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RESEARCH PAPER

Diseases prevalent in *Kharif* crops grown in Barmer district of Rajasthan, India

Durga Prasad
Department of Plant Pathology, College of Agriculture (Agriculture University), Baytu (Rajasthan) India
(Email : dp.coabaytu@gmail.com)

Abstract : In the *Kharif* season, pearl millet (*Pennisetum glaucum*) is the predominant crop of the Barmer district followed by cluster bean (*Cyamopsis tetragonoloba*) and moth bean (*Vigna aconitifolia*). Sesame (*Sesamum indicum*) and green gram (*Vigna radiata*) are other important *Kharif* oilseed and pulse crops, respectively. A survey was conducted to determine the status of major diseases of *Kharif* crops grown in the Barmer district of the *Marwar* region of Rajasthan, India. Five blocks and three villages in each block were surveyed through a random field survey method during the collection of diseased samples every Sunday for the practical classes of agricultural students of the College of Agriculture, Baytu; in August and September 2023. Per cent disease incidence was recorded on randomly selected plants in a particular field of selected location. The incidence of diseases was observed based on typical field symptoms and later the association was confirmed through microscopic examinations in the laboratory. In survey, yellow mosaic (virus), leaf crinkle/ curl (virus), bacterial leaf spot/ blight (*Xanthomonas phaseoli)* of green gram;green ear/ downy mildew (*Sclerospora graminicola*), rust (*Puccinia substriata*) and blast (*Pyricularia grisea*) of pearl millet; Phytophthora stem blight (*Phytophthora parasitica* var. *sesame*) and phyllody (Phytoplasma) of sesame; yellow mosaic (virus)and bacterial leaf spot/ blight (*Xanthomonas axonopodis* pv. *cyamopsidis*) of cluster beanwere recorded with >50% incidence. However; charcoal rot (*Macrophomina phaseolina*), web blight (*Rhizoctonia solani*), Cercospora leaf spot (*Cercospora canescens*) and anthracnose (*Colletotrichum lindemuthianum*) of green gram; Alternaria blight/ leaf spot (*Alternaria sesame*) of sesame,sorghum rust (*Puccinia purpurea*) and Alternaria blight/ leaf spot (*Alternaria cyamopsidis*) of cluster beanwere noticed with 10 to 50% incidence.

Key Words : Barmer, Green gram, *Kharif*, Moth bean, Pearl millet, Rajasthan, Sesame

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INTRODUCTION

Plant disease has greatly influenced the evolution of human society and food production over thousands of years (Palmgren *et al.,* 2015). In the early agricultural era, there were very few overt plant disease management strategies since plant disease epidemics were perceived as divine retribution. Due to the typically low yields and lack of substantial food stocks, food shortages may quickly arise during disease epidemics, which might have severe repercussions on human society. Examples of such famines include the Bengal famine, which was caused

by rice brown spot, and the Irish Famine, which was caused by potato late blight. Plant diseases cause enormous annual losses in terms of both quality and quantity of food output (Strange and Scott, 2005). Plant diseases still cause 20–30% of actual output loss annually, even though scientific and technological advancements have significantly reduced the frequency and intensity of epidemics in recent decades (Oerke, 2006). These losses are a reflection of our poor understanding of the mechanisms and causes that lead to the formation of epidemics, which in turn reflects our lack of effective strategies to manage them, let alone eradicate them. In addition, several agronomic techniques and plant disease management measures employed in contemporary agriculture have led to unanticipated issues such as the depletion of natural resources and biodiversity, environmental degradation, and hasty development of pathogens (Gonthier *et al.,* 2014). The main goal of plant protection is to shield crops from biotic and abiotic stressors that reduce output. Disease-related crop losses pose a serious risk to rural households' livelihoods and global food security (Avelino *et al.,* 2015). To assess the effectiveness of crop protection practices, evaluate integrated pest management strategies more effectively (Savary *et al.,* 2006), assess systems sustainability (Cooke, 2006) and evaluate pest and disease management strategies as an ecosystem service (Allinne *et al.,* 2016), quantitative data on crop losses and a deeper understanding of their drivers have been mentioned as being essential. An annual loss of about 20% to 30% owing to plant diseases has an impact on global agricultural productivity. According to the report (2013) of the National Bank for Agricultural and Rural Development, the diseases cause the loss of almost 30% of crops annually in India. An estimated 60,000 cores are lost each year as a result of such type of losses. Our economy and people, which mostly depend on crops and agriculture, will therefore be impacted, either directly or indirectly, if a crop is harmed by a disease (Vipinadas and Thamizharasi, 2015). Field crop output is significantly hampered by diseases. They both directly and indirectly lower yields by weakening the plant and lowering the quality and quantity of goods both before and after harvest. The difficulties vary from deadly ones that destroy local or regional production to aesthetically pleasing ones that make the harvested product less commercially viable. Furthermore, one of the problems facing the agriculture segment in India is the multitude of diseases that target crops. Consequently, the goal of this study was to recognize and catalogue diseases prevalent and affecting the main crops grown in the Barmer district area of Rajasthan, India.

