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Physiological Disorders and Nutritional Deficiencies in Cotton

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Cotton, known as "the King of fibres", continues to be the predominant fibre in the Indian textile industry, despite stiff competition from the man-made synthetic fibres. It assumes a place of pride in Indian economy, as cotton production, processing and trade in cotton goods provide employment to about 60 million people in our country. Further, the export of raw cotton, yarn, textile, garments, cotton seed cake, oil and other byproducts earn valuable foreign exchange. In India, cotton is grown in three agro climatic zones, northern zone where cotton is raised entirely under irrigation, central and south zones where it is predominantly a rainfed crop. Cotton provides employment to several million people in cultivation, trade, processing, manufacturing and marketing, sustaining directly or indirectly about 10 per cent of the population of India (Status paper of Indian cotton, 2019). A minimum temperature of 15ºC is required for better germination at field conditions. The optimum temperature for vegetative growth is 21-27ºC & it can tolerate temperature to the extent of 43ºC but temperature below 21ºC is detrimental to the crop. Cotton grows best in clay loam soil. As a glycophyte, cotton shows higher tolerance to abiotic stresses than other major crops. According to a press release from the United States Department of Agriculture (USDA), cotton production is expected to decline in the upcoming years due to nutritional deficiencies and physiological disorders. This paper provides the information about nutrient deficiencies affecting cotton production and some of the mitigation measures to withstand the constraints.

Nutritional Deficiencies in Cotton

Nitrogen: Nitrogen is an essential constituent of aminoacids, nucleic acids, chlorophyll and protoplasm.
Deficiency symptoms: N deficiency symptoms first appear on the older leaves at the bottom of the plant. N is a mobile element and is rapidly translocated to the young developing parts. Early season deficiency results in plants with pale green yellowish leaves and stunted growth. Late season deficiency leads to reduced boll retention. Plants suffering from N deficiency, mature earlier and vegetative growth is shortened.
Correction Measure: Urea 1% foliar spray or DAP 2% can control this deficiency

Phosphorus: It is the second most commonly applied fertilizer nutrient. The plant takes up P as inorganic anion. The form of uptake is largely governed by pH.
Deficiency Symptoms: Dark green stunted plants, delay in blooming and fruiting. Small leaves and the symptoms first appear on the lower or older leaves and progress upward on the stalk.
Correction Measure: Foliar application of 2% DAP

Potassium: K plays an important role in fibre development and the turgor driven expansion of fibre cells ultimately determines the fibre length.

Deficiency Symptoms: Older leaves are chlorotic, droopy and have yellow spots between the veins the edges turn yellow then brown curt downward and die.
Correction Measure: Foliar spray of 1 % KCl

Calcium: Calcium is the second of the secondary nutrients; it is readily transported to the root surfaces by mass flow.
Deficiency Symptoms: Large plants and few fruiting forms. Crinkle leaf and poor root growth.
Correction Measure: Soil application of gypsum @ 50 kg/ha.

Magnesium: The most important function of Mg is its occurence in the centre of the chlorophyll molecule. It plays an important role in N metabolism. Proportion of protein-N decreases in Mg deficient crop caused by the dissociation of the ribosomes. Mg helps in translocation of cellulose and determines fibre quality.
Deficiency Symptoms: Presence of high Ca may induce Mg deficiency leading to "reddening" of leaves. In contrast to Ca, deficiency symptoms are initially observed in the older leaves. The reddening occurs due to reduced photosynthetic activity. Sometimes the Mg deficiency is confused with natural ageing late in the season. Leaf cupping and interveinal chlorosis,
Correction Measure: Foliar spray of MgSO4 @ 1 %

Sulphur: Constituent of aminoacids (cysteine and methionine), coenzyme A, thiamine and biotin.
Deficiency Symptoms: The plants are small and spindly with short, slender stalks. Deficiency is first seen on upper young leaves. Leaves first turn to light green to light yellow followed by pronounced yellowing.
Correction Measure: Foliar spray of MgSO4 @ 1 %

Iron: It plays an important role in photosynthesis, nitrate and sulphate assimilation and synthesis of chlorophyll.
Deficiency symptoms: Interveinal chlorosis of young leaves which progresses over entire leaf. In severe cases leaves turn completely white.
Correction Measure: Soil application of FeSO4 @ 5 kg/ha or foliar spray of 0.5% FeSO4.

