EFFECT OF DRYING METHODS ON QUALITY OF COTTON FIBERS BEFORE GINNING

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Abstract

The PCSI (Pakistan Cotton Standard Institute) standard test methods for measuring moisture percentage in Pakistan seed and lint cotton relate the drying system. The decline in weight is taken as the amount of moisture and is stated as a percentage (%) of the quantity of either the humid or dried material. It is essential to evaluate the standard methods and compare them to know that which drying method detoriates the cotton fibers to the minimum. Three cotton varieties MNH-93, Niab-78 and Ali Akbar-703 were taken to dry with natural, artificial drying methods and cotton storage technique. The fibers were tested for effective length, fineness and strength. It was observed that natural drying technique least influenced the cotton fiber properties whereas artificial drying technique the most. On the other hand storage technique detoriates at intermediate levels but does not reduce the moisture to the exact level required. Artificial drying technique proved to be fastest as the temperature control in this technique is in our hands.

Keywords: Drying, moisture, natural & artificial drying system, fiber properties

1. Introduction:

The moisture presents in the fibers effect many of their properties. This is a major influence on fiber properties if hydrophilic fibers are the case like cotton, as it absorbs or desorbs moisture from the ambient atmosphere. Generally we can say that the fibers that absorb the greatest amount of moisture are the ones whose properties change the most [1]. Majorly three main categories of the characteristics are influenced; Mechanical, electrical and dimensional. It has been seen in general that the moisture content of the cotton fiber remains in between 5 to 10% [2]. Therefore the actual moisture content during processing has a significant influence on the mass of the fibers [3, 4]. Commercially this factor is very vital, because the textile fiber are bought and sold in huge quantities and hence by weight.

1.1 Moisture content of seed cotton during ginning operation

The most important factor in preserving quality during ginning is the fiber moisture content [4]. At higher moisture levels cotton fibers are stronger but trash is harder to remove and cleaning machinery is less efficient [5, 6]. Consequently, selecting ginning moisture content before ginning is a compromise between good trash removal and quality preservation. In normal cotton in most conditions moisture content must be 5 ½ % to 6 ½ % moisture level at the gin stand apron [9].

Fig 1.1 Gin Stand apron

1.2 Moisture content of lint cotton after ginning operation

Before the cotton lint reaches tempers and press for baling, moisture is added through moisturizer to prevent induced electrostatic charges [8, 10]. Moisture is added as the lint slide in an attempt to regain extra turnout. It is difficult to add more than 1.5 to 2 percent moisture to the fiber on the lint slide using humid air. If the lint is dried to 5 percent moisture we can only accept about 7 % moisture in the bale. Adding moisture at the lint slide also makes the bale press work easier [11]. It takes approximately 1.2 times more peak hydraulic pressure to press fiber at four percent moisture versus seven percent moisture content.

Fig 1.2 Moisture measurement of Cotton Bale

2 Materials and methods

PCSI standard test methods for determining moisture content in seed and lint cotton is based on natural drying, artificial drying and cotton storage techniques. The moisture content standards for seed, lint cotton and standards for storing seed cotton, developed by PCSI are active in the ginning as well as spinning industry of Pakistan.

2.1 Natural drying system

Seed cotton, because of morning humidity is often too wet to gin without some drying. Therefore, especially in our country, we dry the seed cotton through natural system. Sunlight is the major source of heat energy abundantly available in Pakistan. Using sunlight one can dry the cotton fibers as they are spread over a flat surface. During the day time in summer temperature (in degree centigrade) rises to 40s in the southern parts of Pakistan. Normally sunshine is available for 8-10 hours a day as shown in figure 2.1.

