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MAJOR DISEASES OF WHEAT AND THEIR MANAGEMENT: A REVIEW

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ABSTRACT

Wheat is the staple crop throughout the world and a great source of nutrition. Sometimes the wheat plant gets attacked by pathogens like fungi, bacteria and virus. Some of the common disease their symptoms and management are studied. The complexity of the interaction between a pathogen and its host, influenced by biotic and abiotic factors of the environment, make the control of these disease. Fungi is the most common causative agent in case of wheat. Some of the common disease caused by fungi are leaf rust, stem rest, stripe rust, loose smut, tan spot, powdery mildew, ergot and common bunt. Virus and bacteria also cause diseases in wheat. Wheat strike mosaic virus one of the diseases is bacterial blight of leaf. These diseases can be controlled by using disease resistant varieties. Due to the infection of these diseases there can be loss of 40-50% but sometimes it may be more. These diseases can be controlled by using some control measures. There are several chemical and herbal methods are used for the control of these diseases.

***Keywords*:** Wheat, disease, management, control, symptoms, pathogen.

INTRODUCTION

Wheat is on the top rank in the world among the cereals both on the basis of area and production that's why it is also known as "king of cereals". Wheat is a staple crop in the world. It is the second largest consumable cereal crop throughout the world after the rice. In India wheat is a Rabi crop. It is preferably grown in tropical areas of the world. Wheat is an annual grass cultivated mostly in all moderately dry temperature climates. It needs comparatively cool, moist, spring having 10-degree Celsius temperature at the time of sowing, warm, and bright days at the time of sprouting and dry harvest periods. Wheat is grown best in areas having 35cm to 60cm annual rainfall. The best soils for wheat are clay and loams. The best fertilizer is barnyard manure. For proper cultivation of wheat, the fields are cleared and then ploughed 4-5 times before sowing. Healthy and ripe seeds are sown in slightly moist soil. Sowing generally starts in October and continuous upto middle of November fertilizer is added for obtaining better yield. The crop is harvested when the grains are well ripened and the straw becomes golden yellow or light yellow, dry and brittle. In our country it is generally harvested between February to start of June depending on various regions. Wheat is generally grown in northern part of India it includes states like Punjab, Haryana, Uttar Pradesh, Bihar, Gujrat etc.

Wheat is full of nutrients like it contains dietary proteins, starch, fat, polysaccharides and lipids (Curtis *et al*., 2002). Mostly gluten protein is present in the wheat. It can be used for various purposes like making breads, dishes, cookies, pasteries and a lot of other eatables like this. It can be also used in cosmetic industries preparing lotion, creams or other items also. It is used in paste, malt, dextrose, gluten, alcohol and in making of various other products like this. Wheat belongs to a grass cereal family known as Poaceae one of the largest family of the cereal grains. It belongs to the genus *Triticum.* Most common variety of wheat is *Triticum aestivum* it is generally used to make breads (Melanin Figueroa *et al.,* 2018). Wheat belongs to family poaceae, it is a grass family. It belongs to order cyperales. Genus of the wheat is *triticum.* The wheat plant is typically 0.7 to 1.2m tall. It has long thin leaves. Leaf is formed at each node and a leaf sheath wraps around the stem and a leaf blade. Wheat has small auricles. These auricles get around the stem at the point where around the stem at the point where the leaf sheath meets the leaf blade. Wheat has a single main stem containing 2 or 3 tillers per plant. Tillering starts when the plant is at 3-4 leaf stage when first nodal root is seen. The spike or ear is formed at the top of the plant. One spike contains 30-50 grains. Wheat plant has two types of roots i.e. seminal roots and nodal roots. The lower nodes are associated with the tillers and become increasingly important as the plant grows. Grain is small having weight of 30-60 gm depending on the variety and growing condition.

