Physiological disorders in Cotton

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Introduction

Cotton is an important cash crop grown for its fiber since time immemorial. India ranks first in area (12.9 million hectares) under cultivation however the productivity is low (420.7kg/ha) as against world average of 797 kg/hectare (Cotton Association of India, 2019). Physiological disorders are one of the causes of decline in yield. Physiological disorders are caused due to environmental, plant and soil factors. Square and boll shedding, leaf reddening, parawilt, leaf drying, square and boll drying, bad boll opening and leaf malformation due to 2,4-D are the major physiological disorders that occur in cotton.

Square and boll shedding

Square and boll shedding is quite common in cotton. Around 60 % shedding of squares, and shedding of 8% of flowers and 5 % of bolls is considered as normal under ideal growth conditions. In cotton plant, there is a strong correlation between photosynthetic supply of carbohydrates and the demand of carbohydrates for developing bolls. When the supply is lower than the sink demand, the plants tend to shed its younger bolls to protect larger bolls for which more resources are allocated. However excessive boll shedding due to biotic and abiotic stresses causes severe yield loss in cotton.

Causes

Low light due to overcast condition, high humidity, low and excess moisture, heavy rainfall, excess plant population, excessive vegetative growth, deficiency of nutrients and hormones are the major causes of boll shedding in cotton

Prevention of excessive boll shedding in cotton

1. By preventing excessive vegetative growth
    i. Timely application of recommended dose of plant growth regulators
    ii. Avoid applying excess nitrogenous fertilizers
    iii. By avoiding over irrigation
2. Adjusting the planting geometry (plant to plant and row to row spacing) so as to enable the penetration of sunlight to the lower fruiting branches)

3. Alleviating the deficiency of nutrients and hormones by need based foliar spray of 1% DAP from 60 days after sowing and /or foliar spray of Napthalene Acetic Acid (10 ppm- 10 mg/litre of water) at 60 or 70 DAS.

Leaf reddening

Causes

The major causes for leaf reddening in cotton are mineral nutrient stress, water logging, drought, low temperature stress, high light stress, incidence of sucking pests, strong winds, microbes, choice of genotype, certain insecticides, herbicides like 2,4-D and spraying of cocktail of incompatible combination of chemicals. Abiotic stresses in general create a transient nutrient deficiency in plants, as the uptake of mineral nutrients is hampered due to various reasons. Reduction in uptake of mobile nutrients like, N, P, K and Mg under abiotic stress conditions, leads to translocation of nutrients from older leaves to newer leaves at the top. These stresses thus accelerate senescence of older leaves by degradation of chlorophyll. Accumulation of anthocyanin pigment occurs to protect the leaves from further damage.

Leaf reddening due to nutrient Deficiency

Leaf reddening due to sucking pests

Possible measures which can be taken to prevent leaf reddening in cotton

- Foliar spray of 2 % DAP along with 1% Potash or Potassium Nitrate at about 90 DAS
- Foliar spray of 2 % Urea, 0.5 % Zinc Sulphate and 0.2 % Boron twice at 15 days interval
- Foliar spray of 19:19:19 (1%) or 2 % DAP with 1 % Magnesium Sulphate at peak boll formation stage.
- Avoid planting susceptible genotypes like RCH-2 Bt and Mallika Bt

- Avoid spraying insecticides like Methomyl and Thiodicarb
- Planting improved desi cotton varieties which are highly tolerant to abiotic and biotic stresses
- Planting short duration varieties which can escape biotic and abiotic stresses
- Practicing early sowing so as to enable the plants to avoid stress during the critical stages
- Planting desi varieties/hybrids with less nutrient demand under rainfed conditions
- Following moisture conservation measures like mulching and nutrient conservation measures like intercropping and crop rotation

Parawilt

Causes

- Excessive irrigation/heavy rainfall leading to water logging of cotton fields especially in heavy clayey soils
- Poor uptake of nutrients and water due to damaged roots under anaerobic conditions
- Water logging preceding prolonged dry spell with high temperature and bright sunshine hours
- Planting hybrids/varieties with heavy boll load demanding more nutrients, water and photo assimilates.
- Excessive vegetative growth resulting in more transpirational loss of water.

