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Effect of irrigation and moisture-conservation practice on growth, yield and quality of cotton (*Gossypium* species) as summer and rainy-season crops in central Uttar Pradesh

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ABSTRACT

A field experiment conducted during 1987 and 1988 showed possibility for cultivation of cotton (*Gossypium* sp.) as summer crop and as a ratoon crop (second flush) during the rainy season, with an average productivity of 24.4 q/ha (12.8 q/ha from summer crop and 11.6 q/ha from ratoon crop). The summer crop required 10 irrigations administered at 80 mm cumulative pan evaporation (CPE) for optimum production. However, use of mulch along with application of jalshakti @ 5 kg/ha in furrows considerably reduced the irrigation requirement of summer crop. From an overall consideration of yield, return, water economy, water-use efficiency, easy availability of mulching material, 6 irrigations at 120 mm CPE may be provided to summer crop of 'Vikas' cotton superimposed with maize-stover mulch in between the crop rows.

In Uttar Pradesh cotton (*Gossypium* sp.) is a rainy-season or autumn-harvested crop. Its boll-bursting period coincides with peak rainy season which affects the yield adversely. The boll-bursting period of 'Vikas' ('CA 10-2') cotton does not coincide with the peak rainy season. It is suitable as a summer crop in areas having adequate facilities for irrigation as well as a ratoon rainy-season crop in rainfed areas. A winter (*rabi*) crop like wheat can be planted after the harvest of ratoon crop. In summer crop, due to dry, desiccating and hot environment the irrigation requirement is considerably high, particularly in light-textured soil. Raman *et al.* (1990) reported an economy of 50% of irrigation water by adopting alternate-furrow irrigation along with the use of plastic mulch in cotton crop. The water-use efficiency was doubled by plastic mulching. Therefore, the present study was undertaken to find out the irrigation requirement of 'Vikas' cotton during summer season and feasibility to reduce irrigation needs of cotton by mulching and other moisture-conservation practices.

MATERIALS AND METHODS

The experiment was conducted during the summer and rainy seasons of 1987 and 1988

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at Kanpur. The treatments comprising combinations of 4 levels of irrigation [based on commulative pan evaporation (CPE) from USWB Pan-A at 80, 120, 160 and 200] and 8 moisture-conservation practices [control, organic residues mulch @ 5 tonnes/ha, polyethylene mulch (0.90 mm thickness), mixtalol (Paras Photosynth) @ 625 ml/ha (3 foliar sprays at 20-day interval), jalshakti (water-absorbing polymer) @ 5 kg/ha in furrows at planting, organic residues mulch + jalshakti, polyethylene mulch + jalshakti and mixtalol + jalshakti], were replicated thrice in split-plot design. The moisture-conservation practices were kept in main plots and irrigation schedules in subplots. These treatments were applied only in summer crop and their after-effect was studied on the succeeding ratoon crop. The soil was a sandy loam, having pH 7.7, organic carbon 0.39%, total N 0.04%, available P_2O_5 17.4 kg/ha and available K_2O 155 kg/ha, and field capacity was 20.10% of the surface layer. The total rainfall of 400.7 mm and 744.1 mm was recorded during the cropping season of 1987 and 1988 respectively.

'Vikas' cotton was planted on ridges on 6 March 1987 and 27 February 1988 after a presowing irrigation for proper germination. The summer crop was harvested in the last week of June and plants were allowed to stand in the field for ratoon crop which was harvested in last week of November. A fertilizer dose of 70 kg N/ha and 35 kg P_2O_5/ha was applied in all the treatments through urea and single superphosphate respectively in the summer crop. In ratoon crop, 35 kg N/ha was top-dressed in 2 equal splits, at flowering and boll-formation stages.

Soil moisture in different soil layers was estimated before and after every irrigation or effective rainfall and subsequently water use by crops from different soil layers was worked out. The equation E = Y/ET was used to calculate the water-use efficiency of crop under different treatments (Viets, 1962). Halo length, fibre fineness and ginning outturn (%) were calculated.

