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IMPACT OF LAND PATTERN AND HYDROLOGICAL PROPERTIES OF SOIL ON COTTON YIELD

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Abstract

The present study was conducted to determine the water requirement in various planting methods; flat sowing, ridges after first irrigation; flat sowing then skip irrigation; flat sowing, then alternate skip irrigation; flat sowing, then bed and furrow; and Bed and furrow at sowing, compared with conventional flat sowing. Water saving was observed in case of all treatments compared with flat sowing, however, maximum saving was recorded in case of bed and furrow sowing at planting followed by flat sowing, then bed and furrow sowing. However, yield was significantly higher in bed and furrow sowing compared with flat sowing whereas other water saving sowing methods recorded statistically comparable yield with flat sowing.

Introduction

Out of the total cropped area of 22.76 million hectares in Pakistan, cotton is planted on 2.983 million hectares (13.11%). Punjab's share in cotton area is 78% (Babar & Khan, 2008). Water is the most critical input in determining the choice of crop. Cotton is predominantly grown in southern Punjab primarily due to low water requirement and relatively drier conditions. In most areas spread over 0.6 million acres canal water is scarce therefore shortage is met through pumping underground water. The continued harnessing of ground water has resulted serious consequences of depletion of water to deeper layers which in the long run is forecasted to have immense implications. Saving of one or two irrigation through better management practices may provide dire relief to the farmers not only in terms of lowering the cost of production but also long term conservation of sub soil water (Munro, 1987; Gill, 2000).

Successful cotton production totally depends upon the availability of water. Irrigated agriculture is facing acute competition for low cost and high quality water and world is looking for water saving agriculture, which refers to full advantage of available irrigation facilities (Xi-ping *et al.*, 2004; Howell, 2001). Water saving agriculture intends to raise water utilization rate and efficiency for achieving a high economic yield on irrigated farm land with minimum input of water at both public and private levels. Water saving is a comprehensive exercise using every possible measures in farm production, including full use of natural precipitation as well as efficient management of an irrigation network through a suitable planting method. Planting methods are important factors which affect crop growth development and finally the crop yield. Better irrigation water use efficiency can be achieved through adopting the best management practices of irrigation (Khan & Ullah, 1991).

Adoption of appropriate planting method and water management for successful crop production are the most critical problems especially in cotton growing areas of Pakistan.

No systematic work was done in the past to evaluate various sowing/planting methods in one experiment for water saving and to increase water use efficiency. The present study was designed to find out the most suitable method of planting cotton crop to save water for improving seed cotton yield per unit of land.

Materials and Methods

The experimental treatments tested are listed below:-

T1 = Flat sowing (Control)
T2 = Flat sowing, ridges after first irrigation
T3 = Flat sowing, then skip irrigation
T4 = Flat sowing, the alternate skip irrigation
T5 = Flat sowing, then bed and furrow
T6 = Bed and furrows at sowing

The experiment was conducted in experiment area of Cotton Directorate of Ayub Agricultural Research Institute, Faisalabad, following Randomized Complete Block Design (RCBD) keeping row spacing 75cm and plant-to-plant spacing 30cm. The experiment was provided with all standard cultural and management practices to keep field free of weeds and fertilizer as per standard recommendations of 160-57-0 NPK/hectare.

1. Date of sowing/ method of planting/variety/seed rate: Crop was sown on 15.06.2006 with drill except bed and furrows, where seed was sown with hands (chokas) on the ridges prior to irrigation Seed rate was 10kg/ha for all treatments using FH-113 strain.

2. Fertilizer application: NPK was applied as per recommendations (100:50:0 Kg/ha). The first irrigation was delayed i.e., 02-08-2006 due to intermittent rainfall except in bed and furrow sowing, where first irrigation was applied on 23.06.2006. Further irrigation schedule is mentioned in Table 2 against each treatment.