Symptoms of parawilt

In the affected plant, the leaves exhibit slight drooping symptoms initially. However as time proceeds leaves wilt severely and turn yellow and gradually to red in the presence of bright sunshine. The squares and young bolls already formed will be shed profusely. Damaged roots decrease water and nutrient uptake by plants. The leaves dry rapidly and stick on to the stem. Bolls also get dehydrated rapidly and open forcibly. Eventually the leaves fall off from the plant. The parawilt symptoms appear sporadically in a field. The plants may recover gradually however their growth is severely stunted with smaller leaves with almost no bolls. Parawilt generally occurs in fields, where bright sunshine and dry spell occur after water logging. Browning of conducting tissues is not observed in plants affected by parawilt unlike in *Verticillium* wilt.

Amelioration of parawilt in cotton

- Fields should be drained properly to avoid damage to roots
- Preventing excessive vegetative growth to reduce water loss by transpiration
- Providing irrigation during peak growth stage if facilities are available
- Avoid apply excess fertilizers, FYM and incompatible combination of fertilizers especially under rain fed /water limited conditions.
- Spraying of Cobalt Chloride @ 10 mg/litre on affected plants within few hours of onset of drooping symptoms
- Soil drenching of a mixture of Copper Oxy Chloride 25 g and 200 g Urea in 10 litres of water or Carbendazim 1g/litre around the root zone to prevent secondary infection
- Planting of genotypes tolerant to wilt such as LRA 5166, LRK 516 (Anjali), SRT1, MCU 5 VT, AKH 4, G 27 and Jayadhar

Water logging in cotton

Effects

- Mineral nutrient stress (N, P, K, Mg and Ca) in shoots causing chlorosis of older leaves especially due to N deficiency
- Reddening of leaves, shedding of leaves and squares under severe stress due to excessive production of ethylene, Fe deficiency, damaged roots due to lack of oxygen and build-up of toxic gases such as carbon di oxide and ethylene that are produced by the roots.
- Stunted growth and poor yield with 10 - 40 % yield loss due to reduction in number of bolls

Waterlogged Field

Fe deficiency during water logging

Lenticel formation

Management

- Ensure proper drainage in the fields to drain out the excess water by providing adequate slope
- Avoid excessive compaction of soils by following minimum tillage practices
- Foliar application of 1.5 % Urea
- Foliar application of 50 ppm Kinetin

Drought

Effects

Water stress affects the growth rate of cotton by reducing the number and size of leaves produced and thus reducing photosynthesis. The effect of water stress in cotton depends on timing and intensity of drought.

- Exposure to water stress prior to flowering reduces the number of fruiting sites
- The peak flowering period is the most sensitive period to drought and water stress during this critical period severely affects the yield and yield components of cotton
- Induces shedding of squares and young bolls due to hormonal imbalance
- Water stress during late-bloom stages will reduce late-developing bolls and fibre strength
- Water stress during fibre-elongation stage decreases the fibre length

Ameliorative measures

- Cultivating drought tolerant genotypes of cotton
- Foliar spray of 2% DAP during peak flowering stage
- Foliar spray of 0.5% zinc sulphate + 0.3 % boric acid + 0.5 % Ferrous sulphate + 1% urea during critical stages of moisture stress
- Foliar spray of 40 ppm NAA (4 ml of Planofix in 4.5 litres of water) to prevent shedding of fruiting bodies.

