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# INFLUENCE OF IRRIGATION WATER TYPES AND STRESS LEVELS ON COTTON FIBRE AND YARN QUALITY FOR DIFFERENT VARIETIES

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Cotton fibre quality is being deteriorated day by day due to various reasons and shortage/ poor quality of irrigation water is one of the reasons for the low quality of cotton fibre. The effect of the stress of water can be seen on the fibre length, strength and elongation. All these properties of fibre have also a significant influence on yarn characteristics and thus the yarn quality is also dependent on agronomic practices including irrigation. When new varieties are evolved it becomes necessary to examine such cotton varieties keenly, so that one which reflects maximum agricultural as well as industrial benefits can be recommended. The present study was planned to explore the spinning performance of various cotton varieties under different water quality treatments and water stress levels. Cotton of four varieties (CIM-501, CIM-496, CIM-499, and NIAB-111) under different types of irrigation water (canal water and tube well water) and different water stress levels (75ET, 100ET and 125ET) were selected for this research. The effect of these treatments was investigated on cotton fibre span length, strength and fibre elongation as well as on yarn quality. The study revealed that effect of different cotton varieties, water types and water stress levels on fibre and yarn quality was highly significant. Yarn characteristics showed greater values for the canal water similarly fibre length and elongations were better for canal water. Yarn tensile properties were decreased with increase in the water stress. The overall results indicated that the cotton variety NIAB-111 performed better as compared to other varieties. It is suggested that the cotton farmers may be trained by the agri. extension staff regarding maintenance of fibre quality through cultural practices and better irrigation techniques.
**Keywords:** Water quality, water stress level, cotton yarn quality, agri. extension

## INTRODUCTION

Cotton is the most important cash crop of Pakistan and contributes significantly to the economy of the country. Besides supplying raw material to the textile industry of Pakistan, it is also a source of livelihoods for millions of farm families in cotton growing areas of the Punjab and Sindh. Cotton accounts for 6.9 percent of value added in agriculture and 1.4% of GDP (Govt. of Pakistan, 2011). The production and yield of cotton in Pakistan recorded a gradual increase. For instance in 2007-08 the cotton was grown at an area of 3054 thousand hectare with the yield of 649 kg/hectare and in 2010-11, the area was 2689 thousand hectare but the yield increased as 725 kg/hectare. Pakistan also possesses significant position on the world cotton map with 5$^{th}$ position is cotton production and consumption; while it is among top yarn exporting countries of the world.
Variations in the quality of raw cotton do have negative impact on end yarn quality (Steadman, 1997). Intrinsic fibre quality may not be improved after harvesting but most of the research conducted by agronomists, breeders and physiologists has been directed toward improving cotton yield, and there are few cultural strategies suggested by the researchers for improving fibre quality during the growth stage. Thus, farmers have inadequate options of such production practices that result in cotton of acceptable fibre quality. Fibre strength is a major contributing factor to the quality of yarn and spinning performance (Mogahzy *et al.,* 1998). Considerable variation in the staple length of the cotton fibre might be found within a variety and even within a single boll. Fibre quality traits depend on both varietal (genetic) and growing (environmental and developmental) factors and lower tensile properties of fibre from the mature bolls may be due to exposure to different environments, i.e. extended time on the plant or exposure to higher moisture and heat levels (Hsieh and Wang, 2000). Cotton fibre value depends on many aspects such as fibre whiteness, stable length, strength, and fineness.
Cotton fibre is delicate and may be affected by the environment, cultural practices and picking methods. It is imperative to analyze the performance of cotton fibre with respect to the environment in which they are grown, but it is also rather difficult to study the mechanical properties of cotton fibre because of its irregular cross-section. In a study, Inoue *et al.* (2006) established differences in the fundamental mechanical properties of single cotton fibres in terms of how the fibres are affected due to cultivating method, and comparing cotton yarns made of non-organic or

organic cotton fibres. It was found that the effect of the area of cultivation was significant. Iftikhar *et al*. (2007) reported that the cotton farmers have low level of knowledge regarding recommended cotton varieties according to their areas. In the ginning process, cotton-seed hairs are removed, separated, and cleaned from cotton bolls by to form cotton bales containing. Cotton bales used in textile processing may contain varied cotton fibre varieties grown on differing soils under different agro-climatic conditions with varying irrigation and fertilizer applications. Textile processing requires these multiple cotton bales to be blended, cleaned and processed to form uniform yams. Yam strength is determined by fibre strength and length. With increased processing speeds, cotton fibre classification improvements are required (Foulk and Mcalister, 2002).