3. Management of weeds: First hoeing was carried out manually on 03.07.2006. Second and third hoeings were carried out with Kasula on 11.07.2006 and 24.07.2006 respectively. On 01.08.2006 weeds were eradicated with tractor drawn hoeing cultivator. Gramaxon (broad spectrum weedicides) was sprayed on 22.08.2006

4. Spraying schedule

a. Proclaim and Actara were sprayed on 24.08.2006 against bollworms and jassid respectively.
b. Cure was sprayed on 01.09.2006 against bollworms especially against spotted bollworm.
c. Abamectin was sprayed on 30.09.2006 against bollworms and mealy bug.

5. Other operation

a. Gap filling (chokas) was carried out on 22.06.2006 to get appropriate plant stand.
b. Thinning was carried out at two different stages first on 26.06.2006 and second on 18.07.2006

In each treatment the data was recorded for number of monopodial branches per plant, number of sympodial branches per plant, plant height, number of nodes to first fruiting branches, number of bolls/plant and average boll weight, Ginning Out Turn (G.O.T %) and final yield in kg/ha.

The replicated data was subjected to statistical analysis.

Results and Discussion

The data of mean performance of different treatments is given in Table 1 and data of water received by various treatments is given in Table 2. The highest yield was recorded in 'bed and furrow' sowing compared to other sowing methods while lowest yield was recorded in flat sowing and alternate skip irrigation as compared to control Flat sowing, then skip irrigation. Maximum water was required in flat sowing (Control) followed by sowing, ridges after first irrigation, flat sowing, then skip irrigation, flat sowing, the alternate skip irrigation and flat sowing, then bed and furrow whereas minimum water was required in case of bed and furrow sowing. Similar results has also been reported by Anwar *et al.,* (2003). The saving of water in case of bed and furrows at sowing when compared with flat sowing (Control) was 6.49 inches (equivalent to 2 irrigations), which is phenomenal. If seen on cotton acreage in one year the bed and furrow is the best management practice to raise the crop with minimal water. It might be due to the reason that land configuration impacts the yield of cotton seed in treatments of ridge and furrow (Pendke, *et al.,* 2001).

The highest number of plants was recorded in Bed and Furrow at sowing bed and furrows at sowing while lowest in sowing, ridges after first irrigation (flat sowing, ridges after first irrigation). However, there were non-significant differences in number of plants in different treatments. But higher number of plants in case of Bed and Furrow at sowing indicates higher survival in this planting system. Our finding are in agreement with Stevens *et al.,* (1996), who conducted a four year study on cotton crop and found that cotton seedlings are better protected from wind and blowing sand through better field management practices. There were non-significant differences among six treatments for number of monopodial (vegetative) branches per plant. However, higher number of monopodial branches were observed in case of Flat sowing than bed and furrow compared to lowest in Flat sowing, ridges after first irrigation.

There were significant differences amongst six treatments. The highest number of sympodial (fruiting) branches were recorded in flat sowing. Then skip irrigation while the lowest in case of flat sowing then bed and furrow sowing method. There were non significant differences among six treatments. The maximum height was recorded in case of bed and furrow at sowing (103.26cm) followed by flat sowing, then alternate skip irrigation (94.95cm) which was lowest in flat sowing, then bed and furrow. The first fruiting branch was observed on 9.40 nodes in case of bed and furrow sowing while at 6.60 node in case of flat sowing, then alternate skip irrigation. The differences among six treatments were significant. The delayed fruiting in case of bed and furrow at sowing was obviously due to frequent light irrigations in early stages for plant establishment.

Table 1. Mean performance of various traits at different treatment levels.

