Biochemical Variation in Bt and Non Bt Cotton Genotypes in Different Plant Parts

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Introduction

Cotton (*Gossypium spp.*) is one of the most important fiber and cash crop of India. It is also known as a king of appraisal fiber and white gold. Bt cotton is effective against the Bollworm pest complex of cotton. All chemical constituents affect the quality and quantity of fiber and oil content (Prajapat *et al*. 2018). Bt cotton is a genetically modified (GM) cotton derived from *Bacillus thuringiensis* (Bt), a common soil bacterium. The gene, Cry-1AC, produces a protein toxic to lepidopteran (Bollworm) insects when ingested. Bt cotton has the added property of producing its biopesticide to protect itself from insect pests (Abbas,2018).

Cotton is the world's most important fiber crop and the second most important oil seed crop. The primary product of the cotton plant has been the lint that covers the seeds within the seed pod, or boll. This lint has been utilized for thousands of years for clothing for the people of ancient India, Asia, America, and Africa. Cotton fabrics have been found in excavations at Mohenjo-Daro in India and in pre-Inca cultures in the Americas. Lint, the most important economical product from the cotton plant, provides a source of high-quality fiber for the textile industry. The cotton seeds, the primary by product of lint production, are an important source of oil for human consumption, and the cellulose from the stalk can be used for products such as paper and cardboard. India is an exception to most countries, with only 30% of its cotton production area planted to *G. hirsutum*, 17% planted to *G. arboretum*, 8% to *G. herbaceum*, and the remaining area planted to interspecific and intraspecific hybrids (Hutchinson *et al*. 1947).

Primary Metabolites

The importance of primary metabolites in Bt and non-Bt cotton plants. Both Bt and non-Bt cotton rely on carbohydrates for energy. Sucrose and glucose levels can affect growth rates and overall plant vigor. Essential for cell wall structure in both genotypes, contributing to plant stability and resistance to environmental stresses. Crucial for protein production in both types. Differences in amino acid profiles can impact growth, stress responses, and fiber quality. Primary metabolites play key roles in energy metabolism and biosynthetic pathways in both Bt and non-Bt varieties, affecting yield and stress resilience. Primary metabolites are essential for the growth, structural integrity, stress responses, and fiber quality in both Bt and non-Bt cotton. Understanding these differences can aid in breeding and cultivation practices to enhance cotton production and resilience.

Secondary Metabolites

Secondary metabolites play a significant role in both Bt and non-Bt cotton plants. Secondary metabolites like phenolics, flavonoids, and terpenoids enhance resistance to herbivores and pathogens, offering protection especially in non-Bt cotton, which lacks the Bt toxin. Secondary metabolites help plants cope with environmental stresses such as drought, salinity, and UV radiation by acting as antioxidants and signaling molecules. Certain secondary metabolites influence the quality and characteristics of cotton fiber, potentially affecting its market value.

Compounds like flavonoids can attract beneficial insects, including pollinators, which is important for reproductive success. In both Bt and non-Bt cotton, secondary metabolites are crucial for defense, stress response, and overall plant health. Understanding these metabolites can inform breeding strategies and pest management practices to optimize cotton production.

Antioxidant Enzyme Activity

Antioxidant enzyme activity is vital in both Bt and non-Bt cotton plants. Antioxidant enzymes (e.g., superoxide dismutase, catalase, peroxidase) mitigate damage from reactive oxygen species (ROS) generated during biotic (pests) and abiotic (drought, salinity) stress. Higher antioxidant enzyme activity can improve resilience in both Bt and non-Bt cotton, helping plants cope with adverse conditions. Antioxidants support healthy growth by maintaining cellular integrity and function, crucial for overall plant development and yield. Antioxidant activity can affect

fiber development, potentially influencing quality and strength. The activity levels of antioxidant enzymes may differ between Bt and non-Bt cotton, reflecting their responses to pest pressures and environmental stressors. Antioxidant enzyme activity is essential for managing oxidative stress and enhancing resilience in both Bt and non-Bt cotton. Understanding these differences can aid in breeding and management practices aimed at improving cotton health and productivity.

Oil Quality

Oil content is important for both Bt and non-Bt cotton plants in terms of economic and industrial value. While Bt cotton helps protect plants from pests, leading to potentially healthier seeds, the oil content in Bt and non-Bt varieties is typically comparable. Any differences are usually the result of environmental conditions or pest pressure rather than genetic modification. The iodine value (IV) and peroxide value (PV) are important parameters in determining the quality of oil, especially when comparing genetically modified crops like Bt cotton with non-genetically modified ones like non-Bt cotton. The iodine value is a measure of the degree of unsaturation in the fatty acids of oil. It reflects the amount of iodine (in grams) that reacts with the double bonds in the fatty acids in 100 grams of oil. Higher IV indicates a higher number of double bonds, which means more unsaturated fats.

Unsaturated fats are considered healthier for human consumption and are important for industrial uses like in soap making and food production. Low iodine values generally indicate that the oil is more saturated, which means it is more stable and less prone to oxidation, but it might have lesser health benefits. The peroxide value measures the degree of oxidation in the oil by quantifying the amount of peroxides present, which are early indicators of rancidity. It is reported in terms of milliequivalents of active oxygen per kilogram of oil. A low peroxide value indicates that the oil is fresh and has not undergone significant oxidation. Higher PV means that the oil is starting to go rancid, and its shelf life is compromised. Oils with high PV may develop unpleasant odors and flavors, making them less suitable for consumption or use. The iodine value is an indicator for assessing the degree of oil unsaturation (Dawodu, 2009).

Benefits of Bt and Non-Bt Cotton

Bt cotton is genetically modified to produce a toxin derived from the bacterium *Bacillus thuringiensis (*Bt), which is toxic to specific pests, especially bollworms, which are major pests in cotton farming. Bt cotton can naturally ward off certain pests, it significantly reduces the need for chemical pesticides. This leads to a decrease in the overall cost of pest management and can be better for the environment. Lower pesticide usage can also result in less chemical runoff into soil and water bodies, promoting environmental sustainability and reducing harm to non-target organisms such as beneficial insects. By protecting plants from severe pest damage, Bt cotton often leads to higher yields compared to non-Bt cotton under pest pressure conditions. Healthier plants with less pest damage often produce seeds and fibers of higher quality, benefiting both farmers and industries that process cotton for textiles and other uses. Farmers growing Bt cotton often achieve higher profitability due to reduced pest control costs, higher yields, and better quality of cotton, making it a viable option in areas with high pest infestation rates. Non-Bt cotton is preferred in organic farming and by consumers who are concerned about genetically modified organisms (GMOs). It can be grown in compliance with organic certification standards. non-Bt cotton does not kill specific pests, it may help maintain a more balanced ecosystem of insect species. Bt cotton targets only specific pests, which can lead to an imbalance or harm to other species over time. Farmers growing non-Bt cotton may use a variety of pest management approaches, including integrated pest management (IPM), chemical pesticides, or biological controls. This allows them to be more flexible in addressing different pest issues without relying on the Bt gene. Non-Bt cotton seeds are typically less expensive than Bt cotton seeds. While non-Bt cotton may require more investment in pest control, the lower cost of seeds can benefit small-scale or resource-limited farmers.

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