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A review of cotton diseases and their management

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Abstract

Cotton is one of the most important crops in Iran. The importance of cotton in creating employment is such that by creating one job in cotton cultivation, five jobs can be created in related industries. However, the cultivated area of this product, which was 320,000 hectares in the mid-seventies, has reached 90,000 hectares in the 2018-2018 crop year. In fact, the area under cotton cultivation, which accounted for 40% of industrial products, is now less than 13%. Currently, Iran is an importer of cotton, and in 2017, 142 million dollars were spent on importing this product, which is a large figure for the country considering the currency restrictions and problems caused by sanctions. The combination of these factors has forced the Ministry of Agricultural Jihad to put the plan of self-sufficiency in cotton production until 1404 on its agenda. Considering the non-fulfillment of the goals of this plan in the last three years, it is necessary to identify and analyze the variables affecting this policy. Cotton diseases are one of the important factors of crop reduction, and their management is the solution to this problem. In this article, some important diseases of cotton and its management strategies in Iran have been described.

Key words: Cotton, Disease, Symptom, Management.

Introduction

Cotton or white gold named Gossypium has a special place among people because of the short and long cellulose fibers on the seed that can be spun and its flour, which is directly fed to livestock. In Iran, approximately 150 to 250 thousand hectares in the provinces of Golestan, Mazandaran, Razavi Khorasan, South Khorasan, Qom, Semnan and Kerman have been dedicated to the cultivation of this plant.

Cotton diseases during the growing season of this plant cause a lot of damage to the product and reduce the yield and quality of the product. Therefore, in order to reduce damage, farmers should identify cotton diseases and their control and treatment methods and use them to prevent damage to the farm and reduce crop yield (Naraghi et al., 2018a); (Naraghi et al., 2018b); (Naraghi et al., 2019a) and (Naraghi et al., 2019b)

Cotton Diseases and Their Management

Seed decay and seedling damping-off

Seed rot is caused by various fungi such as Fusarium, Alternaria, Aspergillus niger, etc., and this disease is one of the most

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important diseases of cotton, and due to the contamination of the field with this disease, a large percentage of seedlings are destroyed. Seed decay is caused by the activity of microorganisms in the soil that attack the seed under suitable conditions.
This disease is spread by using low-quality and inappropriate seeds, compacting the soil and planting seeds in great depth. If the care of the seedlings continues for the first two to three weeks after planting, after this date they will be almost resistant to pathogens unless late cold or spring rains provide the environment for the activity of pathogens.

Symptoms of cotton seedling damping-off disease

The symptoms of seedling seed rot disease appear in the form of seedling death before and after germination, seed rot in the soil before germination, ring rot, brown spots in the axis of the cotyledons, spots on the leaves in the form of burns, etc (Figure 1).

Figure 1. Symptoms of cotton seedling damping-off disease

Management methods for seed rot or seedling death from cotton diseases

- Use of suitable and quality seeds
- Planting seeds at the right depth of the soil
- Pick up on time
- Use of okra leaf cotton cultivars because the bolls are less infected with disease
- Control of boll-feeding pests.
- Use of fungicides in seed fields after ripening or harvest time
- Failure to harvest cotton in rainy conditions
- Store in humidity conditions below 11%
- Good ventilation in the warehouse
- Accuracy in harvesting time and not causing physical damage to cotton seeds
- Depilation of cotton seeds with acid or heat
- Disinfection of seeds with appropriate fungicides before planting (Mansour et al., 2020); (Naraghi et al., 2017); (Naraghi et al., 2020) and (Naraghi et al., 2022).

Alternaria blight

This disease in most areas and Alternaria leaf spot and Alternaria blight of cotton by fungi of the genus. Farms are spreading, but the amount of damage is not the same in all farms. Due to the severity of cotton

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contamination with Alternaria blight, the leaves on the plant fall and new leaves grow.

Alternaria blight symptoms usually appear as dark brown or black contiguous or circle-like spots.The wave-shaped state is a decrease in the level of photosynthesis, leaf fall, leaf burn and early bud opening (Figure 2).