RESULTS AND DISCUSSION

Yield and its attributing characters

The yield and yield-attributing characters were influenced by irrigation levels and moisture-conservation practices in summer crop (Table 1). The high frequency of irrigation schedule at 80 mm CPE resulted in the maximum plant height, number of sympodial branches, number of bolls/plant and seed-cotton yield, followed by irrigation as 120 mm CPE and lowest in 200 mm CPE irrigation level.

As regards the moisture-conservation practices polyethylene mulch + jalshakti showed the best effect on all the yield attributes (Table 1). Irrigation at 120 mm CPE in conjunction with organic mulch alone or with jalshakti was the best economics.

The yield of ratoon crop was less than in summer crop. The reduction in yield may be attributed to rainy season followed by low temperature at the time of boll development and its maturation. The low temperature during this period caused abnormal opening of bolls and quite a good number of bolls remained unopened.

Quality characters

Quality characters like halo length, fibre fineness and ginning outturn did not differ in main crop of summer and ratoon crop of the rainy season. The moisture-conservation practices improved the fibre length.

Table 1. Effect of irrigation schedule and moisture-conservation practice on growth, yield attributes and seed-cotton yield of 'Vikas' cotton

Treatment	Plant height (cm) at harvest				Sympodial branches/ plant at harvest				Bolls/ plant				Seed-cotton yield (q/ha)			
	Summer crop		Ratoon crop		Ratoon crop		Summer crop		Summer crop		Ratoon crop		Summer crop		Ratoon crop	
	1987	1988	1987	1988	1987	1988	1987	1988	1987	1988	1987	1988	1987	1988	1987	1988
Irrigation at CPE (mm)																
80	80	89	119	125	23.8	21.3	22.8	18.0	11.0	9.1	8.6	8.4	15.9	14.2	12.0	12.2
120	76	85	115	121	22.0	19.8	20.8	17.1	9.6	8.4	8.2	8.1	15.2	13.6	11.7	12.0
160	73	82	112	117	20.8	18.4	19.9	15.9	7.8	6.8	7.4	7.8	13.0	11.5	11.1	11.6
200	69	79	109	114	19.3	16.9	17.6	14.1	6.1	5.7	6.4	7.6	9.8	8.9	10.6	11.2
CD (P = 0.0.5)	0.2	0.4	0.7	0.2	0.7	0.7	1.0	0.9	0.55	0.48	0.54	0.42	2.10	1.91	NS	NS
MCP																
Control	67	74	103	113	16.8	13.8	15.1	10.8	6.1	5.4	5.3	5.8	11.2	9.5	9.1	10.3
Organic mulch	79	89	122	123	24.7	21.6	21.8	18.5	10.0	9.0	9.6	9.9	14.5	12.8	12.9	13.0
Polyethylene mulch	80	89	122	123	26.5	23.3	22.7	20.9	11.3	9.4	10.0	10.0	15.5	13.7	13.3	13.4
Mixtalol	71	78	107	116	16.8	16.0	16.4	13.5	6.6	5.5	6.0	6.1	11.9	11.2	9.8	10.4
Jalshakti	69	77	105	114	15.7	15.1	15.9	12.6	6.5	5.8	5.4	5.9	11.5	10.8	9.3	10.3
Organic mulch + jalshakti	78	90	122	124	25.9	22.4	23.9	19.4	10.3	9.1	9.7	10.1	15.3	13.0	12.9	13.1
Polyethylene mulch + jalshakti	80	91	123	125	27.2	23.6	27.9	22.5	11.3	9.9	10.3	10.2	15.7	14.0	13.3	13.4
Mixtalol + jalshokti	73	80	107	116	18.2	16.8	18.2	14.0	7.1	6.0	6.1	6.0	12.3	11.5	10.0	10.5
CD (P = 0.05)	1.0	0.9	1.3	1.3	0.7	1.1	0.8	0.7	0.67	0.67	0.67	0.81	2.70	2.50	1.78	2.25

MSP, Moisture-conservation practice

Table 2. Effect of irrigation and moisture-conservation practice on quality characters of 'Vikas' cotton