Common diseases in wheat: On the basis of pathogens diseases can be of three types:

1. Fungal diseases

1.1 Loose smut (*Ustilagotritici*)

Symptoms:

Loose smut is a wind-borne fungal disease in seed. The pathogen lives in the wheat seed till the germination and then it reaches to the shoots and infects the head part. A healthy wheat plants can be infected by the wind-borne spores in the initial two days of flowering from the infected plant. Fungus can also be spread with the help of rain and insect. Spores land on healthy flowers they get germinate and become dormant within the ovary until seed germinates. As much as the heads are infected more and more loss of the yield will be there. It damages the wheat crop by the means of the kernels (Bakkeren and Schirawski, 2008).

Management

The symptoms of the diseases can be seen in the headings of the plant. The membranes during flowering and smut pores are dispersed leaving the dark, bare rachis. Brown to black fungal spore masses develop on the diseased heads of the plants. To eradicate the disease always healthy, certified seeds should be used along with a fungicide as its very hard to identify the infected seed and a healthy one. Most effective way to control over loose smut is the use of disease resistance variety. Certified seeds which are free from pathogens should is also the best way to control over it (Agarwal *et al.,* 1993).

Fig. 1: Plant affected by loose smut (**Arif Abhrahim, 2019**)

1.2 Stripe rust (*Puccinia striiformis*)

Symptoms:

This is the most common economically effecting disease (Chen, 2005). Stripe rust is generally found in cold temperature (13-24ºC). When the temperature is in range from 10ºC-16ºC the chance of the disease gets increased. Cold, long winters, mild and wet springs encourage the diseases (Chen *et al.,* 2014). The fungus can remain through cold climate on wheat as a dormant mycelium under the snow. Yellowish orange pustules get developed on the leaf of the wheat. These pustules are round having the spore masses of rust which develops on the top as well as leaf sheath. Long, narrow stripes and irregular growth are also seen in this disease. As the plant gets matured tissues seems to dry and brown, giving a burning like appearance to the plant. There are many varieties which are susceptible to *Puccinia striiformis* which causes loss upto one billion US dollar per year (Beddow *et al.,* 2015).

Management

The most important method to prevent the disease is to use the resistant varieties. Cultural practices can also help to reduce the effect of the diseases (Hovmøller *et al.,* 2015). We can also reduce the effect of the stripe rust by controlling over grassy weeds and volunteer wheat before three weeks of seedling. At proper interval of time there should be field inspection so that the symptoms can be identified in very earling stage and treatment can be done. Cultivators should have knowledge regarding the symptoms of stripe rust. Certified seeds should be used to prevent the stripe rust (Line and Chen, 1995). Monoculture of single variety should be avoided because chances of single variety becomes more prominent to a particular pathogen.

Fig. 2: leaf affected by stripe rust (**Rupinder Singh, *et al.,* 2017**)

1.3 Powdery Mildew (*Blumeria graminis f. sp. tritici*)

Symptoms

Powdery mildew is generally grown in humid and semi-arid areas. Mild temperature, increased humidity, high nitrogen fertilizers are some of the factors which are responsible for powdery mildew. Mildew affects the plant before the flowering stage causing the severe loss in the crop. Major infection gives birth to lodging, early death of leaves decreasing the seed size and loss in the yield occurs up to 40%. Fungal patches of white or grey colour are formed on the leaves, stems and head parts of the plant (Daamen, 1989). The infection starts from lower leaves and get spreaded upto the upper part of the plant. The other side of the infected seed becomes chlorotic and gets yellow and brown coloured. When the plant gets matured, fungus changes the colour and turns into grey and brown, tiny round and black fruiting bodies formed on the leaves. Kernels are infected spikes are poorly developed, tiny and malformed (Fiedorow *et al.,* 2004).

Management:

Most effective way to control to control this disease is to use the resistant varieties. Crop rotation can also be proved to prevent the leaves to destroy the volunteer wheat. One another method is by using a balanced nitrogen fertilization. Infrequent, heavier irrigations will be more beneficial than more frequent lighter irrigation. Mixture of two tablespoons of apple cider vinegar per quart of clean water then the spray of mixture over plants to organically powdery mildew traces.

Fig. 3: wheat leaf affected by powdery mildew (Photo: Alfredo Martinez.)

