

# Microbial Interactions in Natural Sources of Textile Industry: A Review

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**ABSTRACT:** Microorganisms acting as pathogens are known to damage natural products. But this interaction of microorganisms turns to be beneficial in the evolution of newer processes and bettering the existing ones in our day to day life. Interactions of microorganisms in agricultural production are also well known. Microorganisms were known to decrease the shelf-life of agricultural produce, but actually their proper usage is beneficial in increasing the agricultural output as well as in all other fields associated with life.

**KEY WORDS:** Bt cotton, Tamarind kernel powder, Plant growth promoting *Rhizobia*.

## I. INTRODUCTION

Cotton, Jute, Wool, Natural silk are the preferred fibers that satisfy the basic need for clothing in humans. Research has been focused towards evolution of new processes and bettering the existing ones in the production of these fibers. This is more crucial due to the scarcity of natural resources required in their production. Cotton is the preferred fiber for clothing due to its wide availability; hence research has been diverted right from its cultivation incorporating innovative farming techniques consisting of the usage of bio-fertilizers and compost with the avoidance of synthetic chemical fertilizers, insecticides and pesticides.

## II. ACTIVITY OF MICROORGANISMS IN NATURE [1]

Microorganisms are known to bring undesirable changes in natural products, which are referred to as Bio-degradation. But, many interactions are actually beneficial to the environment as it is a natural method of waste treatment. This leads to recycling of many essential elements contained in the waste. The damage caused by microorganisms on textile materials during production and storage, known as Mildew or rotting, leads to their deterioration [2, 3]. It is a serious problem faced by the manufacturers and users alike. Microorganisms also lead to the hydrolysis of natural Guar and Tamarind Kernel Powder based printing thickeners used during printing of textiles. These microorganisms which include bacteria, fungi, algae and virus are unicellular organisms growing rapidly under humid and warm climate. Bacteria can be further subdivided into Gram positive bacteria like *Staphylococcus aureus*, Gram negative bacteria like *Escherichia coli* and Spore bearing or non-spore bearing type. Some of these bacteria are pathogenic and cause infections. Fungi, molds and mildew are complex organisms with slow growth rate. They are part of our everyday life and found everywhere in the environment and on and in our bodies [4].

## III. ROLE OF MICROBES IN FARMING ACTIVITIES

Microbes play a vital role in enhancing plant productivity and yield in cropping systems. This beneficial potential of the microbes is studied and employed in growth promotion, particularly in terms of fertilization and disease control [5]. These microorganisms are also referred to as Plant Growth Promoting (PGP) microbes or also as Plant Growth Promoting *Rhizobacteria* (PGPR) in the commercial terminology. These PGP microbes are widely used in cotton farming activities to enhance the production coupled with better quality [6, 7].

Cotton is the most important fiber and commercial crop of the world. Agricultural cultivation of cotton is heavily reliant on the use of chemical fertilizers, herbicides and pesticides in order to control the different biotic and abiotic stresses. Biotic stresses are due to insect pest incidence, which is a major constraint in cotton output. Plant growth and productivity is heavily influenced by the interactions between plant-roots and the surrounding soil, including the

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microbial populations within the soil. In order to meet the challenging needs and requirements of today, development of improved transgenic varieties of cotton using tissue culture techniques has been an effective option [8].

### **Promotion of Growth of Cotton Plants and Mechanisms of Disease Suppression [9, 10]:**

Cotton crop produce has been constantly affected globally by different emerging, re-emerging and endemic plant pathogens. This has led to an indiscriminate use of synthetic pesticides and fungicides leading to serious environmental deterioration. Pathogen resistance has also enforced for the discovery of newer agents. Researchers have deduced that rhizospheric microbes that are able to suppress plant pathogens could be effectively employed as bio-control agents, replacing the chemical pesticides. The basic requirement for the effectiveness of PGPR is their ability to colonize the rhizosphere, rhizoplane, or the root interior of the host plant. There are numerous mechanisms of plant pathogen suppression, which includes direct inhibition of pathogen growth through production of antibiotics, toxins, Hydrogen Cyanide (HCN) and hydrolytic enzymes like chitinases, proteases, lipases, that degrade virulence factors or the cell-wall component of the pathogens.