Symptoms of Alternaria blight disease

Figure 2. Symptoms of cotton Alternaria blight disease

Alternaria blight management methods of cotton diseases

- Use of resistant cultivars
- Plowing after harvesting and burying plant remains
- Use of resistant and high-quality seeds
- Using potash fertilizers before planting and having a basic food plan
- Planting seeds at the right temperature
- Depilation of seeds with acid
- Seed disinfection before planting
- Spraying the field after the appearance of the first leaves
- Control of pests that damage bolls

Ascocyte blight, lightning or burn

Fungi causing ascocytic blight disease, Supers prouting and Super brotamento due to not providing humidity and lack of ventilation are prevalent in cotton fields. The fungus that causes the disease attacks the leaves, stems, and bolls slow and causes damage to them.

Ascocytic blight symptoms of cotton diseases

The symptoms of ascocytic blight disease are the appearance of brown or dark spots with a purple border on young leaves, leaf fall, brown canker on the stem, death of the upper parts of the stem, and the fall of the infected parts (Figure 3).

Figure 3. Symptoms of cotton Ascocytic blight disease

Ascocytic blight management methods of cotton diseases

- Use of resistant cultivars
- Deep plowing after harvest
- Disinfection of seeds before planting
- Not planting cotton seeds in wet conditions
- Crop rotation of cotton with non-host plants
- Burying plant remains

Helmentosporium leaf spot

The fungus that causes this disease is Helminthosporium. The fungus that causes this disease in the spring when the environmental conditions are favorable, starts to work and causes damage in cotton.

Symptoms of Helminthosporium leaf spot from cotton diseases

The symptoms of this disease are in the form of round and light brown spots, which become dark and gray after a while are painted If Helminthosporium leaf spot contamination is high, the leaves will fall prematurely (Figure 4).

Figure 4. Symptoms of cotton Helminthosporium leaf spot disease

Helmintosporium leaf spot management methods

- Use of resistant cultivars
- Disinfection of seeds before sowing
- Deep plowing after harvest
- Burying plant residues after harvesting

Curvularia leaf spot

Curvularia leaf spot disease caused by *Curvularia lunata* fungus. The fungus that causes the disease spends the winter in the seed coat and plant residues and attacks all the aerial parts when the conditions are suitable.

Curvularia leaf spot symptoms

The symptoms of this disease are in the form of brown spots with a yellow border, which are egg-shaped. The symptoms of this disease are in the form of brown spots with a yellow border, which are egg-shaped (Figure 5).

Figure 5. Symptoms of cotton Curvularia leaf spot disease

Curvularia leaf spot management methods

- Use of resistant cultivars
- Disinfection of seeds before sowing

Cercospora leaf spot

Alternaria leaf spot caused by *Cercospora gossypina*. This disease is caused by Alternaria cercospora leaf spot in some areas under cotton cultivation and causes a lot of damage to this product.

Cercospora leaf spot symptoms

Cercospora leaf spot symptoms appear as red to purple spots on the leaves that gradually darken.
In general, the symptoms of this disease are mostly seen in the aerial parts of the cotton plant (Figure 6).

Figure 6. Symptoms of cotton Cercospora leaf spot disease

Cercospora leaf spot management methods

- If possible, do not plant cotton in wet areas
- Prevent any stress from entering the plant
- Crop rotation with non-host plants
- Burying plant remains and destroying them

Grey or Areolate mildew

This disease is the first in the United States caused by Ramularia areola, the causative agent of cotton powdery mildew damage has been done and there is no report of damage caused by this disease in cotton fields in Iran so far.

Grey or Areolate mildew symptoms

The symptoms of this disease are light green to yellow spots on the surface of the leaf and fluffy white spots under the leaf. In case of severe infection of cotton with grey mildew disease, the spots on the leaves turn white (Figure 7).

Figure 7. Symptoms of cotton Grey or Areolate mildew disease

Grey or Areolate mildew management methods

- Use of healthy and certified seeds
- Collect plant remains and destroy them
- Proper plant density in the field
- Regulation of irrigation and supply of moisture required by cotton

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Powdery mildew

The surface powdery mildew of cotton is caused by the fungus *Oidiopsis gossyoii*, which was discovered for the first time in cotton fields in Isfahan It has been reported.

Powdery mildew symptoms

Wrinkling of the leaf blade, reddening of the plant and white coating on the back of the leaf are the symptoms of the white powdery mildew disease in cotton (Figure 8).