Treatment	Halo length (mm)				Fibre finenes (millitex)				Ginning outturn (%)			
	Summer crop		Ratoon crop		Summer crop		Ratoon crop		Summer crop		Ratoon crop	
	1987	1988	1987	1988	1987	1988	1987	1988	1987	1988	1987	1988
Irrigation at CPE (mm)												
80	23.3	23.1	23.4	23.2	166.0	169.7	166.6	168.2	33.9	33.7	33.7	33.4
120	23.0	23.0	23.2	23.1	165.8	168.6	165.8	168.3	33.8	33.7	33.6	33.3
160	22.8	22.8	23.2	23.1	166.0	168.8	165.8	168.3	33.8	33.7	33.5	33.3
200	22.7	22.7	23.2	22.9	165.3	168.8	165.8	168.2	33.7	33.6	33.5	33.4
CD (P = 0.05)	NS	NS	NS	NS	NS	0.77	NS	NS	NS	NS	NS	NS
MCP												
Control	20.5	20.9	20.8	21.5	164.8	167.6	164.7	165.5	33.6	33.5	33.3	33.1
Organic mulch	23.7	23.5	24.0	24.5	166.4	169.3	166.7	169.4	33.9	33.8	33.6	33.5
Polyethylene mulch	24.2	24.1	24.2	24.5	165.9	169.5	166.4	169.5	33.9	33.8	33.7	33.5
Mixtalol	22.7	21.8	23.0	21.5	165.8	168.7	164.3	166.9	33.7	33.6	33.4	33.2
Jalshakti	21.9	21.5	22.8	21.4	165.4	167.7	164.7	166.3	33.6	33.6	33.3	33.1
Organic mulch + jalshakti	23.8	24.4	23.9	24.6	166.6	170.2	167.1	171.2	33.9	33.8	33.8	33.5
Polythylene mulch + jalshakti	23.4	24.6	24.2	24.7	166.8	170.3	167.7	171.5	34.0	33.9	33.9	33.6
Mixtralol + jalshakti	22.7	21.8	23.1	21.7	165.5	168.7	166.4	166.3	33.7	33.7	34.4	33.2
CD (P = 0.05)	0.66	0.70	0.55	0.64	1.15	0.96	0.72	0.89	NS	0.11	0.39	0.34

MCP, Moisture-conservation practice

However, the fibre fineness and ginning outturn could not changed. The maximum increase in fibre length was observed with polyethylene mulch + jalshakti (Table 2), which may be attributed to favourable soil-moisture regime for proper development of plant and better boll formation and development, and ultimately better fibre length. Increasing level of irrigation though considerably improved the yield components, the differences in different parameters were non-significant. These results are in conformity with those of Hutchinson *et al.* (1985).

Water use

The total amount of water used in summer crop was higher than that in ratoon crop. Water use was considerably influenced by different levels of irrigation and moisture-conservation practices. Maximum water use was in 80 mm CPE irrigation level, whereas it was minimum in 200 mm CPE irrigation. Reddy and Pandey (1980) also reported similar results. Maximum water use was recorded under the control, whereas the lowest under plyethyelene mulch + jalshakti, with a difference of 143.8 mm (Table 3). The reduction in moisture use due to moisture-conservation practices may be ascribed to simultaneous check of soil-moisture losses through evaporation.

Water use efficiency

Water-use efficiency showed a close relationship with yield. The highest water-

Table 3. Effect of irrigation schedule and moisture-conservation practice on water use and water-use efficiency in 'Vikas' cotton (mean data of 2 years)