Fig 2.1 Average annual temperature in cotton belt of Pakistan

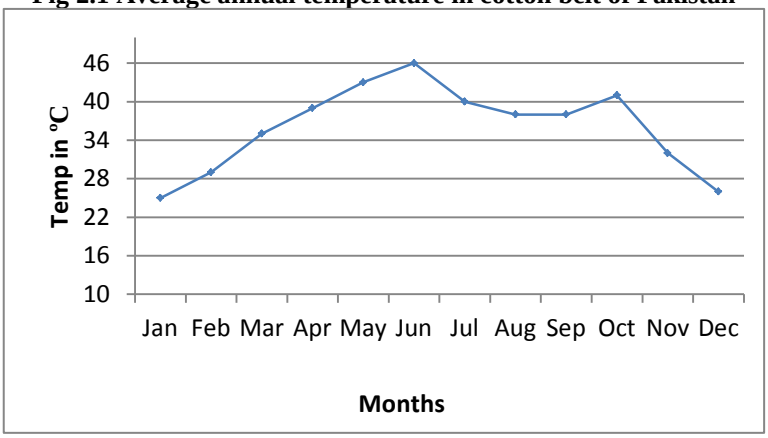
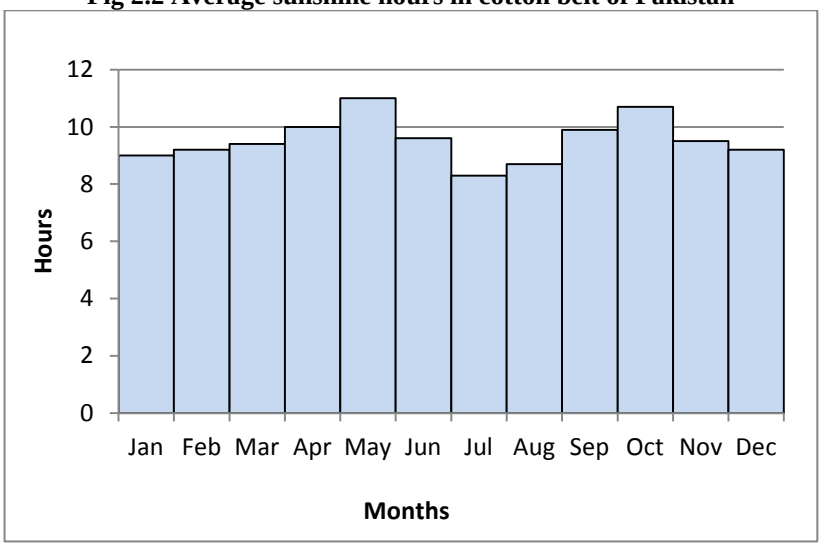


Fig 2.2 Average sunshine hours in cotton belt of Pakistan



Seed cotton that is wet about 20% moist will not gin satisfactory. As per PCSI the seed cotton must be spread on a platform and expose it to the sun for several hours which reduces the moisture to 10%. This process is locally called as dandhari / khalari.

Fig. 2.3 Natural drying (Dandhari)

2.2 Artificial drying system

In some areas of coast region, there is so much wet cotton that has almost always been made to dry it before ginning, therefore they use artificial drying equipment called “drier”. Some of these driers dry the seed cotton by passing it through a large cylinder or tower through which forced a hot air at the rate of 40 to 100 cubic feet for each pound of cotton the temperature of the drying is 150 to 250 ºF. This process consumes a lot of heat energy as compared to the natural drying process which consumes not energy produced by man, but is time consuming [7, 12].

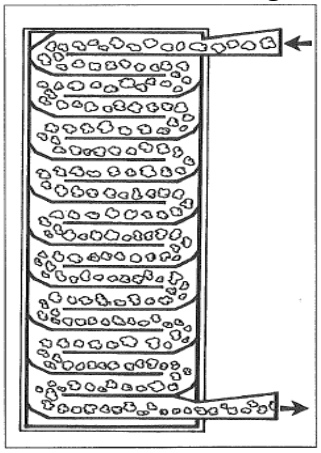


Fig 2.4 Schematic diagram of Drier

2.3 Storing seed cotton

Storing seed cotton is basically not a process of drying and hence reducing the moisture of cotton fibers, instead it is a process of preserving the moisture. Seed cotton can be safely stored in modules/heaps not more than 18 x 12 x 10 ft, if its moisture content is kept at 12 % or less. Wet cotton or containing green plant material will heat during storage and quickly deteriorate. Cotton damage in this manner produces low grades and poor quality seed. Modules/heaps should be checked daily. A ventilation machine should be used to save the seed cotton modules from heating or discoloring. This process is mainly used for types of cotton fiber containing no more than 12% or less moisture.