Figure 8. Symptoms of cotton Powdery mildew disease

Powdery mildew management methods

- Use of healthy and certified seeds
- Create proper ventilation between plants
- Removing weeds and plant debris
- Compliance with crop rotation
- Balance in watering and fertilizing the plant

Cotton Rust

Rust In tropical areas under cotton cultivation, rust disease spreads and causes damage to this product. Puccinia cacabata and Phakospora gossypii cause rust disease in cotton.

Rust symptoms

The symptoms of rust disease are purple brown spots on the leaves, petioles and stems, which fall off when the disease is severe (Figure 9).

Figure 9. Symptoms of cotton Rust disease

Rust management methods

- Use of resistant cultivars
- Removing plant debris
- Use of healthy and certified seeds
- Seed disinfection before planting

Charcoal rot

Macrophomina phaseolina is the cause of charcoal rot disease in cotton. This disease mostly spreads in hot and dry environmental conditions and causes damage to this plant.

Charcoal rot symptoms

Yellow or pink spots on the leaves, blackening of the roots, drying of the leaves on the plant, softening of the infected parts and their falling due to the wind are the symptoms of charcoal rot disease, the most important of which is the rotting and blackening of the root end (Figure 10).

Figure 10. Symptoms of cotton Charcoal rot disease

Charcoal rot management methods

- Planting resistant cultivars
- Prevent moisture stress from entering the plant
- Sunning the soil and disinfecting it
- Planting a mixture of cotton and mung bean
- Balanced irrigation as needed by the plant

- Control and fight against sucking pests
- Basic food plan and establishing the balance between food elements phosphorus and potassium

Fusarium wilt

This disease has spread in the world and exists in most areas under cotton cultivation and causes damage to this plant. The amount of damage of this disease is related to the growth stage when the plant is exposed to the attack of the pathogen. Mushroom is Fusarium wilt at relatively high temperature, *Fusarium oxysporum* f.sp.*vasinfectum* soil is the cause of this disease. Acidity and lightness and low humidity are more reported.

Fusarium wilt symptoms

The symptoms of this disease are wilting of seedlings, yellowing of leaves, dwarfing of seedlings, curling of the edges of the leaves upwards. Leaves dry and hang. In case of severe contamination of cotton with fusarium wilt of tissues in a ring it changes color and causes the loss of seedlings (Figure 11).

Figure 11. Symptoms of cotton Fusarium wilt disease

Fusarium wilt management methods

- Use of resistant cultivars
- Crop rotation with non-host plants such as cereals and alfalfa
- Having a basic diet plan and consuming potassium in order to increase disease resistance
- Deep plowing after harvest
- Solarization of farm soil
- Biological control using bacterial and fungal antagonists

Verticillium wilt

This disease is one of the most damaging diseases in cotton and it exists in most of the cotton growing areas of Golestan, Fars, Razavi Khorasan, South Khorasan, Ardabil, Qom, etc. The causal agents of Verticillium wilt disease are Verticilium dahliae and V. albo-atrum species are those that spread more in wet, alkaline conditions and heavy and clay soil.

Verticillium wilt symptoms

Symptoms of verticillium wilt in cotton include yellowing of the leaves and the loss of seedlings, browning of the edges of the leaves, shrinking of the edge of the leaf towards the top of the leaf, dwarfing and changing the color of the texture, hanging of the leaves, severe falling of leaves and bolls, and drying of the plant (Figure 12).

Figure 12. Symptoms of cotton Verticillium wilt disease

Verticillium wilt management methods

- Use of resistant cultivars
- Disinfection of seeds before planting
- Choosing the right planting pattern and observing the right distance between the rows and on the planting rows
- Alternation with non-host plants, especially rice and alfalfa
- Soil solarization
- Removal of contaminated plant residues in the field
- Deep plowing after harvest
- Having a basic food plan and using potash fertilizers in order to increase resistance
- Controlling sucking pests in the early stages of cultivation
- Adjust irrigation periods
- Biological control using bacterial and fungal antagonists (Naraghi et al., 2022) and (Zhang et al., 2023) and (Naraghi, 2024).

Boll rot

Boll rot disease is usually present in all cotton growing areas, but the amount of damage is in rainfed areas or fields which have been irrigated excessively. Increasing the growth of plant foliage, humid environments and Rain during boll formation increases boll rot in cotton. Aspergillus niger and Aspergillus flavus are the causal agents of boll and fiber rot disease in cotton. The cause of cotton bolls falling after rain is the disease of boll rot, which causes them to fall.