These organisms have an exceptional soil conditioning potential. Multifunctional organisms such as *Trichoderma harzianum* are able to enhance plant growth by solubilising phosphate (P) and micronutrients required by plants, such as iron and manganese, and also suppress plant pathogens. HCN production suppresses microbial growth and may inhibit pathogens such as root-knot, bacterial canker and black rot in the case of tomato and tobacco cultivation. However HCN may prove to be harmful to plants by inhibiting energy metabolism and reducing root growth. HCN is produced by different species of bacterial genera like *Alcaligenes*, *Aeromonas*, *Bacillus*, *Rhizobium* and *Pseudomonas*. Other mechanisms involved in disease suppression include activation of the own defense system of the plant, known as Induced Systemic Resistance (ISR). These microbes have an ability to increase the tolerance capabilities of the plants to adverse environmental stresses, which include salt stress, drought stress, weed infestation, nutrient deficiency, and heavy metal contaminations. The term 'Induced Systemic Tolerance' has been thus used to describe the capacity of PGPR to elicit tolerance to salt and drought. A range of salt-tolerant rhizobacteria identified so far has exhibited beneficial interactions with plants in stressed environments. These PGPR, namely *Rhizobium*, *Azospirillum*, *Pseudomonas*, *Flavobacterium*, *Arthrobacter* and *Bacillus*, utilize osmoregulation; oligotrophic, endogenous metabolism; resistance to starvation; and efficient metabolic processes to adapt under dry and saline environments. The bacteria, with their physiological adaptation and genetic potential for increased tolerance to drought, increasing salt concentration, and high temperatures, could improve plant production in degraded sites. Volatile compounds released by PGP bacteria and fungi are able to trigger ISR, resulting in enhanced expression of defense related genes in the host.

### **Microbes useful for suppressing Disease in Cotton [3]:**

Cotton cultivation is affected by pathogens resulting into a high economic burden onto the farmer fraternity. Fungal and bacterial pathogens like *Pythium ultimum*, *Rhizoctonia solani*, *Fusarium* species, *Verticillium* species, *Thielaviopsis basicola* and *Xanthomonas* are responsible for seedling diseases. Strategies employed to prevent such disease include selection of suitable varieties and planting times, crop rotation with non-host species, optimization of seed bed preparation and irrigation schedules, agrochemicals and improvements in farm hygiene practices. Quite often, many fungicides are not effective against soil-borne pathogens and so the strategy that controls disease caused by one pathogen may not be effective in controlling others, or even it may actually promote the damage caused by other pathogens. Disease resistant cotton varieties have been developed which exhibit an increased resistance to *Fusarium* and *Verticillium* species.

### **Development of Bt Cotton [11, 12]:**

Bt Cotton is a Genetically Modified Organism (GMO) cotton variety, which produces an insecticide to counter the assault of bollworm. These genetically engineered or modified organisms are called 'Transgenics'. Insect pests, mainly bollworms, affect the cotton crop and hence are responsible for substantial loss of cotton yield in the world. Bollworms are of three types:

American Bollworm:	<i>Helicoverpa armigera</i>
Pink Bollworm:	<i>Pectinophora gossypiella</i>
Spotted Bollworm:	<i>Earis vitella</i>

In the years before the advent of Bt Cotton, insecticides were used in order to curtail this loss. But this resort was neither economical nor environmental friendly. Also by the passing of time, insects developed resistance against these insecticides, termed as 'Host Resistance'. This rendered the insecticides ineffective after a few years of usage against the same pests. Hence it has become utmost necessary to develop a resistant cotton cultivar against bollworms in order

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to curb the yield losses by them. Bt Cotton was the only resource to control bollworms due to the absence of natural inherent resistance source to the bollworms in the germplasm of cotton.

Bt Cotton refers to the strains of the bacterium *Bacillus thuringiensis* responsible for producing over 200 different Bt toxins, each harmful to different insects. The 'Bt' is the short form of ubiquitous soil bacterium *Bacillus thuringiensis*. This Gram positive and spore forming bacterium is responsible for forming parasporal crystals during stationary phase of its growth cycle. The synthesized crystalline (Cry) proteins called 'Endotoxins' are highly toxic to certain insects, and are responsible for eliminating caterpillars by its frontal attack on the epithelium tissue of midgut of the insect.

