectious diseases was 7 million metric tons (Sinclair, 1987). Soybean is widely utilized in our food, animal food and industrial application due to its high protein content (40%), oil (20%) and meal production from the seed. The oil extract from soybean is free from any poisonous material. The oil has predominant proportion of polyunsaturated fatty acids, which help to reduce the cholesterol level of human body (Neergaard, 1977 and Khan *et al.*, 1998). Pakistan is deficient in edible oil production. In order to meet up the shortage, palm oil is imported from Malaysia and soybean oil from USA and Argentina. Approximately US $1 billion is spent on the import of edible oil which is the second highest import bill after fossil fuel (petroleum) (Anonymous, 1999-2000). Because of the low yield of the traditional oil-seed plants (mustard, ray, rape seed etc) edible oil demand cannot be met. Attempt is therefore being made to cultivate nontraditional oil seed plants (sunflower and soybean) in Pakistan. Edible oil is one of the basic food requirements. The shortage of edible oils had started developing from 1970 due to rapid increase in population, per capita consumption and local edible oil production remained almost stagnant. Despite the fast increasing demand of edible oil, the outflows for the last 5 years were 413.4 to 856 million US Dollar (State Bank of Pakistan, Annual report, 1999-2000).

The agro-climatic condition of Pakistan is not conducive in general for palm oil cultivation. Sunflower and soybean have been found to have the potentiality to raise the productivity of edible oil in Pakistan (Nasir, 2003). In Pakistan, soybean seed diseases cause many losses on soybean production (Ghafoor and Khan, 1976; Hussain *et al.*, 1989; Shaukat *et al.*, 1989; Asif *et al.*, 2001). More than 40 fungi, bacteria and viruses have been reported to be actively associated with the seeds of soybean (Hartman *et al.*, 1999).

Infectious diseases caused by fungi, bacteria, viruses and nematodes effect the quality of soybean products (Sinclair, 1987). Sinclair and Dhingra (1975) have reported 66 fungi and 3 bacterial diseases associated with soybean seeds, source of primary inoculum of field diseases. Common diseases of soybean in Pakistan are anthracnose, charcoal rot, pod and stem blight, *Fusarium* root rot, wilt and collar rot, purple seed stain and rust.

Domestic production of oilseeds in Pakistan meets only 30 percent of demand. So, there is a dire need to up lift its production through disease control. The present work is a review of soybean disease research findings from Pakistan and the brief understanding of diseases concerned.

FUNGAL DISEASES

ANTHRACNOSE

Anthracnose is a fungal disease caused by the fungus *Colletotrichum dematium* var. *truncatum* and several related species (Jiskani, 2001). Typically this disease does not cause severe symptoms or yield loss. Development of anthracnose is favored during periods of moderate temperatures and high humidity or wet weather.

Symptoms: The fungus infects stems, petioles and pods of plants nearing maturity or early reproductive stages. Symptoms of anthracnose are reddish veins, rolled leaves, and dark blotches on stems, pods and leaf petioles. Dark brown or reddish-brown areas may cover the surface of infected stems and pods. Lower branches die. Later, infected areas may become covered with the black fruiting bodies of the fungus (acervuli). Severe infection can lead to premature defoliation. Seed in infected pods may be shriveled and moldy and stained brown or dark or show no external sign of the disease. The fungus is carried over on the seed. Germinating seed may be killed before they produce a seedling. Some times dark brown sunken cankers develop on the cotyledons of young seedlings. Dark brown lesions on cotyledon, become water soaked, quickly wither and fall off in seedling stage. The irregularly shaped brown blotches caused by anthracnose may resemble pod and stem blight. Often, anthracnose and pod and stem blight occur together on the same plants late in the season.

Perpetuation: The fungi survive between seasons in infested crop residue and seed. Early season infection can be from seed inoculum, while infection during flowering is mostly from infected plant residue. High plant populations and wet canopies favor disease development.

CHARCOAL ROT

Fungal pathogens which cause charcoal rot in soybean are *Macrophomina phaseolina*, *Rhizoctonia bataticola* and *Sclerotium bataticola* (Mirza, 1988 ; Chaudhry *et al.* 1988 and Kunwar *et al.* 1986), Reduced plant vigor resulted in increased seed infection by *Chaetomium, Cladosporium* and *Fusarium* species. Low rainfall and high temperature in the early growing season of soybean caused seed infection with *Macrophomina phaseolina* (Jordan *et al.* 1992).

