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ALTERNATE FURROW IRRIGATION FOR ENHANCING WATER USE EFFICIENCY IN COTTON

Khalid Hussain Khan, M. Asghar Rana & M; Arshad
Faculty of Agricultural Engineering & Technology, University of Agriculture, Faisalabad

Two varieties of cotton (Niab-78 and Niab-92) were grown under furrow and alternate furrow irrigation methods. In alternate furrow irrigation, 40.61% less water was used. Water use efficiency in both the varieties was 22 and 21% higher in alternate furrow irrigation as compared to every furrow irrigation. Variety Niab-92 gave maximum water use efficiency in both the methods. Alternate furrow irrigation received less amount of water and produced almost the same yield as in every furrow irrigation method.
Key words: alternate furrow irrigation, water use efficiency

INTRODUCTION

In Pakistan, water for crop production amounts to 3.83 x 104 million cubic meter (MCM) as against total availahle water supplies of 1.25 x 105 MCM. Rest of the available water is lost through distribution network of canals and water courses of the Indus basin (Walter, 1990).

Furrow irrigation represents an important class of surface irrigation. To take care of short time waterlogging caused through irrigation and/or rainfall, furrow irrigation is generally practised for row crops which are sensitive to standing water. Furrow irrigation permits more efficient use of irrigation water as compared to other surface irrigation methods. Average water saving by furrow irrigation is up to 32% as compared to border irrigation (Khan et al., 1998). Water saving can be improved by irrigating alternate furrows instead of irrigating every furrow. In addition, alternate furrow irrigation method may supply water in a manner that greatly reduces the amount of wetted surface which in turn tends to reduce water losses through evapotranspiration and deep percolation. Deep percolation can be reduced because less wetted surface with alternate furrow results in lower infiltration. Einsenhaver and Youth (1992) reported that alternate furrow irrigation can reduce water application, irrigation costs and chemical leaching and results in higher crop yield. They observed that irrigation water application may be reduced by 20% with alternate furrow irrigation.

It is evident that reduced evapotranspiration in the alternate furrow irrigation method is due to reduction in the amount of wet soil surface compared to that in every furrow irrigation. This study therefore, was planned to compare alternate furrow irrigation with conventional furrow irrigation in terms of water saving and crop yield.

MATERIALS AND METHODS

This study was conducted at the experimental farm of the University. The data regarding amount of water supplied and seed cotton yield were obtained, whereas water use efficiencies were calculated in order that the efficiency of alternate furrow irrigation method could be evaluated. Randomized complete block design with three replications was used. Each treatment had ten lines of crop and eleven furrows. The length of each furrow was 30 m while row to row distance was 75 cm.

Treatments: T_1 = All furrows were irrigated on each turn of irrigation. T_2 = Every other furrow was irrigated alternately on each turn of irrigation.

Varieties: V_1 = Niab-78; V_2 = Niab-92

Irrigation water was applied after 15 days interval using cut throat flume (3 x 8") as described by Michael (1978). The time required to fill the furrows and flow rate were recorded to estimate the amount of water applied to each plot. The depth of water applied to each treatment was determined by using the following relationship:

$$d = Qt/27.8A$$

Where 'd' is the depth in cm, 'Q' is the discharge in litres per second, 't' is the time in hours and 'A' is the area in hectares. Fertilizers were applied at the rate of 110 and 55 kg/ha of nitrogen and *PP5* respectively. Full dose of P_2O_5 and half of the nitrogen was applied at the time of sowing and remaining nitrogen was applied with first irrigation. Attack of whitefly, spotted bollworm, pink bollworm, American bollworm, jassids, etc. was checked through using recommended sprays of Novacron, Baythride TM and Bulldock. Data obtained were subjected to statistical analysis (Steel and Torrie, 1984) and LSD test at, 5%

Table 1. Volume of water applied to individual replicates (m^3)