1.4. Leaf rust

Puccinia triticina is the causative agent of the leaf rust (Anikster *et al.,* 1997). This is the most common fungal disease found on wheat. This disease caused destruction of wheat in many regions of U.S.A and India (Joshi *et al.,* 2004). Humid condition and mild temperature are the factors which make the disease occur. Reason for the occurrence of leaf rust is that *Puccinia triticina* has high diversity and has high adaptability to wide range of climate (Huerta-Espino *et al.,* 2011). Infection causes the loss of yield by reducing the size of grain and number of grains per head. Small reddish-orange oval fruiting bodies are formed on the surface of the leaf. These postulates may be found in scattered or it may be in clustered form. When the plant gets matured the spores turn black. These pustules are mostly found on the lower leaves and leaf sheath. Disease mostly occurs in the lower leaves as fungus firstly develop here. When favourable conditions occur, spores get spreaded and exponential growth occurs and severity of the disease affects the crop yield. Pustules occurring on the leaves, cover almost whole the leaf.

Management

Leaf rust can be managed by using the wheat varieties which are resistant to leaf rust. There are some varieties which are susceptible to disease but these have the ability to tolerate the infection. Foliar fungicide can be used for susceptible varieties. Seed treatment can also be used to control the leaf rust (Ellis *et al.,* 2014). Avoid early sowing and excess nitrogen application. The eradication of volunteer plants and crop debris, which can harbour inoculum over the winter. The prevalence of different rust races is always changing in response to the different wheat varieties being grown with different Lr genes.

Fig. 4: Leaf blade affected by leaf rust in wheat plant (Source: Cereal Disease Laboratory, ARS, USDA)

1.5. Tan Spot (*Pyrenophora tritici-repentis*)

Symptoms

Tan spot is the most common disease in the northern plains caused by *Pyenophora tritici-repentis*. The disease occurs in conjugation with leaf rust and septaria leaf blotch and is associated with reduced tillage. Tan spot affects the yields and weight of the grains (Shabeer and Bockus, 1988). Oval or diamond shaped, brown leaf spots which are darker in the middle and yellow on the periphery. Yellow border gives an "eye spot' appearance. As the infection increases more spots starts to develop on the leaves. Large number of dead tissues get produced. Due to tan spot the leaves get damaged and early death of the plant occurs. Sometimes small fruiting bodies known as psudo-thecia appear on the stubble.

Management

Crop rotation minimum for one year out of wheat is one of the best methods to control tan spot. Along with this there are number of tan spot disease resistant varieties available. When there is high risk in flag leaf foliar fungicide is used. Host genetics and *Ptr* structure are also used tocontrol the tan spot (Strelkov and Lamari, 2003). When the conditions are favourable for disease fungicides can be used for effective result.

Fig. 5: Leaf affected by tan spot (Photo *courtesy of Sam Tragesser, Senior Research Associate).*

1.6. Ergot (*Claviceps purpurea*)

Symptoms

Claviceps purpurea is the causative agent for the ergot which leads to the loss of both yield and quality of the crop due to this disease. *Claviceps* produces mycotoxins which are of great concern. Tough, purplish-black sclerotic about half inches length ergot bodies instead of healthy grains. Along with it a yellowish, sugary honeydew develops on the he infected seeds at the time of flowering before the development of the ergots. This honeydew also found on the other parts of the plant. Wheat straw should not be baled for feed if it still has ergoty heads.

Management

Before using the seeds for sowing clean the seeds properly which are free from sclerotia. Deeper planting proved to be very beneficial in the ergot disease as sclerotia cannot grow at depth. Use of varieties having short flowering periods can be done to avoid infection. Crop rotation should be applied with non-host crops such as legumes or corn. Foliar fungicides at heading have not been shown to be effective in managing ergot. Cleaning using gravity-type or colour sorters can help reduce the amount of ergot sclerotia in a seed lot. Ergot sclerotia tend to be lighter and less dense allowing for the removal of these structures. Removal of weeds and unwanted seeds can also be done. Crop rotaion is also an effective way to control over the ergot disease in wheat (Mantle *et al.,* 1977).