Treatments		Plant Pop./ha	No. of Mon. Br./Plant	No. of Symp. Br./Plant	Plant height (cm)	No. of nodes to 1st fruiting branches	Boll Wt. (gm)	No. of bolls/ plant	GOT (%)	Yield (kg/ha)
		1	2	3	4	5	6	7	8	9
T1	Flat sowing (Control)	27554	3.80	13.73	90.40	8.60	3.98	24.33	37.13	1435
T2	Flat sowing, ridges after first irrigation	26161	3.07	14.46	85.80	7.00	4.42	24.46	40.26	1417
T3	Flat sowing, then skip irrigation	25341	3.33	17.20	88.60	6.60	3.95	24.13	39.53	1492
T4	Flat sowing, then alternate skip irrigation	24521	3.13	14.00	94.93	8.20	4.74	22.80	40.53	1320
T5	Flat sowing, then bed and furrow	22676	3.93	13.20	88.53	6.70	4.29	25.13	39.46	1417
T6	Bed and furrow at sowing	30673	3.33	14.60	103.26	9.40	3.77	24.20	39.73	1722
	LSD (0.05)	NS	NS	2.30	NS	1.45	NS	NS	NS	295.15

Table 2. Irrigation water availability to different treatments.

Treatments		1st Irrigation (inches) 02.08.06	2nd Irrigation (inches) 15.09.06	3rd Irrigation (inches) 07.10.06	Avg. (inches)	4th irrigation (inches)	Total (inches)	Rainfall (inches)	G. Total (inches)	Water saving (inches)
T1	Flat sowing (Control)	3.62	3.35	3.27	2.56	0	10.24	12.78	23.02	-
T2	Flat Sowing, ridges after first irrigation	3.51	2.85	2.81	2.29	0	9.17	12.78	21.95	1.07
T3	Flat Sowing, then skip irrigation	3.57	2.56	2.44	2.14	0	8.57	12.78	21.35	1.67
T4	Flat Sowing, the alternate skip irrigation	3.02	2.12	1.95	1.77	0	7.09	12.78	19.87	3.15
T5	Flat Sowing, then bed and furrow	2.41	0.97	0.86	1.06	0	4.24	12.78	17.02	6.00
	Date of irrigation	23.06.06	08.07.06	15.09.06		07.10.06				
T6	Bed and furrow at sowing	0.96	1.03	0.88	**0.94**	0.88	**3.75**	**12.78**	**16.53**	**6.49**

The differences among treatment is case of bolls weight were non significant. The range in this trait was from 3.77gm (bed and furrow at sowing) to 4.74gm (flat sowing, then alternate skip irrigation. The differences in case of number of bolls per plant were non significant as range from 24.13 (flat sowing, then skip irrigation) to 25.13 (flat sowing, then bed and furrow) were marginal. GOT (%) reflects proportion of lint in percentage of the total seed cotton. There range of GOT among treatment was from 37.13 (flat sowing) to 40.53 (flat sowing, then alternate skip irrigation. The GOT (%) is highly influenced by the environmental factors, therefore high error resulted in non-significant differences. Similar results have also been reported by the replacement of the conventional tilling methods (Stevens *et al.,* 1996). There were marked significant differences in case of (bed and furrow at sowing) compared to other five treatment. However, there were non significant differences among flat sowing (Control) to flat sowing, then bed and furrow treatments. The superiority of yield in case of bed and furrow at sowing seems to be due to better plant population and a better combination of number of sympodial branches, number of bolls per plant. GOT or other several unaccounted traits (Mobley & Albers, 1993; Mehmood, 2000).

The detailed water availability in case of different treatments is given Table 2. Contrary to flat sowing (control), normally practiced by the farmers, minimum water required to raise crop was in case of bed and furrow sowing (16.53 inches) recording saving of 6.49 inches of water and simultaneously recording the highest yield of 1722kg/ha (Harris & Smith, 1980; Gill, 1999). The other treatment sowing visible saving (6.0cm) of water was flat sowing, then bed and furrow (flat sowing, then bed and furrow) compared to control without any adverse effect on yield. It might be due to the reason that ridges and furrow sowing in heavy soils are helpful in the disposal of water in times of heavy rainfall, to avoid danger of water logging (Walton, 1962). From the results described above it is synthesized that flat sowing, then bed and furrow or bed and furrow at sowing are the two best management practices to grow cotton with less water. The farmers who have hand on planting machinery for bed preparation may adopt bed and furrow at sowing technology. The other farmers may adopt flat sowing and later concession to beds to combat water scarcity issue.

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