Boll rot symptoms

The symptoms of boll rot disease in cotton are spotting and decrease in the quality of fibers and seeds. With the progress of boll rot disease, the spots enlarge and cover the entire boll (Figure 13), causing it to rot (Zhang et al., 2022) and (Naraghi et al., 2024).

Figure 13. Symptoms of cotton Boll rot disease

Boll rot management methods

- Proper ventilation of the farm
- Planting resistant cultivars
- Controlling pests and insects that carry disease-causing fungi
- Eliminate the host weeds of the pathogen
- As much as possible, the harvest should not be during the rainy season
- Balanced use of nitrogen fertilizers and preventing excessive growth of plants

Internal boll rot

The causal agents of internal boll rot disease are fungal genus including Nematospora, Eremothecium, Spermophthora. These fungi are injected into cotton bolls by sucking insects and cause damage. Due to the severity of internal rot disease, cotton seed bolls turn black and rot (Zhang et al., 2022).

Internal boll rot symptoms

Rot inside the boll, falling of the boll, reduction in size and weight of the boll, yellowing or browning of the fibers, secretion of slimy and milky liquid, changing the color of the bolls to orange are the symptoms of internal rot disease of cotton bolls (Figure 14).

Figure 14. Symptoms of cotton internal boll rot disease

Internal boll rot management methods

- Use of resistant cultivars such as okra leaf cultivar
- Controlling sucking pests such as aphids
- Having a basic meal plan

Cotton anthracnose

Anthracnose is one of the most important damaging diseases in cotton, which can kill seedlings and bolls in the final stages of their growth. Infect and cause damage to this plant. The cause of this disease is fungi of the Colletorichum genus, which are suitable for when the conditions become active, they start to cause damage (Zhang et al., 2022).

Antracnose symptoms

This pathogen infects all aerial parts of the plant. Symptoms of cotton anthracnose include brown spots on the leaves which are sometimes red, there are brown spots on the stem and boll (Figure 15).

Figure 15. Symptoms of cotton Antracnose disease

Cotton antracnose management methods

- Using healthy and unpolluted seeds
- Disinfection of seeds before planting
- Use of resistant cultivars

Bacterial stem blight

Bacterial stem blight is one of the most damaging diseases of cotton, which is caused by a bacterial pathogen, *Xanthomonas campestris* p.v. *malvacearum* and spreads in cotton fields. Black leg disease is more common in dry and desert climates than in other regions. Bacteria causing bacterial blight attacked all parts of cotton and caused damage (Zhang et al., 2022).

Bacterial stem blight symptoms

The symptoms of bacterial stem blight disease are seedling death, reduced photosynthesis, reduced plant stand, leaf, branch and bud fall. In some regions, when the conditions are suitable, the bacteria causing bacterial blight destroys the whole crop (Figure 16).

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Figure 16. Symptoms of cotton Bacterial stem blight disease

Bacterial stem blight management methods

- Use of resistant cultivars
- Disinfection of seeds before planting
- Depilation of seeds
- Spraying fields at the time of seedlings and buds according to the opinion of the herbalist expert
- Deep plowing and burying plant residues immediately after harvesting
- Adjust the amount of irrigation and adjust the humidity in the field
- Two-year crop rotation with non-host plants
- Control of sucking pests such as mites and mites
- Having a basic and suitable diet plan for cotton

Crown gall

Agrobacterium tumefaciens is a bacterial pathogen, the crown gall, which has a global distribution and causes damage to most plants (Zhang et al., 2022) and (Naraghi et al., 2024).

Crown gall symptoms

Round galls with an uneven surface at the crown and root are symptoms of crown gall, and the tissue inside the galls is soft, white and spongy (Figure 17).