Symptoms: Disease appears in hot, dry weather usually after the plants have initiated flowering and have begun setting pods. Plants become weak, mature early and when dry, show light gray or ashy black discoloration of stem. The disease characterized by sudden wilting of plants. Leaves of infected plants turn yellow, and entire plants wilt and die with the leaves remaining attached. The most reliable diagnostic symptom is the development of tiny black specks (sclerotia) just beneath the epidermis, or bark, of the taproot and lower stem. The small sclerotia resemble a sprinkling of powdered charcoal in the diseased tissue, hence the name charcoal. Wilted plants often occur in circular patches in low areas of a field. Plants infected by the charcoal rot pathogen may have premature yellowing of the top leaves and premature leaf drop. Plants in the driest parts of the field will likely show symptoms first. Look for unfilled upper pods and general low plant vigor. In some cases, the upper one-third of the plant may have only flat pods without seed.

Seedling infection. Root infection by germinating microsclerotia can occur very early in soybean plant development. Wyllie (1976) reported that *M. phaseolina* could infect up to 100% of soybean plants within 3 or 4 weeks after planting. The fungus can continue to infect soybean plants throughout growing season and charcoal rot symptoms can be are evident in soybean plants of all ages.

Perpetuation: The fungi perpetuate on the infected host plant debris in dry soils for a long period, but in moist (wet) soil, it cannot survive for longer.

POD AND STEM BLIGHT.

In Pakistan, Jaskani (2001) reported *Diaporthe phaseolorum* as causal agent of pod and stem Blight.

Symptoms: Many black flasks shaped pycnidia, usually arranged in rows, developed on the lower portion of the main stem, branches and pods as plants reach maturity. Pycnidia also found scattered on dry poorly developed pods. Seeds are badly cracked, shriveled and may be encrusted with a white fungal mass. Seeds infected with pod and

stem blight produce diseased seedlings that frequently become blighted and die. Generally, pod and stem blight is first observed occurring on fallen petioles near the base of attachment or on stems just above petiole attachment.

Pod and stem blight has little effect on crop yield, but seed quality can be greatly affected. The disease is principally of concern to soybean seed producers. Pod and stem blight can be confused with anthracnose. Warm, humid weather favors the development of both diseases. Occurring late in the season, both diseases frequently occur together on the same plants.

Perpetuation: The fungi survive the winter in both infected seed and crop residue. Infected crop residue can lead to high levels of pod and stem blight in fields. Seed infection occurs only if pods become infected. Pod infection can occur any time starting at flowering, but extensive seed infections will not take place until plants have pods that are beginning to mature

Damage to pods by insects will favor the development of both pod and seed infections. Early maturing soybean varieties and early plantings tend to be affected more than later maturing cultivars and late plantings. This is because the early maturing and early plantings mature during more disease- favorable conditions than the late maturing and late plantings. Delayed harvest can significantly increase pod and stem blight in both early- and late- maturing cultivars.

FUSARIUM ROOT ROT, WILT AND COLLAR ROT

In Pakistan *Fusarium* root rot, wilt and collar rot of soybean has been recorded on soyabean which are causing heavy losses (Hussain *et al.,* 1989 and Khan *et al.,* 1974). Frequently *Fusarium* spp. are found on root rot, wilt and cololar rot infected soybean (Asif *et al.,* 2001). Ferant and Carroll (1981) recorded *Fsarium oxysporum* Sheldon form roots and stem of wilted soybean plants. Lee, (1984) isolated *F. moniliforme* Sheldon, *F. solani* (Mart) Sacc. and *F. oxysporum* from soybean seed. *Phytophthora megasperma* f. sp. *sojae* may also be a cause of stem and root rot in soybean (Saleem *et al.,* 1993).

Symptom

Root rot: Seedlings are stunted or damp off; adult plants show root rot. Dark brown to black lesions form on root and lower stem; plants may wilt in dry weather Severely infected plants are stunted, wilted, and have yellow leaves. Seedlings may damp off. *Rhizoctonia* usually makes reddish-colored lesions on the roots. Heavily infected roots (hypocotyls) appear dry and rough and a chocolate-colored rot may progress up the pith. *Fusarium* causes elongated lesions without definite margins. Often the roots (hypocotyls) turn entirely brown in color. *Fusarium* seldom extends beyond the soil line.

Fusarium wilt: Fusarium wilt as the name suggests causes a wilting of the soybean plant. This wilting has often been misdiagnosed year as Phytophthora root rot. From a distance the affected plants do look to have Phytophthora root rot. Affected plants have a wilting of the stem tips and the upper leaves are scorched. The middle and lower leaves can turn yellow or have pale (dull) yellow spots. In severe cases the leaves will dry up and drop prematurely leaving the petiole behind. The leaves usually remain attached to plants killed by Phytophthora root rot. There also is no evidence of a stem lesion or external decay does not go above the soil line as with Phytophthora. A lenthwise cut through the roots and stem will reveal a browning of the vascular tissue and pith. This may be confused with early-season brown stem rot. Fusarium infested roots often have red, orange or white mycelium visible.