Fig. 6: Ergot disease in wheat (courtesy of Mike Shillinglaw, Agriculture and Agri-Food Canada).

1.7. Common Bunt / Stinking Smut (*Tilletia foetida* & *T. caries*)

Symptoms

Common bunt is caused by two fungi *Tiletiafoetida* and *T. caries.* These fungi generally grow on the surface of the seed and in soil. Infection mostly occurs at the time of germination when the conditions are cold and wet conditions. The fungi firstly penetrate and infect the coleoptilebefore seed emerges out. The grains are filled with black spores called as teliospores. The kernels get dull grey brown which are known as bunt balls. When the infection gets sever in the fields, dark clouds of bunt spores can be observed during the harvesting.

Management

Treat the seeds with fungicides prior to planting to control the common bunt. Certified and fungi tested seeds should be used. Seeds should be properly cleaned with the help of seed conditioner. Planting should be done when the temperature is warm and it is unfavourable for the fungi. Use of previous crop should be avoided for the next crop.

Fig.7: Wheat spike affected by common bunt (*Photo by Martin Nagelkirk).*

1.8. Stem Rust

Symptoms

*Puccinia graminis*is the disease-causing agent in case of stem rust of wheat (Leonard and Szabo, 2005). This fungus affects when the conditions are warm and moist. Red-brick masses urediniospores are seen on the leaf sheaths and stems. Due the effect of the stem rust there is reduction in size of grain and plant lodging occurs. This disease effects badly before grain fill. There is loss of spikes also.

Management

To control the stem rust disease plant resistant varieties should be used. The alternate host barberry should be eliminated so that disease causing spores can be controlled. In this particular stem rust disease fungicides are not so much effective as resistant varieties are used.

Fig. 8: Postulates of rust on the stem of wheat (by Sarosh Bana)

2. Viral diseases

2.1. Wheat streak mosaic virus

Symptoms

This disease occurs generally in the spring season when the temperature starts rising. The symptoms of the WSMV can be generally seen in the peripheral region of the fields (Duveiller and Sharma, 2012). Effect of this disease seen in the growth of the plant as the plant shows stunted growth and gets yellow in colour. Leaves gets mottled and gains light green yellow colour having discontinues streaking. In the last when infection gets at the peak leaves gets brown finally resulting in death. Loss in the yield depends on the amount of infection. In dry conditions loss is observed at high rate.

Management

WSMV can be controlled by the use insecticides so that mites can be reduced. It's better to use disease resistant variety. Eradication and burning of the infected plants can also be a solution to control over this disease. Weeds like annual or perennial grasses should be removed at regular interval. Apply miticide in winter when the conditions are favourable (Connin, 1956).

Fig. 9: Leaf of wheat affected by wheat streak mosaic (Rupinder Singh, A. Mahmoudpour, M. Rajkumar and R. Narayana, 2017)

3. Bacterial diseases

3.1. Leaf blight

Symptoms

This disease is caused by bacteria *Psudomonas syringae*. Lesion margin get formed on the leaves of the wheat. When there is high humidity for a long-time symptom of the leaf blight starts to develop. When humidity gets decreased spots turns grayish and get tanned and bleached over the time. Sometimes whole the leaf also gets killed. Lesions of bacterial blight can be seen from the stem elongation stages through ripening. It is like tan spot. In Asia this pathogen is component of Helminthosporium leaf blight complex (Duveiller *et al.,* 2007).

Management Planting diseases resistant variety is the best method to control over this disease. Use of fungicides is not so much effective. Proper diagnose should be there when the chances of infection are higher and precautions should be taken before the infection or at very early stage of infection.

Fig. 10: leaf of wheat affected by leaf blight of Bacteria (***Image: M. Burrows)***

CONCLUSION

Pathogenic diseases affect wheat crop and offer challenge to increase its production and yield. The effort to summarize the most significant diseases affecting production of wheat plants and their management strategies has been made in this review. The management strategies including use of various chemicals and some herbal methods is found to be beneficial in controlling many fungal diseases.

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