Some researchers have also reported the impact of water stress on cotton lint quality, particularly during the fibre elongation period which results in a decrease in fibre length and maturity. Water stress in late bloom stages of cotton, will reduce fibre strength in bolls and increase micronaire of existing bolls. Fibre length and strength is also affected prior to boll opening (McWilliams, 2004). The performance of agricultural operations is dependent on the professional education and improvement in skills of agri. extension agencies/organizations as well as farmers (Hassan *et al.*, 2007). In this context, the main objectives of the present paper are to analyze the effect of different type of water (tube-well and canal) and water stress levels on fibre and yarn quality characteristics (span length, strength and elongation) for some promising verities of cotton.

## MATERIALS AND METHODS

The research work was initiated in the Department of Fibre Technology and conducted collaboration with the Institute of Agri. Extension & Rural Development, University of Agriculture, Faisalabad and NIAB, Faisalabad. The lint cotton samples of varieties CIM-496, CIM-499, CIM-501 and NIAB-111 was collected and tested at Nuclear Institute of Agriculture & Biology (NIAB), Faisalabad. The following variables were selected for this research work and other variable selected are given as follows.

Cotton Varieties: $V_1$= CIM-496; $V_2$= CIM-499; $V_3$= CIM-501; $V_4$= NIAB-111

Water Type: $W_1$= Tubewell Water; $W_2$= Canal Water

Water Stress: $D_1$= 125 ET; $D_2$= 100 ET; $D_3$= 75 ET

All four cotton varieties were irrigated with tube-well and canal water separately at three water stress levels as mentioned above. Thus in total 24 treatment combinations were applied. After selecting all possible treatment combinations, the cotton was picked and ginned and then tested for its fibre quality characters viz. fibre span length, fibre strength and elongation. These quality characteristics were determined on High Volume Instrument (HVI-900) manufactured by Zellweger Uster Ltd. (Switzerland). Standards test methods (ASTM, 1997) were applied for measurement of fibre characteristics. The yarn was spun with the help of miniature spinning machine and the yarn was evaluated for lea-strength and count strength product. Yarn lea-strength was determined with the help of yarn strength tester, while yarn count was determined by using skein method. A lea of 120 yards was fed to the instrument for determination of yarn strength. Count strength product value was found by multiplying the count value with the respective lea-strength of the spun yarn. The procedure of testing was adopted as mentioned in ASTM standards (ASTM, 2004). Completely Randomized Design was applied for the analysis of variance of data for testing the differences among various quality characteristics as suggested by Faqir (2004). Duncan's Multiple Range test was applied for individual comparison of means among various quality characters.

## RESULTS AND DISCUSSION

***Fibre length*****:** The analysis of variance of the data indicated that the effect of different cotton varieties (V), water quality (W) and water stress (D) upon fibre length was highly significant while the effects of all possible interactions on span length were non-significant. Duncan's multiple range test and the comparison of individual treatment means for different varieties presented in Table 1 showed that the mean value of span length for CIM-496, CIM-499, CIM-501 and NIAB-111 were 28.15, 29.40, 27.84 and 30.30 mm respectively. The results showed that span length values for different varieties are significantly different from each other. The results indicated that the maximum value for span length was recorded for NIAB-111 followed by CIM-499, CIM-496 and CIM-501 respectively. These results get some support from the research study by Hsieh and Wang (2000) who concluded that fibre length depended upon both varietal (genetic) and growing (environmental and developmental) factors. Also, Akram (2003) reported the range for staple length for some Pakistani medium staple cotton as 26.02 to 29.47 mm. The mean value of span length for different water types W1 (tube well) and W2 (canal) were 28.78 and 29.06 mm respectively. The results indicated that the maximum value for span length was recorded for W2 followed by W1. In a previous study Balkcom *et al.* (2006) reported that as irrigation increased fibre length was also increased.

Duncan's multiple range test and the comparison of individual treatment means for different water stress levels presented in Table 2 also showed that the mean value of span length for D1, D2 and D 3 were 29.27, 28.97 and 28.53 mm respectively. The results revealed that span length values for different water stress levels are significantly different from each other. The highest value of 29.27 mm was recorded for D1 followed by D2 and D3 with their mean values as 28.97 and 28.53 mm, respectively. These results get support from the research study of Sharif (2000) recorded that the range of staple length of different Pakistani cotton varieties between 26.92 to 29.72 mm. Also, Balkcom *et al.* (2006) reported that as irrigation increased, which implied fibre length increased.