Fig 2.5 Cotton storage

3 Experimental

MNH-93, Niab-78 and Ali Akbar - 703 **(**BT cotton) were dried with three different methods i-e natural drying, oven drying and storage of cotton fibers. BT stands for Bacillus thuringiensis, which is a recently grown type of cotton is getting increasing popularity these days. Characteristics of cotton fibers were tested before and after the drying processes. The properties measured include effective length bundle fiber strength and fineness. Effective length of cotton sample is measured using Comb sorter, the standard test method used is ASTM D1440-96, Standard test method for length and length distribution of cotton fibers (array method). Fiber fineness is measure using USTER Micronaire 775 and the standard test method used is ASTM D1448 Standard test method for micronaire reading of cotton fibers. Bundle strength of cotton fibers is measure using USTER Stelometer 754 and the standard test method used is ASTM D1445-95, Standard test method for breaking strength and elongation of cotton fibers (flat bundle method). Before drying by the three different methods cotton was observed to have moisture of 20%.

Tables 3.1, 3.2 and 3.3 show details of the mean values obtained by various measurements for length, fineness and strength of MNH-93, Niab-78 and Ali Akbar – 703 before and after natural drying.

Table 3.1 Cotton fiber properties before and after natural drying

	Effective length in mm		**Fiber Fineness (MIC)**		**Fiber Strength (tppsi)**	
	Before drying	After drying	Before drying	After drying	Before drying	After drying
MNH-93	28.5	27.5	4.4	4.3	94.0	84.3
Niab-78	26.0	24.5	4.4	4.3	92.5	82.1
Ali Akbar-703	28.5	28.0	5.0	4.9	104.6	95.6

Following table 3.2 gives difference in length fineness and strength of MNH-93, Niab-78 and Ali Akbar-703 before and after the artificial drying

technique. Another table 3.3 shows measurement of the three said properties of cotton before and after storage technique.

Table 3.2 Cotton fiber properties before and after Artificial Dryer

	Effective length in mm		Fiber Fineness (MIC)		Fiber Strength (tppsi)	
	Before drying	After drying	Before drying	After drying	Before drying	After drying
MNH-93	28.5	26.0	4.4	4.3	94.0	81.7
Niab-78	26.0	23.5	4.4	4.3	92.5	78.2
Ali Akbar-703	28.5	27.0	5.0	4.9	104.6	90.6

Table 3.3 Cotton fiber properties before and after storage

	Effective length in mm		Fiber Fineness (MIC)		Fiber Strength (tppsi)	
	Before drying	After drying	Before drying	After drying	Before drying	After drying
MNH-93	28.5	28.0	4.4	4.4	94.0	83.6
Niab-78	26.0	25.5	4.4	4.4	92.5	80.4
Ali Akbar-703	28.5	28.5	5.0	5.0	104.6	93.8

To better understand the difference of values before and after different drying techniques, the results are shown in bar charts. Figure 3.1, 3.2 and 3.3 shows the difference in length of the three cotton varieties before and after natural drying, artificial drying and storage technique respectively.