Boron: Important for assimilate translocation during reproductive parts.
Deficiency Symptoms: With progress in deficiency, the terminal growing point dies, short leaf petioles with dark green rings, excessive shedding of buds and young bolls, bolls dry and fall young leaves become thick, brittle with water spots.
Correction Measure: Soil application of borax 0.5 kg/ha or foliar spray of borax 0.2% (Rajendran *et al.*, 2010)

Manganese: Manganese is required in minute quantity for optimum production of cotton. It is associated with iron movement within the plant which in turn helps in the synthesis of chlorophyll.
Deficiency Symptoms: Yellowing of cotton leaves at top of plant following irrigation, they become puckered, mottled, and partially chlorotic and distorted in early stages with necrotic lesions subsequently appearing along the veins.
Correction Measure: Soil application of FeSO4 @ 5 kg/ha or foliar spray of 0.5% FeSO4.

Zinc: Zinc is a metal component of several enzymes (carbonic anhydrase). It is also involved in the auxin production and synthesis of RNA. Zinc deficiency has become a limiting factor in crop production now-a-days.
Deficiency Symptoms: The leaves become thick and brittle with their margins cupped upwards. Squares and flowers that are formed tend to shed.

Correction Measure: Soil application of ZnSO4 5 kg/ha or foliar application of ZnSO4 1% (*Source*: CICR, Technical bulletian, 2006 and TNAU Agri Portal, 2021).

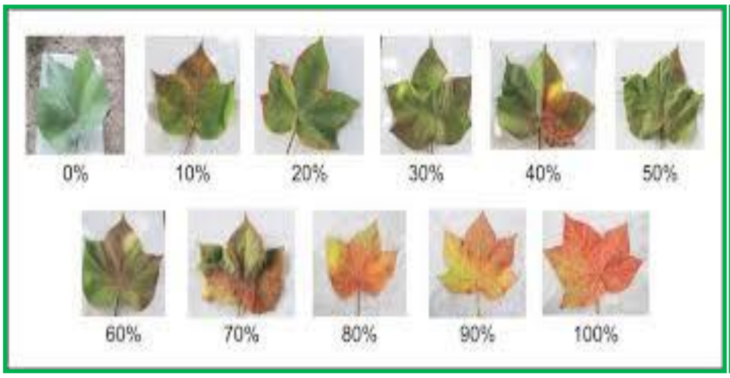
Physiological Disorders

Physiological disorders appear in cotton as a reflex of plant response to environmental stresses, nutritional imbalances and chemical factors.

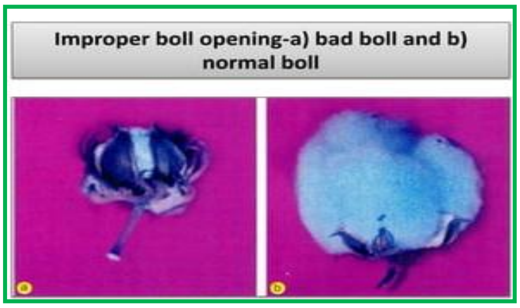
Bud and boll shedding: Due to insufficient light, production of key hormones like auxin in the leaf is also limited inducing a hormonal imbalance in the plant causing bud and boll shedding.

Management: Under such conditions, foliar application of 1% urea or 2% diammonium phosphate (dap) during flowering at 10-15 days interval was found beneficial.

Leaf reddening: Leaf reddening in cotton is also known as red leaf disease (lalpatti). This disorder is an outcome of interaction of location, variety, environmental condition and nitrogen supply. Apperance of red leaf symptom is primarily, due to the accumulation of anthocyanin pigment. Leaf reddening may occur at any growth stage of the crop. It is generally observed 90 days after sowing particularly where cotton is grown in red or laterite soils.



Management: Adjustment of sowing time for enabling the crop to skip over the adverse environmental condition during boll development stage. Magnesium sulphate at 0.5% can be sprayed. Leaf reddening incidence due to sucking pests may be overcome by spraying recommended insecticides



Bad boll opening: Bad boll opening is also called as Tirak. Symptoms are premature and improper cracking of bolls, instead of normal fluffy opening. 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. The capsule wall of the bolls become tight and does not open completely. The affected bolls may turn black in color with time. The fibre as well as seed quality are affected.

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

Crinkle leaf: Due to high amount of magnesium in waterlogged soil and calcium deficiency leads to development of chlorosis, distortion of leaves and crinkled leaf symptoms. Initially the symptoms are seen in the young leaves and gradually spread to the lower canopy.

Management: Gympsum application can neutralize manganese toxicity.

Conclusion

Cotton research has witnessed many progressive developments over the past half a century to address the above-mentioned challenges and limitations. The base for everything lies within the physiological mechanisms of cotton plant. One of the tools used in reducing environmental risks and increasing the yield is cultivar development through physiological breeding and genetics. Exogenous application of many growth regulators and nutrients helps the plants to cope with varying disorders and deficiencies. Cotton researchers worldwide have initiated and performed largely coordinated research projects in every physiological aspect of cotton science. These efforts have greatly accelerated cotton research worldwide and helped to address the key issues of cotton production and farming.

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