Material and Methods

Geographically, the Barmer district of the Marwar region of Rajasthan, India is situated at 71.81 longitude, and 25.87 latitude at an elevation of 160 meters. The main crops grown in the Barmer district during the *Kharif* season are pearl millet (*Pennisetum glaucum*), cluster beans (*Cyamopsis tetragonoloba*), and moth beans (*Vigna aconitifolia*). Other significant oilseed and pulse crops for the Kharif season are sesame (*Sesamum indicum*) and green gram (*Vigna radiata*), respectively. During the collection of sick samples for the practical activities of agricultural students at the College of Agriculture, Baytu; every Sunday, five blocks (Baytu, Barmer, Gudha Malani, Chohtan and Sheo) and three villages within each block were surveyed using a random field survey approach throughout August and September 2023. The surveys were carried out at a time when they should have coincided with the proper stages of crop growth in every field that was sampled. In the survey study, ten plants were selected randomly from the farmer's field. The incidence of each disease was observedbased on its typical visual field symptoms. The per cent disease incidence was calculated as per its standard formula i.e. (number of diseased plants x 100)/ total number of plants observed. During the survey, the diseased plant samples were collected in a paper envelope and brought to the laboratory for identification of pathogens. In some diseases, the pathogen wasexamined under a compound microscope with 40X magnification (Aneja, 2004) to ascertain the identity of pathogen-associated.

Results and Discussion

Investigations were made to determine the status of major targeted diseases of field crops grown in agro-climatic conditions of the Barmer district of western Rajasthan. During the survey, several diseases likeyellow mosaic (virus), leaf crinkle/ curl (virus), bacterial leaf spot/ blight (*Xanthomonas phaseoli)* of green gram; green ear/ downy mildew (*Sclerospora graminicola*), rust (*Puccinia substriata*) and blast (*Pyricularia grisea*) of pearl millet; Phytophthora stem blight