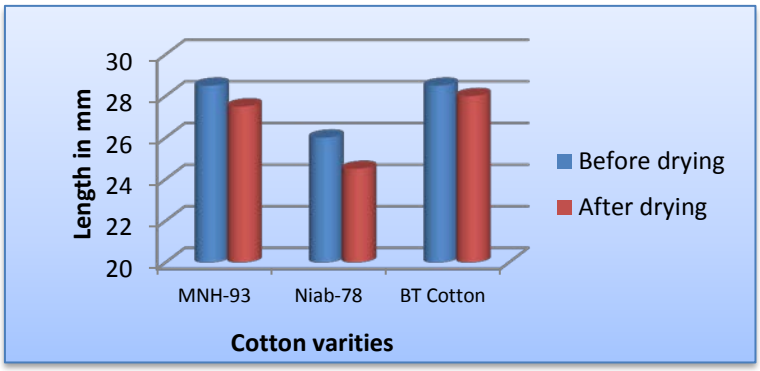


Fig 3.1 Effect of natural drying on Effective Length of cotton fibers

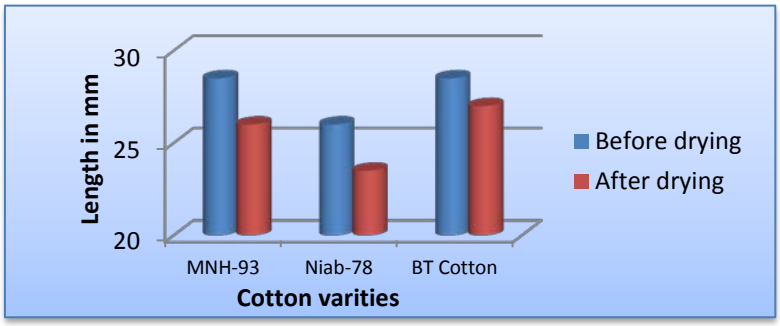


Fig 3.2 Effect of artificial drying on Effective Length of cotton fibers

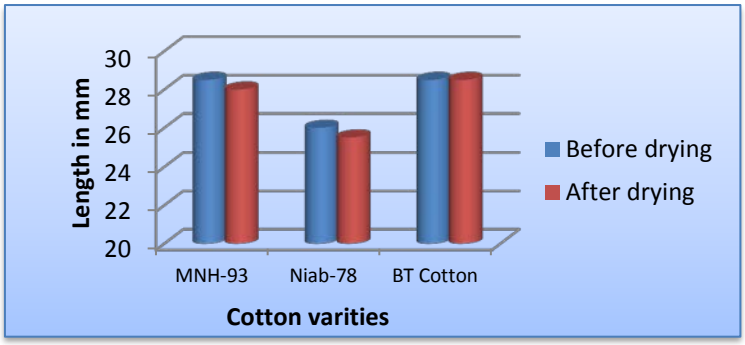


Fig 3.3 Effect of storage on Effective Length of cotton fibers

It is clear from the three figures that artificial drying technique influences the length of material the most when compared with other two drying techniques used in the experiment. On the other hand natural drying technique least influences the length of cotton fibers for MNH-93, Niab78 and Ali Akbar-703. Effect of storage technique has intermediate effect on the length of fibers cotton fibers.

Below are the results of the influence of the drying techniques on MIC value of MNH-93, Niab78 and Ali Akbar-703. It is observed in all three varieties of cotton that they are influenced to very minor effect by the three drying techniques.