PURPLE SEED STAIN

Purple seed stain on soybean was first reported in Korea in 1921 (Suzuki, 1921) whereas, in the United States, it was first reported in Indiana in 1924 (Gardner, 1926). Purple seed stain does not reduce yields directly, but it may cause reduced stands (Schuh, 1999). *Cercospora kikuchii* infects leaves, stems, and pods of soybean (*Glycine max* (L.) Merr.), where it causes purple seed stain and Cercospora leaf blight (Matsumoto and Tomoyasu, 1925; Suzuki, 1921; Walters, 1980). Purple seed disease stain is one of the soybean diseases in Pakistan (Jiskani, 2001).

Symptoms. Symptoms are, as the name implies, a pink to purple to dark purple staining of the soybean seed coat. The discolored area will range from specks to large blotches that may envelope the entire seed. Seeds are often dull, cracked and rough. Round, reddish purple spots that later become purplish black also develop on pods. Infected seed can result in diseased seedlings and reduced stands. Cotyledons will become dark purple, shrivel, and fall off. This can spread to the stem, producing necrotic areas that can girdle the stem and kill seedlings. Less affected seedlings are stunted. Interestingly enough, infected seed may not show any of these symptoms. Under field conditions, symptoms of Cercospora leaf blight are observed at the beginning of and throughout seed set. Reddish purple,

angular-to-irregular lesions occur on upper leaves exposed to sunlight. Numerous infections cause rapid chlorosis and necrosis of leaf tissue, resulting in defoliation, and can cause substantial yield loss (Schuh,1999).

Perpetuation: Carry over through infected seeds and host plants.
Soybean growing has expanded dramatically in Brazil over the last four decades. It has been the driver for a number of important developments: the establishment of commercial agriculture; the modernisation of transport routes; the increase in international trading; and the interiorisation of the population, all of which are directly connected with the expansion of soybean cultivation.

NEMATODE DISEASES

Soybean crop is attacked by a number of plant parasitic nematodes *Heterodera glycines* (soyabean cyst nematode), *Meloidogyne incognita* (root knot nematode) and *Rotylenchulus reniformis* (reniform nematode) but root knot nematode (*Meloidogyne* spp.) has been reported to be the most damaging in Pakistan (Maqbool *et al.,* 1992) while the chemical control by Aldicarb was found very effective against *Meloidogyne* spp. (Hafeez *et al.,* 1998). These nematodes are often reported yield reduction upto 33% on susceptible soybean varieties (Rebois, 1973), but if pathogen are allowed to develop unchecked, loss may occur up to 90% (Kinloch, 1974). Soybean cyst nematode, *Heterodera glycines*, root knot nematode, *Meloidogyne incognita* and sting nematode, *Belonolaimus longicaudatus* predispose seedling and young plants to *Fusarium oxysporum* to cause wilt (Ross, 1965).

Symptoms
Soybean cyst nematode: A potentially serious disease, plants are stunted and may have small pinhead sized cysts on roots. The cysts are white, later turning brown. Stunted plants develop in elliptic or lens-shaped areas in the field with the long axis parallel to the direction of major tillage.

Root knot disease: Infected plants may be stunted and yellow-green, with a tendency to wilt under moisture stress during hot, dry weather. The disease can be identified by the presence of knots or galls of varying size and shape on the roots of infected plants.

VIRAL DISEASES

In Pakistan, two viral diseases have been recorded. Soyabean mosaic virus (SMV) and Mung Bean Yellow Mosaic Virus (MBYMV). SMV is a viral disease of soybean transmitted by aphids (Sinclair, 1982) while, Ali and Hassan (1993) reported that primary source of this virus in NWFP is the infected seed from the previous crop. MBYMV disease is transmitted by white fly (*Bemisia tabaci*) (Ahmad and Harwood, 1973). The soybean crop is attacked by a number of viral diseases but Yellow Mosaic disease caused by MBYMV is the most common and serious disease, especially in tropical and subtropical countries (Costa, 1975). This disease is also widely distributed in India and Bangladesh (Nene, 1972). The causal virus was initially recorded on mung Bean and urdbean (Nariani, 1960). Aftab *et al.,* (1990) reported that there are certain natural MungBean Yellow Mosaic Virus resistant varieties, which should be further propagated for better crop production.