(*Phytophthora parasitica* var. *sesame*) and phyllody (Phytoplasma) of sesame; yellow mosaic (virus) and bacterial leaf spot/ blight (*Xanthomonas axonopodis* pv. *cyamopsidis*) of cluster bean were recorded with >50% incidence. However; charcoal rot (*Macrophomina phaseolina*), web blight (*Rhizoctonia solani*), Cercospora leaf spot (*Cercospora canescens*) and anthracnose (*Colletotrichum lindemuthianum*) of green gram; Alternaria blight/ leaf spot (*Alternaria sesame*) of sesame, sorghum rust (*Puccinia purpurea*) and Alternaria blight/ leaf spot (*Alternaria cyamopsidis*) of cluster bean were occurred on the farmer's field with 10 to 50% incidence. The occurrence of crop diseases noticed in the above survey is quite in conformity with the reports of earlier workers. Green gram is attacked by several pathogens, especially yellow mosaic (virus), leaf crinkle/ curl (virus), Cercospora leaf spot (*C. canescens*, *C. cruenta*), bacterial leaf blight (*Xanthomonas phaseoli*), powdery mildew (*Erysiphe polygoni*), anthracnose (*Colletotrichum capsici*), charcoal rot (*Macrophomina phaseoli*), web blight (*Rhizoctonia solani*), Alternaria leaf spot (*Alternaria alternata*), Ascochyta blight (*Ascochyta phaseolorum*), root disease complex (*Pythium* spp., *Rhizoctonia solani*, *Fusarium* spp.), reniform nematode (*Rotylenchulus reniformis*) androot-knot (*Meloidogyne* spp.) nematodes. Among all these diseases, the yellow mosaic virus and Cercospora leaf spot arethe most destructive in causing qualitative and quantitative losses worldwide (Nair *et al.,* 2019; Prasad *et al.,* 2021; Singh *et al.,* 2022). In pearl millet, downy mildew (*Sclerospora graminicola*) is considered the mostimportant disease in Asia and Africa (Williams, 1984; Hash *et al.*,1999 and Singh, 1995). Ergot, the second most important also severely affects pearl millet cultivation in India (Arya and Kumar, 1982). Other important fungal diseases (smut, rust and blast), and bacterial andviral diseases also adversely affect the pearl millet yield (Kumar and Arya, 1976; Singh *et al.,* 1993 and Wilson, 1999). Phytophthora blight (*Phytophthora parasitica sesami*), stem and root rot (*Macrophomina phaseolina*), bacterial blight (*Xanthomonas campestris* pv. *sesami*), Cercospora leaf spot (*Cercospora sesami*), Alternaria leaf spot (*Alternaria sesami*), powdery mildew (*Oidium* sp, *Sphaerotheca* sp., *Leveillula* sp.) and phyllody (*Phytoplasma*) are the important diseases of sesame (*Sesamum indicum*) in India(Anonymous, 2013 and Prasad *et al.,* 2023). Bacterial blight (*Xanthomonas axonopodis* pv. *cyamopsidis*), Alternaria leaf spot (*Alternaria cyamopsidis*), yellow mosaic (Virus) and powdery mildew (*Erysiphe polygoni*) are the important diseases that threaten cluster bean (guar) crop production in several guar growing regions (Singh *et al.,* 2018 and Singh 2014). Grain mold, anthracnose, leaf blight, downy mildew, charcoal rot, rust, ergot, smuts, and virus diseases including maize stripe and maize mosaic are among the economically significant diseases that affect sorghum in most semi-arid tropical regions (Thakur *et al.,* 2007). The symptoms of some diseases (Fig. 1) of green gram, pearl millet, sesame, cluster bean (guar), sorghum and citrus observed in the Barmer district of Rajasthan during the survey along with morphological characteristics ofpathogens associated with the diseases are as follows:

Green gram diseases:

Yellowmosaic :

When leaves are young, they first have little yellow patches or spots. The leaves may turn entirely yellow when the yellow tint gradually gets worse. Necrotic signs are apparent in infected leaves as well. Very few flowers and pods are typically produced by the diseased plants, which often mature late. Small and twisted pods are seen. A single-stranded DNA virus of the genus Begomovirus and family Geminiviridae, it is the cause of mungbean yellow mosaic disease.The virus endures in weed hosts and other legume crops, persistently dispersing through the white fly (*Bemisia tabaci*).

Leaf crinkle/ curl :

The initial signs manifest as chlorosis around certain lateral veins and their branches close to the margin on the youngest leaves. The margins of the leaves are curled downward. A few leaves exhibit twisting. The underside of the veins has a reddish-brown discoloration that reaches the petiole. Older leaves begin to severely curl and become rugose, and they thicken. There was a noticeable curling and crinkling of the leaflet tips. Both internodes and petioles were shortened. The look of the infected plant is bushy and stunted. The virus that causes it is spread by thrips.