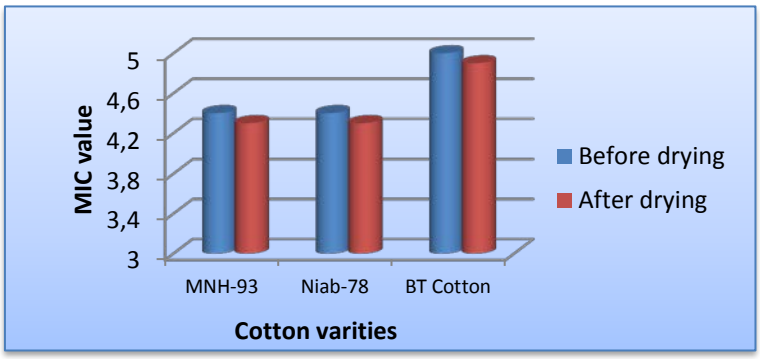


Fig 3.4 Effect of natural drying on fineness of cotton fibers

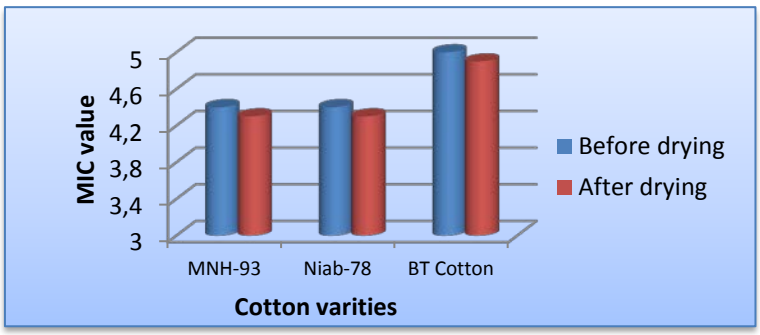


Fig 3.5 Effect of artificial drying on fineness of cotton fibers

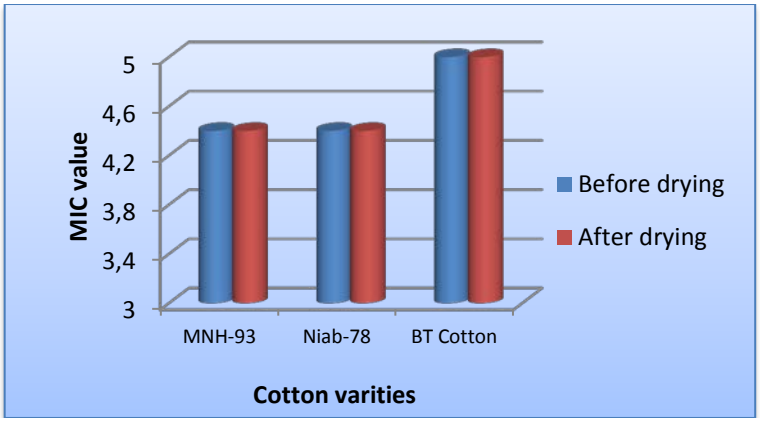


Fig 3.6 Effect of storage on fineness of cotton fibers

It can be seen in all figures 3.4, 3.5 and 3.6 that storage technique is observed to have no effect on MIC value of any of the cotton variety used in the experiment. But natural and artificial drying techniques have negligible effect.

Below are the results of the influence of the drying techniques on strength of MNH-93, Niab78 and Ali Akbar-703.