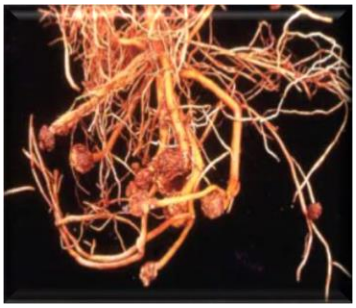

Figure 17. Symptoms of cotton Crown gall disease

Crown gall management methods

- Use of resistant cultivars
- Removal of infected plants

Leaf curl virus

The causal agent of cotton leaf curl disease is a virus of the family of Geminiviridae and genus of Begomovirus. In some areas under cotton cultivation, this disease has become a growth limiting factor for high-yielding and disease-sensitive cultivars and has caused great damage to this crop. If the plant is infected with the leaf curl virus in the early stages of growth, a lot of damage is caused (Zhang et al., 2022).

Leaf curl virus symptoms

The symptoms of the viral disease of cotton leaf curl are the decrease in the number of bolls in the plant and the weight of the bolls. Also, in the infected plants, the level of photosynthesis is reduced and the leaves turn yellow. The amount of damage is different in different fields and cultivars, and as it was said, the greatest amount of damage caused by this disease is in the early stages of plant growth (Figure 18).

Figure 18. Symptoms of cotton Leaf curl virus

Leaf curl virus management methods

- Use of virus-resistant cultivars
- Controlling weeds that are host for the virus
- Controlling cotton sucking pests
- Having a basic and suitable diet plan for cotton
- Regular watering according to plant needs

Cotton red leaf

The causal agent of cotton red leaf disease is a virus of the luteovirus genus. When the conditions are suitable, these viruses start their activity and cause damage to the plant. The severity of the infection depends on the time and age of the plants (Zhang et al., 2022).

Cotton red leaf symptoms

The symptoms of cotton red leaf disease appear as yellowing of the leaf blade and

then it's turning purple. As the disease progresses, the entire surface of the leaf turns red, but the veins remain green. Symptoms start first in older leaves and then spread to young leaves. If the disease is severe, cotton leaves may turn red, the leaves of the plant should fall (Figure 19).

Figure 19. Symptoms of cotton Red leaf disease

Cotton red leaf management methods

- Use of virus-resistant cultivars
- Controlling virus-carrying pests such as aphids and controlling their populations
- 89 Control and destroy field weeds in order to reduce the population of the overwintering form of the virus

Root-knot nematode

One of the most important diseases that is prevalent in hot and dry regions is root-knot nematode. Various species of nematodes in the world cause damage to plants, but only one or two species attack cotton and cause damage to it. One of the nematode species is *Meloidogyne incognita*, which causes damage in cotton (Zhang et al., 2022).

Root-knot nematode symptoms

Nematodes act as an internal parasite and feed on the vascular tissues of the plant. By feeding the nematode on the plant tissue, the shape of the cells changes, the root size decreases, the hairy and lateral roots decrease, as well as the increase in cell division and the formation of calluses around the root. Nematode attack on the cotton plant also causes yellowing of the leaves, reducing the number bolls and generally reduce or stop the growth of the plant (Figure 20).

Figure 20. Symptoms of cotton Root-knot nematode

Root-knot nematode management methods

- The use of non-host plants in crop rotation in order to reduce the population of nematodes
- Controlling field weeds
- Using plants that attract nematodes, such as parsley, and then destroying them in order to reduce the nematode population
- Controlling disease-carrying pests, especially sucking pests
- Deep plowing at least three months before planting
- Use of healthy and certified seeds
- Choosing the right planting date
- Optimal plant density in the field
- A basic and suitable food plan for cotton growth

Conclusion

By managing cotton diseases, the yield can be increased as much as possible. Cotton harvesting can be done manually or by a harvesting machine (cotton harvester). If machine harvesting is developed, the cost of cotton production will be greatly reduced. In manual harvesting, more than one stage is usually harvested in two or three rows, but in recent years, due to the lack of workers and the increase in the cost of harvesting, the entire crop is harvested in one row. Harvesting should be done when maximum pods have opened. In this case, you should not wait for all the pods to open, if there is a delay in harvesting the crop, it may hit the autumn rains and disrupt the harvest and reduce the quality of the crop. Harvest date depends on climatic conditions, variety, planting date and agricultural management of the field. Usually, if the cotton is planted in the second half of May, it can be harvested in one field from November 15 to December 15. It is recommended to turn the crop into a cotton ginning factory as soon as possible after harvesting, to transfer and store the cotton until delivery due to the loss of washing quality, avoid harvesting unripe and rotten bolls, and harvest until the dew (or humidity) dries up (from rain) delay.

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