Charcoal rot :

The initial symptom of the disease is a yellowing of the lower leaves, which is followed by partial defoliation and drooping. Dark brown lesions can be seen on the stem section close to the ground, and the bark at the

collar region has shreds that eventually rot the affected area and cause the plants to suddenly die. It is simple to remove the stem section, leaving the rotting root section in the ground. When the infection spreads to the pods, the young seeds shrivel and turn black as the pods open too soon. Pycnidia and sclerotia are abundantly found in the diseased plant parts. *Macrophomina phaseolina* is the fungus that causes it. The mycelium of the fungus is dark brown, septate, and exhibits constrictions at the hyphal connections. The pycnidia are dark brown with a noticeable ostiole, and the sclerotia are tiny, dark black. Hyaline, elliptical, single-celled conidia are present.

Web blight :

Although the fungus affects every portion of the plant that is above ground, it primarily damages the leaves, killing seedlings. On diseased leaves, water-soaked, irregularly shaped sores emerged. Greenish brown to reddish brown, and finally black, were the colors of these tumours. On the leaves and petioles, a dark brown sclerotia and a fungus with a web-like growth emerged when there was a lot of humidity or rainfall. A reddish-brown lesion at or below the soil's surface appears if the collar region becomes infected. The ulcers encircle the stem, killing the seedling. *Rhizoctonia solani* is the cause of this disease. The mycelium produced by the fungus is septate, dark brown, and has constrictions at the hyphal branches. The mycelium has branches and is colored from hyaline to brown. The septum is of the dolipore type, and the hyphae are multinucleate. Sclerotia are globose, superficially developed, and range in color from white to brown.

Cercospora leaf spot :

Initially, there were small brown spots that developed into larger, darker brown patches, which were the usual symptoms of Cercospora leaf spot. Large necrotic patches were created when nearby spots combined. The centers of well-developed dots were brown with a grey tint. *Cercospora canescens* is the causative agent of Cercospora leaf spot. The mycelium has septa and a color ranging from hyaline to light brown. Conidiophores were multiseptated, straight or flexuous, and ranged in color from light brown to brown. Conidia were straight or curved, hyaline to light brown.

Anthracnose :

The formation of dark brown to black recessed lesions on leaves, usually next to veins, that subsequently turn into greyish-white centers with dark brown or reddish margins were the characteristic symptoms of leaf spots. On the pods, tiny reddish-brown, somewhat sunken dots first appeared. These spots grow and eventually develop black, sunken lesions. Blackening in the veins, especially on the lower surface, was caused by an infection in the leaves. *Colletotrichum lindemuthianum* is the cause of it. The hypha ranged in color from white to dark and was septate. At first, the mycelium was white, but as it progressed, it turned dark black and grew quickly. The conidia were dumbbell-shaped, hyaline and single-celled.

Pearl millet diseases :

Green ear/ downy mildew :

The ear head and leaves both exhibit symptoms of the mostly systemic infection. The infected leaves have areas of light green to light yellow colour on their top surface, while the fungus's white, downy growth is visible on the corresponding lower surface. Sporangiophores and sporangia made up the downy growth that appeared on the lower surface of the leaves. Affected plants develop neither ears nor floral components or if they do, they are entirely or partially deformed into twisted structures of green leaves (green ear disease). It is caused by the fungus *Sclerospora graminicola*. Mycelium is intercellular, non-septate, and systemic. Short, robust and hyaline sporangiophores emerged through stomata to form sterigmata that bear the sporangia. Sporangia are elliptical, hyaline, thin-walled, and have conspicuous papilla.

Rust :

Small uredia that are circular to oval and reddish-brown to reddish-orange mostly form on leaves. Leaf tissue will wilt and get necrotic from the leaf's apex to the base as the illness gets worse. Uredosori quickly covers the leaf, with a greater concentration on the upper surface. Later, telia- which are black, elliptical, and subdermal- replaced Uredia.*Puccinia substriata* is its causative agent. Oval and elliptic in shape, uredospores are pedicellate and have scanty echinulation. Teliospores are two-celled, dark brown, cylindrical to club-shaped, with a flattened apex and a broad top that tapers down to the base.