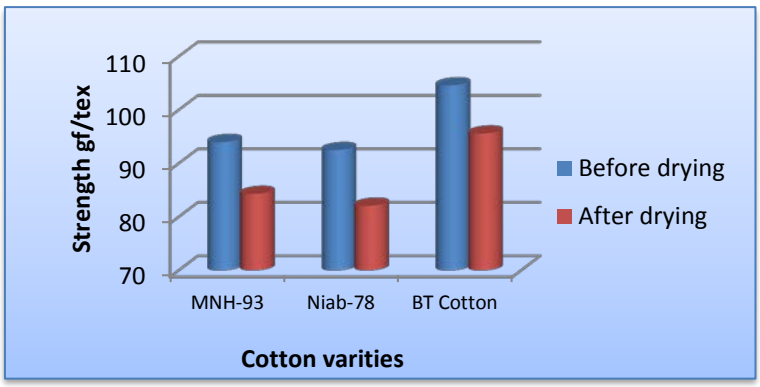


Fig 3.7 Effect of natural drying on Bundle strength of cotton fibers

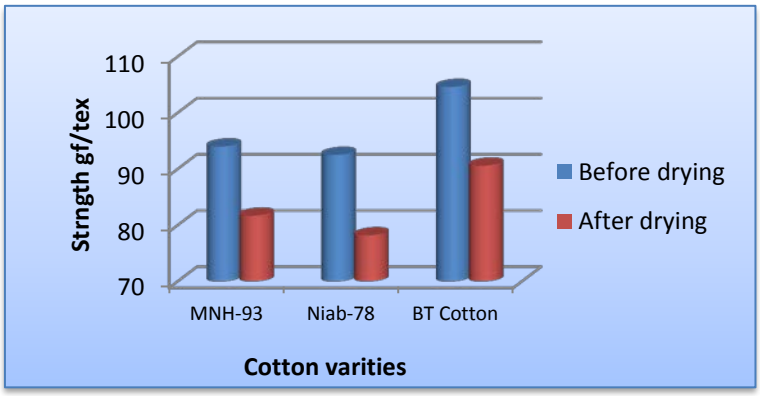


Fig 3.8 Effect of artificial drying on Bundle strength of cotton fibers

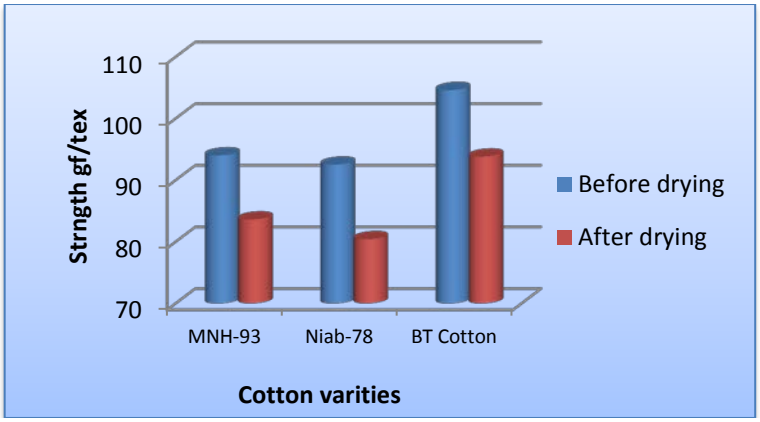


Fig 3.9 Effect of storage on Bundle strength of cotton fibers

It is observed in the above figures 3.7, 3.8 and 3.9 that strength is influenced by the drying technique to an observable level. Here artificial drying technique has again proved to be detoriating the cotton fiber properties the most. Whereas natural drying technique on the other hand least influenced strength of cotton fibers. This effect is also correct as it is said that cotton behaves stronger (up to a certain level) at elevated moisture level. But when the moisture is reduced to cotton becomes weaker.

Conclusion:

It is observed that artificial drying technique is faster to dry the cotton fibers as compared to the natural drying with sunshine and cotton storage technique which prevents the cotton to absorb more moisture. But on the other hand artificial drying technique detoriates the cotton fiber properties the most. It is observed experimentally that length, fineness and strength of cotton fibers is well preserved with the natural drying technique. It can be said that when rapid drying is needed artificial drying technique is the most appropriate answer also when the temperature to naturally dry the fibers is not adequate and there is less sunshine available during the day. But when fiber quality is of utmost importance then we may not plan for artificial drying, instead natural drying is the better technique.

References:

BP Saville. (2000). Physical testing of textiles. Textile Institute CRC Press, Wood Head Publishing Limited.

Steven B. Warner. (1995). Fiber Science Prentice Hall Publishers.

Samir Kumar Mukhopadhyay. (1992). Advances in fiber science. Textile Institute, Manchester, England.

James Gordon Cook. (1984). Hand book of textile fibers. Merrow publishers.

W. S. Anthony, William D. Mayfield DIANE Publishing. (01-Nov-1995). Cotton Ginners Handbook.
A. Stamboulis, C.A. Baillie, T. Peijs. (2001). Effects of environmental conditions on mechanical and physical properties of flaxfibers**.** Composites Part A: Applied Science and Manufacturing, 32 (8), pp. 1105–1115.
Donald J. Leitgeb and Helmut Wakeham. (December 1954). Cotton Quality and Fiber Properties: Part III: Effects of Drying at High Temperatures Prior to Ginning. Textile Research Journal. **Vol. 24** no. 12 1047-1057.
Richard K. Byler. (2006). Historical Review on the Effect of Moisture Content and the Addition of Moisture to Seed Cotton before Ginning on Fiber Length. The Journal of Cotton Science 10:300–310.
Byler, R.K. (2005). The effect of modest moisture addition to seed cotton before the gin stand on fiber length. J. Cot. Sci. 9:145-154.
W. Tsuji, T. Nakao, M. Mori, Y. Yamauchi. (December 1990). Properties and Structure of Never-Dried Cotton Fibers, Part II: American Cotton Cultivated in Japan. Textile Research Journal. **Vol. 60** no. 12 738-743.
Bradow, J. M., and G. H. Davidonis. (2000). Quantitation of fiber quality and the cotton production-processing interface: a physiologist's perspective. J. Cot. Sci. 4:34-64.
Montalvo, J. G., Jr. and T. M. Von Hoven. (2008). Moisture in Cotton by Oven Drying. Journal of Cotton Science, Vol. 12. p. 33-47.
J. Clif Boykin. (2005). The Effects of Dryer Temperature and Moisture Addition on Ginning Energy and Cotton Properties. The Journal of Cotton Science 9:155–165.
Byler, R.K., W.S. Anthony and G.J. Mangialardi, Jr. (2001). Improving the HVI strength measurement by adjusting for measured moisture content. Appl. Engineering Agric. 17(6):821-826.