Tobacco was the first such transgenic plant developed in 1983 in USA. It was followed by the development of the first transgenic cotton plant in 1987 in USA by three organizations: Monsanto, Delta and Pine.

Further research in this aspect led to the development of transgenic bollgard cotton of two types:

1. Bollgard I, containing Cry I Ac Bt gene in its genome; and
2. The next generation transgenic Bt Cotton Bollgard II containing a combination of two genes: Cry I Ac and Cry I Ab into the cotton genome. The effectiveness of Bollgard II is approximately five times more than Bollgard I in conferring resistance to bollworms.

It has been observed that Bt Cotton is ineffective against many cotton pests such as plant bugs, stink bugs, and aphids. Hence as per need, insecticides need to be used for their elimination. In 2006, independent studies were conducted by three different organizations: Cornell researchers, The Center For Chinese Agricultural Policy, and the Chinese Academy of Science on Bt Cotton farming in China found that after seven years, these secondary pests that were normally controlled by pesticide showed an increased proliferation, necessitating the use of pesticides at similar levels to non-Bt Cotton. This led to financial losses to farmers because of the extra expense of genetically modified (GM) seeds.

### Mechanism of Action:

Bt Cotton has been developed through the addition of genes encoding toxin crystals in the Cry group of endotoxin. When insects attack and eat the cotton plant the Cry toxins are dissolved due to the high pH in the insect stomach. The dissolved and activated Cry molecules bond to cadherin-like proteins on cells comprising the brush border molecules. The epithelium of the brush border membranes separates the body cavity from the gut while still allowing access for nutrients. The Cry toxin molecules attach themselves to specific locations on the cadherin-like proteins present on the epithelial cells of the midge, and ion channels are formed which allow the flow of potassium. Regulation of potassium concentration is essential and, if left unchecked, causes death of cells. Due to the formation of Cry ion channels, sufficient regulation of potassium ions is lost and results in the death of epithelial cells. The death of such cells creates gaps in the brush border membrane.

These proteins are characterized by their prominent insecticidal activity, and are grouped into following five classes:

Cry I	Lepidoptera insects
Cry II	Lepidoptera and Diptera insects
Cry III	Colepteran insects
Cry IV	Diptera insects
Cry D	Lepidoptera insects

## IV. CONCLUSION

GM Bt Cotton has several advantages over non Bt Cotton. The main advantages of Bt Cotton are the increase in the yield of cotton due to effective control of three types of bollworms: American, Pink and Spotted bollworms. As insects belonging to Lepidoptera (Bollworms) are sensitive to crystalline endotoxic protein produced by Bt gene, which in turn protects cotton from bollworms. Also, there is a marked reduction in pesticide use in cultivation of Bt Cotton. Hence, there is a remarkable reduction in the cost of cultivation with a drastic reduction in environmental pollution as insecticides are rarely used. There is no health hazards to farm workers engaged in spraying operations due to rare use of insecticides. Bt Cotton has a permanent type of genetic or inbuilt resistance not affected by environmental factors. Thus protects crop from bollworms. Bt Cotton is totally ecofriendly. It does not have any adverse effect on parasites, predators, beneficial insecticides and the organisms present in soil. On the contrary, it promotes multiplication of parasites and predators which help in controlling the bollworms by feeding on larvae and eggs of bollworm. Bt Cotton also has a high growth and fast maturing rate as compared to non Bt Cotton [11, 12].

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Studies showed that due to the lower levels of spraying of pesticides on the cotton crops promoted biodiversity by allowing non-target species like ladybirds, lacewings and spiders to become more abundant. Likewise it was found that integrated pest management strategies (IPM) were becoming more effective due to the lower levels of pesticide encouraging the growth of natural enemy populations.

In spite of several advantages, there are certain limitations of Bt Cotton. The cost of Bt Cotton seeds is quite high as compared to non Bt Cotton seeds. Hence, many times this technology is out of reach of small and marginal farmers. Effectiveness is maintained up to 120 days, after that the toxin producing efficiency of the Bt gene drastically reduces. It is ineffective against sucking pests like jassids, aphids and whitefly. It may also promote commercial malpractice of mixing cheaper non Bt Cotton seeds with genuine Bt Cotton seeds which are comparatively costly. This adversely affects the cotton production as well as the financial conditions of the cultivators using those adulterated seeds [11, 12].

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