Blast :

Plants can become infected at any point throughout

Fig. 1: Occurrence of A. Green gram diseases: 1. Yellow mosaic, 2. Leaf crinkle/ curl, 3. Charcoal rot, 4. Cercospora leaf spot, 5. Bacterial leaf blight, 6. Anthracnose. B. Pearl millet diseases: 7. Green ear/ downy mildew and 8. Rust. C. Sesame diseases: 9. Phytophthora stem blight and 10. Phyllody. D. Cluster bean diseases: 11. Bacterial blight and 12. Alternaria blight. E. 13. Citrus canker and 14. Phyllody affected sesame plant along with agriculture students during the field visit

their growth. Spindle-, eye- and boat-shaped patches with grey centers and reddish-brown borders first emerged on leaves during leaf blast. Node blast is characterized by blackening of the nodal area and node breaking at the site of infection. The neck becomes sooty black and typically breaks at the spot where the neck explosion occurs, directly behind the ear head. It is caused by the fungal pathogen *Pyricularia grisea*. Hyphae are septate and hyaline to brown. Conidiophores are light brown in color, slender, thin-walled, and emerge individually or in groups. Conidia are primarily three-celled, thin-walled, sub-pyriform, hyaline, 1-2 septate, and have a conspicuous hilum.

Sesame diseases :

Phytophthora stem blight :

Phytophthora parasitica var. *sesame* is the causative agent of this disease. The disease first manifests as water-soaked, chestnut-brown patches on leaves and stems, which eventually turn black and cause defoliation. The patches start brown and eventually turn black. The severity of the disease worsens in muggy conditions, killing the plant and giving it a blighted appearance. Diseased plants are easily removed from the main root, which is also affected by the disease.

Phyllody :

Phytoplasma is the causative agent of this disease. Symptoms appear when the flowers are in bloom and turning into green, leafy structures. The plants have deformed flowers at the tip and a clump of leaves. The plant seems bushy due to aberrant branching and shortened internodes, which cause the plant to be stunted. Infected plants typically do not produce capsules, or if they do, the quality of the capsule is poor and contains shrunken and undersized seeds.

Cluster bean diseases :

Bacterial blight :

The leaves first show symptoms of light green and tiny, water-soaked patches. The tissue in the core dies (necrosis) and turns brown as these patches get bigger. The primary sign of these asymmetrical dots is a golden halo or ring surrounding them. *Xanthomonas cyamopsidis* is the bacteria that causes it. The majority of this disease invasion happens at the leaf surface during the *Kharif* season. It is strictly aerobe, rod-shaped, gram-negative, monotrichous, and does not generate spores or capsules.

Alternaria blight :

The disease's symptoms are primarily seen as dark brown, rounded to irregular patches on the leaf blades of the plants. Later on, the water-soaked patches change from grey to dark brown, with light brown lines—concentric rings—inside of the patches. The fungus *Alternaria cyamopsidis* is the casual organism responsible for Alternaria leaf spot disease. Hyphae are intercellular and intracellular, branched, septate, and hyaline to brown. Conidiophores are septate, branched, and olivaceous. Conidia are muriform, septate, linear to obclavate, dark brown, and borne in chains.

Conclusion:

Pearl millet is the main field crop grown in the Barmer district of Rajasthan during the *Kharif* season, followed by cluster beans and moth beans. Other significant *Kharif* pulse and oilseed crops are green gram and sesame, respectively. Yellow mosaic, leaf crinkle/curl, bacterial blight of green gram; downy mildew, rust, and blast diseases of pearl millet; Phytophthora stem blight and phyllody of sesame, and yellow mosaic and bacterial blight of cluster bean were noted with >50% incidence in the survey. However, there have been 10 to 50% incidences of sorghum rust; charcoal rot, web blight, Cercospora leaf spot and anthracnose in green gram; as well as Alternaria blight in sesame and cluster beans.

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