**Table 1. Comparison of individual mean values for cotton fibre span length (mm)**

| Cotton varieties (V) | Water type (W) | Water stress (D) |
|---|---|---|
| CIM-496 = 28.15c<br>CIM-499 = 29.40b<br>CIM-501 = 27.84d<br>NIAB-111 = 30.30a | Tube-well = 28.78b<br>Canal = 29.06a | 125ET = 29.27a<br>100ET = 28.97b<br>75ET = 28.53c |

*Mean values having different letters; differ significantly at 0.05 level of probability*

***Fibre srength*:** The analysis of variance of the data regarding fibre strength shows that the effect of the varieties (V), water quality (W) and water stress (D) was highly significant while the effect of all possible interactions on fibre strength were non- significant. Duncan's multiple range test and the comparison of individual treatment means for different varieties presented in Table 2 showed that the mean value of fibre strength for CIM-496, CIM-499, CIM-501 and NIAB-111 were 27.63, 31.79, 29.28 and 27.23 g/tex respectively. The results revealed that fibre strength values for different varieties are significantly different from each other. The results indicated that the maximum value for fibre strength was recorded for cotton variety CIM-499 followed by CIM-501, CIM-496 and NIAB-111 respectively. Pan *et al.* (2001) recorded a direct relationship between the strength of single fibres and yarns. Likewise, Odemis and Arslan (2005) found reductions in fibre Quality characteristics with the increased amount of saline water.

**Table 2. Comparison of individual mean values for cotton fibre strength (g/tex)**

| Cotton varieties (V) | Water type (W) | Water stress (D) |
|---|---|---|
| CIM-496 = 27.63c<br>CIM-499 = 31.79a<br>CIM-501 = 29.28b<br>NIAB-111 = 27.23d | Tube-well = 29.11a<br>Canal = 28.86b | 125ET = 27.66c<br>100ET = 28.05b<br>75ET = 29.24a |

*Mean values having different letters; differ significantly at 0.05 level of probability*

Comparison of individual treatment means for different types of irrigation water presented in Table 3 showed that the mean value of fibre strength for tube-well and canal water were 29.11 and 28.86 g/tex respectively. The results showed that fibre strength values for different water qualities are significantly different from each other. The results indicated that the maximum value for fibre strength was recorded for W1 followed by W2 respectively. Zhu and Ethridge (1997) concluded that the cool field temperatures at early stages of fibre development have significant influence on cotton fibre strength. Duncan's multiple range test for different water stress levels presented also showed that the mean value of fibre strength for D1, 2 and D3 were 27.66, 28.05 and 29.24 g/tex respectively. The results revealed that fibre strength values for different water stress levels are significantly different from each other. The highest value of 29.24 g/tex was recorded for D3 followed by D2 and D1 with their mean values as 28.05 and 27.66 g/tex, respectively. In a previous study Booker *et al.* (2006) reported that fibre strength improved with a decrease in water application.

***Fibre elongation*:** The analysis of variance of the data regarding fibre elongation shows that the effect of cotton varieties (V), water quality (W) and water stress (D) was highly significant while the effect of all possible interactions on fibre elongation were non-significant. Duncan's multiple range test and the comparison of individual treatment means for different varieties presented in Table 3 showed that the mean value of fibre elongation for CIM-496, CIM-499, CIM-501 and NIAB-111 were 5.69, 5.55, 5.26 and 5.41 percent respectively. The results indicated that the maximum value for fibre elongation was recorded for CIM-496 followed by CIM-499, NIAB-111 and CIM-501 respectively. Amjad (1999) reported that higher the fibre elongation better would be the yarn breaking strength and yarn elongation. Whereas, Mahmood *et al.* (2009) reported that tenacity and elongation properties of single yarn were related directly to the fibre elongation of cotton from which they were spun.

The comparison of individual treatment means for different water types presented in Table 3 showed that the mean value of fibre elongation for tube-well and canal were 5.58 and 5.50 percent respectively. The results showed that fibre elongation values for different water qualities are significantly different from each other. The comparison of individual treatment means for different water stress levels presented in Table 4 showed that the mean value of fibre elongation for D1, D 2 and D 3 were 5.46, 5.54 and 5.61 percent respectively. The highest value of 5.61 percent was recorded for D3 followed by D2 and D1 with their mean values as 5.54 and 5.46 percent, respectively.