2, 4-D drift in cotton

2, 4 D is an auxin type herbicide. Major causes of 2, 4-D damage are spray drift, vapour drift and sprayer contamination. Spray drift is a major problem under windy conditions. Vapor drift is caused by volatalisation of ester containing formulation of 2,4-D. High temperatures, high soil moisture and temperature inversions increases the vapor drift and affect the cotton crop even from a larger distance. Impact of 2, 4- D drift in cotton basically depend upon the stage of the cotton plant which gets affected. A drift during seedling stage results in forced development of vegetative branches and delayed fruiting. If at pre-squaring stage, delay in squaring occurs depending upon the dose of 2-4- D. A plant affected at squaring stage will have a severe impact on yield as fruiting is severely delayed. 2-4-D drift at peak flowering stage may result in shedding of younger bolls. At late flowering stage, fibre quality will be reduced. The loss in yield due to 2-4, D drift is mainly due to delay in fruiting giving lesser time for maturation of later set bolls. Significant yield losses occur when the plants are exposed to 2,4-D at six leaf stage or at pre or early squaring stage.

Symptoms caused by 2, 4-D drift in cotton

Symptoms of 2,4-D injury are generally seen in meristematic regions of a cotton plant where leaves or squares develop. The development of interveinal tissues of newly formed young leaves is affected than in fully matured leaves resulting in the following symptoms

- Overgrown plants
- Cupping and stunting of leaves
- Brittleness, stunting and twisting of stems
- Malformation of newly formed squares, bolls
- Reddening of stems, petioles and bracts
- Yellowing of leaves and squares
- Reduction of root initiation and stem swelling in young cotton plants
- Terminal death of plant at high concentrations of 2, 4-D resulting in abnormal vegetative branching called ‘candelabra effect’

2,4- D drift in Cotton

Management

The malformed leaf once formed may not be recovered. Foliar spray of water can be used to reduce the effect of 2, 4-D drift. To promote new flush, foliar spray of 1% urea is recommended. Foliar spray of 1.5 % calcium carbonate and 50 ppm Gibberellic acid can help in recovery of affected plants by low dose of 2,4-D to some extent. Avoid using sprayers contaminated with 2, 4-D for any other purpose in cotton field, unless washed thoroughly.

Square and boll drying in cotton

Square and boll drying is common in varieties with short sympodial branches and a cluster bearing habit. In other varieties this is seen under extreme weather conditions during flowering. Other factors like insect damage, pollination failure and micronutrient deficiencies contribute to square and boll drying. Non availability or decreased translocation of photosynthates to the reproductive parts may result in this disorder. This is common in problematic soils with salinity, alkalinity and also in light sandy soils with low nitrogen content. The dried squares and bolls turn black in color and immature bolls may crack. Dried bolls are eventually shed from the plant. *Gossypium hirsutum* genotypes are susceptible to this disorder. Adjustment of sowing dates, correction of nutrient deficiencies, prolonging the longevity of subtending leaves by need based spray of nutrients and plant hormones and frequent irrigation in saline soils may be done to ameliorate this disorder.

Bad Boll Opening

Bad boll opening is also called as Tirak. It is premature and improper cracking of bolls, instead of normal fluffy opening.

Symptoms

Leaves turn yellow and subsequently become red. The capsule wall of the bolls become tight and do not open completely. The affected bolls may turn black in color with time. The fibre as well as seed quality are affected.

Causes

- Soil with subsoil salinity
- Light sandy soil
- Nitrogen deficiency
- Prevalence of low humidity , warm and dry weather during fruiting period
- Low moisture and nutrient availability during boll formation

Square drying in Cotton

Boll drying in Cotton

Management

- Adjusting sowing dates so that the boll formation stage is not affected by any environmental stress or nutritional deficiency
- Appropriate nitrogen management at critical growth stages
- Frequent irrigations to reduce effect of subsoil salinity/ alkalinity
- Timely application of nitrogen in light sandy soil
- Use of growth retardant to check excessive vegetative growth

Conclusion

Monitoring plant health and vigor by physiological indices and following the recommended need based management measures help in achieving higher productivity in cotton.

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