Treatment	Seed-cotton yield (q/ha)			Water use (mm)			Water-use efficiency (kg/ha-mm)		
	Summer crop	Ratoon crop	Total	Summer crop	Ratoon crop	Total	Summer crop	Ratoon crop	Total
Irrigation at CPE (mm)									
80	15.1	12.1	27.2	574.7	414.5	962.2	2.7	2.9	2.8
120	14.4	11.9	26.3	421.8	396.1	817.9	3.5	3.0	3.3
160	12.2	11.4	23.6	338.1	384.6	722.7	3.6	2.9	3.3
200	9.4	10.9	20.3	290.6	382.5	673.1	3.5	2.8	3.2
MCP									
Control	10.4	9.7	20.1	482.6	393.6	876.2	2.2	2.4	2.3
Organic mulch	13.7	12.9	26.6	392.3	329.4	721.7	3.6	3.9	3.8
Polyethylene mulch	14.6	13.4	28.0	345.7	322.5	668.2	4.4	4.1	4.3
Mixtalol	11.6	10.1	21.7	452.4	368.2	820.6	2.6	2.7	2.7
Jalshakti	11.2	9.8	21.0	435.8	381.8	817.6	2.6	2.5	2.6
Organic mulch + jalshakti	14.2	13.0	27.2	370.0	325.6	695.9	3.9	4.0	4.0
Polyethylene mulch + jalshakti	14.8	13.4	28.2	338.8	319.7	658.5	4.5	4.2	4.4
Mixtalol + jalshakti	11.9	10.3	22.1	411.3	352.5	763.8	3.0	2.9	3.0

MCP, Moisture-conservation practice

Table 4. Effect of irrigation and moisture-conservation practice on economics of different treatments in 'Vikas' cotton (mean data of 2 years)

Treatment	Cost of cultivation (Rs/ha)			Gross return (Rs/ha)			Net monetary return (Rs/ha)			Profit/Re invested
	Summer crop	Ratoon crop	Total	Summer crop	Ratoon crop	Total	Summer crop	Ratoon crop	Total	
Irrigation at CPE (mm)										
80	4,878	1,814	6,692	6,824	6,498	13,322	1,946	4,684	6,630	1.00
120	4,363	1,748	6,111	6,523	6,341	12,864	2,160	4,593	6,753	1.10
160	4,170	1,682	5,582	5,546	6,017	11,563	1,376	4,335	5,711	1.00
200	4,040	1,682	5,722	4,250	5,735	9,985	210	4,053	4,263	0.75
MCP										
Control	3,832	1,720	5,552	4,699	4,962	9,661	867	3,242	4,109	0.70
Organic mulch	4,092	1,766	5,858	6,185	6,861	13,046	2,093	5,095	7,188	1.25
Polythylene mulch	4,480	1,720	6,200	6,609	7,092	13,701	2,129	5,372	7,501	1.20
Mixtalol	4,035	1,720	5,755	5,220	5,408	10,628	1,185	3,688	4,873	0.85
Jalshakti	4,177	1,720	5,897	5,051	5,244	10,295	874	3,524	4,398	0.75
Organic mulch + jalshakti	4,651	1,766	6,417	6,417	6,956	13,337	1,766	5,190	6,956	1.10
Polyethylene mulch + jalshakti	5,040	1,720	6,760	6,713	7,156	13,869	1,673	5,436	7,109	1.05
Mixtalol + jalshakti	4,586	1,720	6,306	5,394	5,503	10,897	808	3,783	4,591	0.70

MCP, Moisture-conservation practice

The prices considered in above economics are Rs 125/ha for irrigation once, Rs 450/q for seed cotton, Rs 6/q for maize stover mulch, Rs 24/kg for polyethylene, Rs 106/kg jalshakti and Rs 120/litre mixtalol

use efficiency was in low frequency of irrigation and the lowest in higher frequency of irrigation (80 mm) in the summer crop. Polyethylene mulch + jalshakti recorded the maximum water-use efficiency, whereas the control lowest (Table 3). The increase in water-use efficiency due to moisture-conservation practices is attributed to higher economic yield and prevention of water losses through evaporation.

Economics

Scheduling of irrigation at 120 mm CPE was highly remunerative followed by irrigation at 80 mm, whereas that 200 mm CPE the least remunerative (Table 4). It was deduced that 6 irrigations in summer crop at 120 mm CPE are optimum and resulted in net return of the order of Rs 1.10 for each rupee invested on it. Maximum net return of Rs 7,501/ha obtained by the use of plastic mulch was closely followed by organic residue mulch (Rs 7,188/ha), but from the consideration of easy availability and low cost the indigenous organic mulch gave maximum return, being Rs 1.25/rupee invested.

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