Article: RT571

Biotica Research Today

Vol 3:5 309/311

2021

Naturally Coloured Cotton: Eco-Friendly Fibre for Future

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Open Access

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Keywords

Coloured cotton, Coloured lint, Fibre quality, *Gossypium* spp.

Article History

Received in 10th May 2021

Received in revised form 12th May 2021

Accepted in final form 13th May 2021

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How to cite this article?

Premalatha, 2021. Naturally Coloured Cotton: Eco-Friendly Fibre for Future. Biotica Research Today 3(5): 309-311.

Abstract

Cotton with naturally coloured lint other than white is commonly referred as coloured cotton. In India, about 40 coloured genotypes of upland cotton (*G. hirsutum*), in various shades of brown and green colour are available. The naturally colored cotton is a pollution-free, eco-friendly, energy-efficient, cost-effective, non-toxic, novel viable textile material which could be explored for different product developments in the future. Colored cotton has both unique and desirable qualities beneficial to the consumer and the environment. The naturally colored cotton fiber had short upper half mean length, low uniformity index, low fiber strength, good fineness, low elongation (%), good uniformity, and average maturity. As the world is moving toward pollution-free organic textiles and products, the naturally colored cotton is going to be the next buzz word in the market. This is because; the production process of naturally colored cotton skips the most polluting activity (dyeing) of the textile product manufacturing.

Introduction

Cotton with naturally coloured lint other than white is referred as coloured cotton. Naturally-coloured cotton could help reduce the environmental pollution caused by dyes. It can also be noted that the coloured cotton is grown and has been in use since 2500 B.C. Coloured varieties were more popular in diploid cotton. These were cultivated in Asia, particularly India, China and Central Asian Republics of Soviet Union. In various cultivated species, brown and green colours are most common. The fibres of coloured cottons presently available are shorter, weaker and finer than regular upland cotton and can be blended with normal white cottons. Generally, colour linted varieties are poor yielders having low productivity per unit area due to smaller bolls and low ginning outturn.

The cotton can be grown in various shades of brown which ranges from light brown to intense mahogany red. In India, brown linted varieties of tree cotton (*G. arboreum* L.) namely Cocanada 1, Cocanada 2 and Red Northerns were under commercial cultivation mainly on black soils under rainfed condition in parts of Andhra Pradesh. Red linted types were predominant and high in demand for their better dyeing qualities. Wild species are important sources of coloured lint. Among the upland naturally coloured cotton, the widely preferred are brown and green linted types. In the National gene bank of CICR, Nagpur, genetic stocks of more than 50 coloured cottons are maintained. Carvalho *et al.* (2014) reported that the fiber color is a genetically inherited characteristic resulting from the presence of pigments intermingled with cellulose in cotton and also reported that the brown fiber color was controlled by six loci: Lc1 and

Lc2 were responsible for medium brown color of lint, Lc3 was responsible for dark brown, and Lc4, Lc5 and Lc6 were responsible for light brown (Wang *et al.,* 2014).

Brown coloured lint is present *in G. aridum, G. armourianum, G. darwinii, G. mustelinum, G. anomalum, G. capitis-virdis, G. somalense, G. arboreum, G. stocksii, G. areysianum, G. incanum, G. australe, G. sturtianum* while other colours are present in rest of the species. The intensity of brown colour showed negative correlation with fibre quality. The brown lint is present in many wild species and is more stable than green fibre. The wild species *G. gossypioides, G. harknessii, G. herbaceum, G. longicalyx, G. robinsonii, G. sturtianum* var *nandewarense* possess greyish fibre. Depending on the intensity of colour, it can be classified into light brown, khaki/ camel colour, brown, dark brown/ chocolate colour, dirty grey, tan and red. The green colour is less common than the brown shade. It occurs as light green and dark green. Among coloured cotton genotypes, shades of brown are more stable than green genotypes which tend to fade when exposed to the sun.

There is also still limited range of colors, although about ten cotton varieties with different colors have been reported breeding successfully worldwide, on commercial scale brown and green shades are mostly used. Shades may also change depending on seasonal and geographical factors.

Due to the low yields and low spinning capacity, colored fiber has not been greatly used for commercial textile purposes. Nevertheless, there is currently growing worldwide interest in the use of clothing made from naturally colored cotton. The brown fiber color in wild *G. barbadense* may vary from slightly cream to chocolate colored, along with other shades, such as grayish, yellowish, purplish, and orangish. The pigments accumulate in the lumen of lint before ball bursting. In *G. hirsutum*, pigmentation begins to appear in the developing lint 32 days after fertilization after which it takes six days for the colour to develop. In the variety, *G. arboreum*, colour pigments are observed after 46-47 days of fertilization. After this, it takes 5-6 days for the colour development process to complete. However, the complete expression of lint colour takes place only when the boll bursts open and the lint is exposed to sunlight. The lint colour is determined by a group of genes situated at three loci, LC_1, LC_2, and LC_3 (Murthy, 2001). They are dominant over the white alleles and operate in association with modifier genes that are either suppressors or intensifiers. In the presence of strong suppressors, white lint is produced. Often, the genes for lint colour are found to be pleiotropic, *i.e.,* they control more than one trait. This has been the most important problem in the development of economically and technically superior coloured cotton. For example, the gene for brown colour in *G. arboreum* and *G. barbadense* suppresses lint length and its fineness. Similarly, green and brown lints in *G. hirsutum* inhibit fibre development. Generally, all colour genotypes have fibre qualities far below the white variety. However, not all associations are unfavorable. The varieties *hirsutum* tashkent (brown) and Arkansas green have high boll weight. In addition, colour development is also influenced by many environmental factors, especially sunlight, soil nutrition, and soil type. Brown, grey and tan are due to tannin and phenolics present in vaculoles in the fibre lumen. Green fibre is due to the presence of caffeic acid and cinnamic acid present in wax layers interspersed with cellulose layers that envelope the cotton fibres. On continuous exposure to sunlight, green fibre undergo rapid fading that eventually changes to white colour, off-white or brownish.