Irrigation	Every furrow irrigation 1_1			Alternate furrow irrigation 12		
	R-1	R-2	R-3	R-1	R-2	R-3
First	18.7	16.6	19.9	9.8	10.5	10.8
Second	19.5	19.2	18.1	12.0	10.2	8.3
Third	15.6	17.8	20.4	11.6	14.0	12.8
Fourth	25.5	21.3	22.8	12.8	12.3	14.9
Total	79.3	74.9	81.2	46.0	47.0	46.8
Mean			78.4			46.6

Table 2. Mean values of the seed cotton yield (kg/ha)

	Treatments	Seed cotton yield
T_1	(Every furrow irrigation)	1716.667
T_2	(Alternate furrow irrigation)	1692.500
V_1	(Niab-78)	1525.00 A
V_2	(Niab-92)	1884.163 B
LSD		134.30
V_1T_1		1533.333
V_1T_2		1900.00
V_2T_1		1516.667
V_2T_2		1868.330

Table 3. Water use efficiency (kg/ha/mm)

Variety	Every furrow irrigation (T_1)			Alternate furrow irrigation (T_2)		
	Yield kg/ha	Water used (mm)	Water use Eff.	Yield kg/ha	Water used (mm)	Water use Eff.
Niab-78	1533.3	557.52	2.75	1900	536.52	3.54
Niab-92	1517	444.77	3.41	1868	427.53	4.37

probability level was employed to test the significance of treatment means.

RESULTS AND DISCUSSION

Volume of water applied to each replicate of the treatment is given in Table 1. The total volume of water applied to T_1 and T_2 was $78.4m^3$ and $46.6m^3$ respectively. Results showed that volume of water applied to T_2 was 40-61% less than the water applied to T_1. These results are comparable with Wankhede et al. (1984) which showed that furrow irrigation saved 30% of the total water requirements compared with flood irrigation. For every other furrow irrigation, 46% less water use was reported by Graterol et al. (1989) for soybean. From statistical analysis of volume of water applied to treatments, a significant difference was observed.

It was found that every furrow irrigation crj) is significantly different from alternate furrow irrigation (T_2) in terms of volume of water applied. The crop was harvested in four pickings at maturity. Non-significant difference in seed cotton yield was observed due to irrigation treatments. It was found that two treatments had a similar behaviour about the seed cotton production. Total yield obtained from alternate furrow irrigation may compete the yield obtained from every furrow irrigation. It cannot be ignored that this non-significant difference might be due to frequent rainfall during the crop season, which dissipated the effect of irrigation treatments. The yield recorded from Niab-78 and Niab-92 was 1525 and 1884 kg/ha, respectively. The yield of Niab-92 was 19% higher than Niab-78 (Table 2). The significant differences observed could be due to genetic make up of the varieties.

Water use efficiency (WUE) is a potential criterion for improving yield under water stress. This parameter helps to determine with) how much efficiency the applied water has been used by the crop. In other words, it evaluates the efficiency of water utilization by the crop in terms of final output. Depending upon the total water applied and seed cotton yield obtained, the maximum WUE was calculated in alternate furrow irrigation as given in Table 3. The WUE of Niab-78 in T_2 (3.54 kg/ha/mm) was 22% higher than 'I', (2.75 kg/ha/mm). Similarly, the WUE of Niab-92 was 4.37 kg/ha/mm in T_2, being 21% higher than T, (3.41 kg/ha/mm). The WUE of Niab-92 was higher in both the treatments than Niab-78. It is important to conclude that alternate furrow method proved useful and may be adopted to meet the irrigation water shortage. In addition, the alternate furrow irrigation method not only received minimum amount of water as compared with every furrow irrigation but also produced the same yield as in every furrow irrigation method. Since alternate furrow irrigation method is not yet being practised at the farmer's level, it is therefore, recommended that this method of irrigation should be introduced especially in the areas having shortage of irrigation water.