Symptoms: Yellow mosaic occurred as yellow patches on leaves turn chlorotic to brownish, remain stunted and do not flower in early infection. Mosaics characterized by intermingled patches of normal and light green, yellow or white areas of the leaves or fruits, or are whitish areas intermingled with areas of the normal color of flowers or fruits. The mosaic depends on the intensity or particular pattern of discoloration. The mosaic type symptoms may be described as mottling, streak, ring pattern, line pattern, vein clearing, vein banding, chlorotic spotting, etc. The viruses causing most mosaic diseases are mechanically transmitted and usually have aphid vectors in nature, are generally resistant to brief heat treatments, and do not stop flowering or effect the dormancy of buds.

Leaves are mottled green and yellow; small veins turn yellow. Leaves become crinkled in cool weather. Entire plant becomes stunted and yellow. Seed hilums may "bleed" and entire seeds may be mottled brown or black. Some leaf symptoms may be mistaken for 2,4-D injury.
Symptoms vary depending on the variety of the soybean and the strain of the virus. Stunted plants with crinkled and mottled leaves are characteristic of soybean mosaic. Yellow mottling of young leaves during periods of rapid growth is characteristic of bean pod mottle virus infection. Plants infected by tobacco ringspot virus are often stunted, and petiole and leaf growth are abnormal. Plants can be infected by two or more of these viruses.

SEED BORNE PATHOGENS

The most predominantly occurring seed borne fungi of soybean isolated from Pakistan earlier (Ghafoor and Khan, 1976; Shaukat *et al.,* 1989; Hussain *et al.,* 1989, Ali *et al.,* 1995 and Arshad *et al.,* 1996) have been found to be *Alternaria alternata, C. cladosporoides, F. oxysporum, M. phaseolina, Drechslera specifera, F. moniliforme, Curvularia luanata* and *Rhizoctonia solani*. Kunwar *et al.* (1986) studied the histopathology of dark brown and shrunken seeds of soybean and found it to be infected with *A. alternata*. A regional survey of literature on seed borne fungi of soybean revealed 12 species by Karmaker *et al.* (1980) from India, 9 species by Zad (1982) from Iran, which is situated in the east & west of Pakistan respectively. Hussain *et al.* (1989) reported 15 species of fungi from NWFP, Pakistan and we found 39 species of fungi from southern region of Pakistan. Nasir (2003b) found Benomyl the most effective against six most predominantly occurring fungi on seeds of soybean i.e. *A. alternata, C. cladosporoides, M. phaseolina, D. specifera, F. oxysporum* and *R. solani* .

MINOR DISEASES

Leaf spot and pod blight

Leaf spot is caused by *A. tenussine*, pod blight caused by *Alternaria* species (Jiskani, 2001).

Symptoms: Symptoms are generally confined to older leaves. Lesions tend to become circular, dark-brown and zonate with advanced age and size. Centers of older spots may appear gray and often fall out, leaving a dark-brown, lesion border and a shot hole effect on the leaf. Petioles and stalks may also become infected, developing dark-brown elongated spots. The most conspicuous symptom is small, raised black pimples on pods that throw produce out of grade. *Alternaria* infections of bean plants occur throughout the season in the winter vegetable areas of southern Florida. This disease is often found on plants that have been injured by spider mites or nutrient stress.

Bacterial Blight

In Pakistan, Asif *et al.,* (2001) reported following seed borne bacterial species i e., *Corynebacterium flaccumfaciens pv. flaccumfaciens, Pseudomonas syringeae pv. phaseolicola* and *Xanthomonas campestris pv. phaseoli* . They concluded that these might be the cause of bacterial blights in Pakistan.

Symptoms: The bacterial infection causes stunting of young seedling and infected seeds may shrivel and become discolored. (Kennedy and Tachibana, 1973). These diseases may attack the seed, seedlings, leaves and pods. Many seedlings from infected seed may die before or soon after they emerge, but some may continue to live. In either case, they serve as a source of inoculum for nearby plants. During wet weather, lesions on these infected plants produce slimy masses of bacteria that are spread by wind-blown rain or mechanical means. On older plants, the first evidence of infection of the leaves appears in the form of water-soaked spots. Later, the spotted leaf tissue turns brown and dies. The spots on the pods start as water-soaked (greasy) areas and later become surrounded by a brick-red border.

INSECTS AND THEIR CONTROL

Major insects damage soybean crops are stem fly, white fly, green stinkbug, cut worm and larvae. Insects attack on all parts of the soybean plant and feed throughout the growing season. Certain insect can also provide access for disease organism and or transmit them directly to plants. Therefore, understanding the relationships between the insect and the crop will enable farmers to manage pests much better. A new practice to control insect attack is based on knowledge of the economic injury levels of the consequential insects. The economic injury levels are the population of insects that is capable of producing an amount of economic damage, which is at least equal to the cost of controlling the insects. Wise monitoring of major insects is required in order to effectively make decision relative to insecticide application

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