Advantages of the Coloured Cotton

Cotton with artificial dyes has reported itching on the skin and even cancer. With naturally coloured cotton such risks to the human body can be avoided. After dyeing, the chemical residues of finishing affluents are thrown in rivers contaminating all the water and soil. This caused great environmental pollution, which will be avoided in case naturally coloured cotton is grown. The dyeing process adds on to the cost of production which would also be eased once the cotton is homegrown. There is risk of skin cancer among the persons who regularly come in contact with artificial dyes. It is a known fact that most of dyes used in textile industries are carcinogenic. The fabric prepared from naturally coloured cotton lint is free from such adverse effects. There is no need of using artificial dyes, when the fabric is manufactured from naturally coloured cotton. Such fabric can be safely used even by those having sensitive skin. Thus, fabric manufactured from coloured cotton has been found to be the best for human health. Two of the most important consumer acceptance parameters are stability and fastness of the colours to the various processes of washing, bleaching, *etc*. In India, the Central Institute for Cotton Research of Nagpur and several State Agricultural Universities has taken up breeding programs for improvement of coloured cotton. Some naturally colored cotton darkens with exposure to the sun. However, green is less stable and fades to tan when exposed to sunlight.

Limitations of Cultivation

The naturally colored cotton has a small fiber and is not suitable for heavy machine spinning. Due to smaller fiber, it becomes unpractical to use naturally colored cotton for clothing manufacturers. But now, colored cotton is literally squeezed in with the conventional white cotton to make its fiber longer and stronger than other naturally colored cotton to be used in typical looms. They yield less per acre. Naturally colored cotton has failed to face the rapid industrial turnover. However, coloured cottons are inherently inferior to white cotton in one or more aspects. Agronomically some have fewer boll number and boll weight. Economically some are low in yield, and lint index. Technically fibres may be short, weak, and coarse, and colour may not be uniform. Hence, plant

breeders are trying to produce superior varieties by crossing strains with desirable qualities to make coloured cotton more attractive and machine friendly. Furthermore, the yield is low, about half that of white cotton and they are susceptible to certain types of pests. High whiteness per cent, higher wax content, requirement of isolation distance, existence of only a few shades, inconsistency and non-uniformity of fibre colour over seasons and locations are few other problems associated to these cottons.

When cultivated in large areas, natural cross-pollination may occur from white linted to colour and vice-versa. Hence, isolation distance of the order of 50 meters or more may be required between varieties. Contamination may also occur during harvesting, transportation, ginning, pressing, and spinning. Since white cotton is still a major agricultural produce, its contamination with colour lint may have disastrous effects on agricultural economy. Naturally coloured cotton genotypes currently available in the germplasm have limited lint colours. There are only two colours *i.e.* brown in various shades and green. With only two colours, naturally coloured cotton cannot compete with white cotton as varied treatments of colours and shades can be easily imparted to white cotton. Cotton is an often cross-pollinated crop. In natural conditions, cross pollination occurs to the extent of 5-20 percent. Growing of coloured and white cotton in the vicinity will enhance the chance of contamination of white linted genotypes with coloured genotypes and vice-versa. Contamination may occur in three ways, *viz.*, (1) through natural out crossing with white cotton, (2) during ginning, and (3) during delinting. Growing of white cotton in the field in which coloured cotton was grown in the previous year may also lead to contamination through volunteers. Hence, cultivation of coloured cotton shall be raised with an isolation distance of 50 m.

Conclusion

Naturally coloured cotton are gaining importance in the recent years due to concern raised on environmental issues. Using naturally colored cotton will preserve the present environment and protect the people from health hazards like skin cancer. Hence, people are turning to the environment-friendly coloured cotton. These naturally coloured cottons shall reduce or eliminate the costly synthetic dyeing and bleaching procedures. Growing naturally coloured cotton coupled with cotton cultivation under organic farming methods will completely eliminate the usage of synthetic/ inorganic pesticides and synthetic dyes. Naturally colored cottons have not yet been commercialized on a large scale due to some limitations, such as low productivity, poor fiber characteristics, non-uniformity of colours, and so on. Hence, research on naturally coloured cotton should be intensified. There is a lack of proper marketing and premium price for naturally coloured cotton. Hence, it is necessary to develop marketing facilities before starting cultivation of coloured cotton on large scale commercial production.

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