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QAIHER(Urtica dioica} DECORTICATION, EXTRACTION, BLEACHING, SOFTENING AND DYEING

Rubina Daud
Department of Home Economics, Government Girls College, Quetta

Studies were carried out around Murree near Islamabad about decortication, extraction, bleaching, softening and dyeing of fibre from *Urtica dioica* sp.of Nettle plant, while running retting process in such a manner that sustained yields are obtained without disturbing fibre quality. Three different types of treatments viz. snow, tap water and effective microorganisms (EM) were used for retting. Selected shoots were processed for decortication followed by retting. The snow-treated samples took 40 days, the tap water samples10 days and the microbially treated 8 days to be retted. For chemical extraction, boiling in 5% caustic soda solution for 6 hours yielded satisfactory results. On bleaching the fibre, maximum weight loss was observed in snow-retted (9.44%) followed by EM (9.28%) and tap water (8.80%) treatment.
Key words: bleaching, decortication, dyeing, extraction, retting, softening, *Urtica dioica*

INTRODUCTION

The fibre locally known as "Qaiher" in the northern mountains of Murree near Islamabad, Pakistan, is obtained from a *Urtica dioica* sp. of Nettle (Uricacae family), which grows at an altitude range of 1,500-3,000 meters. It is spread over an area of 6.5 million acres. It is important that the bast fibres should be harvested at the right time if best fibre is to be obtained, for if the stems are allowed to become mature, saponification takes place, Since the bast fibres are present in the outer portion of the stem near the bark, the inner wooden portion has to be separated before boiling for the extraction purpose. This operation of separating the fibrous material from the wooden stalk is termed as decortication.

The vegetable fibres lie just under the bark of the stalk. Retting is the most important process by which these stalks are prepared for the extraction of fibres. If the process ofretting is not carried out properly, the quality of the fibre is deteriorated.

Retting is the process by which the fibres in the 'bark' ribbons are separated from the woody stem, and from the extraneous green matter by the removal of pectins and other gummy substances in the stem. This process is completed under the joint action and effect of water, microorganisms and enzymes. In retting, disintegration of the tissue starts from the cambium and proceeds to the ray cells, phloem and cortex, so that the fibre bundles are finally separated from the woody pith or core of the stem cortex. During rotting the organisms feed on pectic substances, proteins of the cell protoplasm, sugars, starch, fats, waxes, tannin and mineral substances.

The most important types of bacteria involved in retting process are spore forming bacilli, penicillium sp. etc. The enzymes which are produced by the bacteria, are able to act best at a pH of 6.8 (Zahid,1973). Retting process is followed by chemical extraction of fibre. The next step is bleaching. The degree of bleaching is usually determined according to the nature of the desired product, for example table-cloths and similar other uses. A hard hand is desired for table-cloths and similar products while for apparel products a soft hand is needed, thus a strong alkaline extraction is carried out. To soften the bleached fibre different softeners are used. The traditional method is the use of ash or talc. Investigations were made of locally,available dyes used by the weavers. Dyestuffs are divided into a number of classes. The ability of the fibres to accept each of these dye classes depends upon several factors. Dyes must be applied in an alkaline medium because dye baths that are strongly acidic may be harmful to cellulose fibres (Phyllis,1982). Therefore this study was conducted to explore various aspects starting from harvest of Nettle stems up to dyeing of fibre in such a manner that sustained yields are obtained without. disturbing fibre quality.

MATERIALS AND METHODS

The samples of Nettle plant shoots were collected from different places around Murree. At the time of harvest, the Nettle plant stalk should have lost its green colour, shiny appearance and the lowest tines of the stalk should have shed their leaves. The shoots were cut 15 cm from the ground. Gloves were worn while cutting the shoots. The steps for fibre extraction were carried out in the following sequence:

i) Decortication, ii) Retting (snow-retting, tapwater retting and microbial retting) iii) Chemical extraction; and iv) Cleaning of fibres.