**Table 3. Comparison of individual mean values for fibre elongation (%)**

| Cotton varieties (V) | Water type (W) | Water stress (D) |
|---|---|---|
| CIM-496 = 5.69a<br>CIM-499 = 5.55b<br>CIM-501 = 5.26d<br>NIAB-111 = 5.41c | Tube-well = 5.58a<br>Canal = 5.50b | 125ET = 5.46c<br>100ET = 5.54b<br>75ET = 5.61a |

*Mean values having different letters; differ significantly at 0.05 level of probability*

***Yarn lea-strength*:** Table 4 indicates that the mean value of yarn lea strength for CIM-496, CIM-499, CIM-501 and NIAB-111 were 102, 115, 109 and 121 pounds, respectively. The results showed that yarn lea strength values for different varieties are significantly different from each other and the maximum value for yarn lea strength was recorded for NIAB-111 followed by CIM-499, CIM-501 and CIM-496respectively. Duncan's multiple range test and the comparison of individual treatment means for different water types showed that the mean value of yarn lea strength for tube-well and canal water were 115 and 118 pound, respectively. The maximum value for yarn lea strength was recorded for W2 followed by W1, respectively. Duncan's multiple range test and the comparison of individual treatment means for different water stress levels revealed that the mean value of yarn lea strength for $D_1$, $D_2$ and $D_3$ were 119, 113 and 106 pounds, respectively. The highest value of 119 pounds was recorded for $D_1$ followed by $D_2$ and $D_3$ with their mean values as 113 and 103 pounds, respectively.

**Table 4. Comparison of individual mean values for yarn lea strength (lbs)**

| Cotton varieties (V) | Water type (W) | Water stress (D) |
|---|---|---|
| CIM-496 = 102d | | |
| CIM-499 = 115b | Tube-well = 115b | 125ET = 119a |
| CIM-501 = 109c | Canal = 118a | 100ET = 113b |
| NIAB-111 = 121a | | 75ET = 106c |

*Mean values having different letters; differ significantly at 0.05 level of probability*

***Count strength product (CSP)*:** Comparison of individual treatment means for different varieties (Table 5) showed that the mean value of count lea strength product for CIM-496, CIM-499, CIM-501 and NIAB-111 were 2087.3, 2329.4, 2214.9 and 2452.1 hanks respectively. The results indicated that the maximum value for count lea strength product was recorded for $V_4$ followed by $V_2$, $V_3$ and $V_1$ respectively. Duncan's multiple range test and the comparison of individual treatment means for different water qualities showed that the mean value of count lea strength product for tube-well and canal were 2322.2 and 2396.1 hanks respectively. The results showed that count lea strength product values for different water qualities are significantly different from each other. The results also revealed that count lea strength product values for different water stress levels are significantly different from each other. The highest value of 2419.6 hanks was recorded for $D_1$ followed by $D_2$and $D_3$ with their mean values as 2300.4 and 2185.6 hanks, respectively.

**Table 5. Comparison of individual mean values for Count Lea Strength Product (hanks)**

| Cotton varieties (V) | Water rype (W) | Water stress (D) |
|---|---|---|
| CIM-496 = 2087d | | |
| CIM-499 = 2329b | Tube-well = 2322b | 125ET = 2419a |
| CIM-501 = 2214c | Canal = 2396a | 100ET = 2300b |
| NIAB-111 = 2452a | | 75ET = 2185c |

*Mean values having different letters; differ significantly at 0.05 level of probability*

***Conclusions*:** Cotton samples from of four varieties (CIM-496, CIM-499, CIM-501 and NIAB-111) under different water treatments (tube well water and canal water) and different water stress levels (125ET, 100ET and 75ET) were analyzed for staple length, fibre strength and fibre elongation. The study revealed that effect of different cotton varieties, water types and water stress levels for staple length, fibre strength and fibre elongation as well as yarn properties was highly significant. Fibre length showed greater value at tube well water than canal water while fibre strength and fibre elongation showed less value at tube well water. Fibre length decreased and fibre strength and fibre elongation increased as increased in the water stress. Yarn lea strength and CSP showed greater value at the canal water. Yarn lea strength and CSP were decreased with increase in the water stress. The overall results indicated that the cotton variety NIAB-111 performed better as compared to other varieties. There is a dire need of creating awareness among the cotton farmers about the quality of water and their ultimate influence on the quality of cotton fibre and yarn. Most of the cotton farmers have low level of knowledge about the said properties therefore the agri. extension specialists should take necessary measures in this regards. It is recommended that Agri. Extension department should initiate need based training for the cotton growers to create the awareness regarding the effect of water quality and stress on the lint quality and their ultimate effect on the yarn quality.

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