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Studies on the irrigation methods and mulching on root characters, water saving and yield of summer irrigated cotton

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Abstract : Field experiments were conducted at Tamil Nadu Agricultural University, Coimbatore during summer 2002 and summer 2003 to study the influence of irrigation methods and mulching on root characters, water saving and yield of summer cotton MCU 12. The results of the experiment revealed that paired row furrow and all furrow method of irrigation and polythene sheet mulching influenced significantly on root spread and root dry weight during both the seasons. Water saving of 43, 43 and 42 percent through paired row furrow, alternate row furrow and skip furrow method of irrigation respectively than all furrow method of irrigation respectively in first crop and the same was 35, 32 and 29 per cent in second crop season. Paired row furrow method of irrigation enhanced the seed cotton yield by 5 and 11 per cent in summer 2002 and summer 2003 respectively over all furrow method of irrigation. Polythene sheet mulching had a yield advantage of 42, 35 and 57 per cent over no mulching, composted coirpith mulching and sugarcane trash mulching in summer 2002 and 56, 36 and 51 per cent in summer 2003 respectively.

Key words : irrigation methods, root length, root spread, root dry weight, water saving, yield and summer cotton.

Introduction

Cotton is known as the "while gold" due to the multifaceted value of lint and other byproducts. Even though man made synthetic fibres are produced in quantum, the natural vegetable fibre is hassle free in the life of human beings and in the eco friendly environment. China continues to occupy the first place, with a total production of 5.3 MMT, as against 4.37 MMT in USA. India more or less maintained its production (2.37 and 2.57 MMT) and productivity (292 and 294 kg ha^{-1}) in the years 2000-'01 and 2001-'02, which is far below the other leading countries (AICCIP, Annual Report, 2001-02). The *kapas* yield of cotton is affected by many factors such as climate, soil type, irrigation, pest and disease, weeds, nutritional imbalance etc. Among them, water is the most vital limiting factor in achieving sustained production. Thus, the present water status demands for the scientific management of available water more efficiently. Scientific agriculture should aim to achieve the twin objectives of higher productivity and better water use efficiency. As the scope of increasing area under irrigation is at far reach, the efficient use of water is crucially dependent on advanced irrigation management techniques. Application of mulches conserves soil moisture and hence improved yield. Different mulches significantly increased the soil moisture status at different soil depth. It has also been reported that black polythene mulch controls weed incidence, reduce nutrient loss and improves the hydrothermal regime of the soil (Ashworth and Harrison, 1983).

Materials and methods

A field experiment was carried out for two seasons of summer 2002 and summer 2003 at Tamil Nadu Agricultural University, Coimbatore to study the response of summer cotton to irrigation methods and mulching on root characters, water saving and

Table 1. Effect of irrigation and mulching on root length (cm) of cotton in summer 2002 and 2003

Treatments	2002					2003				
	No mulch (M_1)	Composted coir pith mulch (M_2)	Sugarcane trash mulch (M_3)	Polythene sheet mulch (M_4)	Mean	No mulch (M_1)	Composted coir pith mulch (M_2)	Sugarcane trash mulch (M_3)	Polythene sheet mulch (M_4)	Mean
Irrigation Methods (I)										
All furrow (I_1)	58.51	51.03	51.06	47.99	52.15	55.06	50.46	46.59	43.85	48.99
Alternate furrow (I_2)	59.02	53.69	54.25	50.40	54.34	55.22	55.28	48.75	46.69	51.49
Skip furrow (I_3)	59.55	56.53	56.49	50.78	55.84	59.63	60.04	56.38	55.99	58.01
Paired row furrow (I_4)	46.61	47.73	46.64	45.49	46.62	54.30	51.48	46.40	42.11	48.57
Mean	55.92	52.25	52.11	48.67		56.05	54.31	49.53	47.16	

Source	SEd	CD (P=0.05)	SEd	CD (P=0.05)
I	0.52	1.28	1.60	3.91
M	0.81	1.66	1.05	2.17
Interaction	1.49	3.14	2.42	NS

Table 2. Effect of irrigation and mulching on root spread (cm) of cotton in summer 2002 and 2003

Treatments	2002					2003				
	No mulch (M_1)	Composted coir pith mulch (M_2)	Sugarcane trash mulch (M_3)	Polythene sheet mulch (M_4)	Mean	No mulch (M_1)	Composted coir pith mulch (M_2)	Sugarcane trash mulch (M_3)	Polythene sheet mulch (M_4)	Mean
Irrigation Methods (I)										
All furrow (I_1)	62.65	64.01	62.76	66.66	64.02	60.28	62.11	57.93	68.17	62.12
Alternate furrow (I_2)	58.18	57.26	62.00	69.76	61.78	50.39	52.38	51.95	57.31	53.01
Skip furrow (I_3)	55.42	54.63	55.77	60.25	56.52	37.34	44.27	49.87	47.58	44.77
Paired row furrow (I_4)	67.18	68.98	67.99	73.57	69.43	58.08	54.33	52.82	63.32	57.14
Mean	60.86	61.20	62.13	67.56	62.94	51.52	53.27	53.15	59.10	54.26

Source	SEd	CD (P=0.05)	SEd	CD (P=0.05)
I	1.68	4.12	1.11	2.70
M	0.87	1.80	1.65	3.41
Interaction	2.26	5.15	3.07	NS

Table 3. Effect of irrigation and mulching on root dry weight (g) of cotton in summer 2002 and 2003

Treatments	2002					2003				
	No mulch (M_1)	Composted coir pith mulch (M_2)	Sugarcane trash mulch (M_3)	Polythene sheet mulch (M_4)	Mean	No mulch (M_1)	Composted coir pith mulch (M_2)	Sugarcane trash mulch (M_3)	Polythene sheet mulch (M_4)	Mean
Irrigation Methods (I)										
All furrow (I_1)	7.27	7.05	6.34	8.90	7.39	6.30	6.38	6.57	6.86	6.53
Alternate furrow (I_2)	6.92	7.20	7.24	7.88	7.31	7.05	5.88	6.44	6.87	6.56
Skip furrow (I_3)	6.24	5.55	5.98	6.73	6.13	6.08	6.38	6.03	7.10	6.40
Paired row furrow (I_4)	7.12	7.00	8.03	8.44	7.65	7.41	7.61	8.57	8.80	8.10
Mean 6.89	6.70	6.90	7.99	7.12	6.71	6.56	6.90	7.41	6.90	

Source	SEd	CD (P=0.05)	SEd	CD (P=0.05)
I	0.12	0.30	0.23	0.57
M	0.13	0.28	0.24	0.50
Interaction	0.26	0.56	0.48	1.04

Table 4. Effect of irrigation and mulching on water use efficiency (WUE) of cotton in summer 2002 and 2003

Treatments	Summer 2002			Summer 2003		
	Total water used (mm)	*Kapas* yield (kg ha^{-1})	WUC (kg ha mm^{-1})	Total water used (mm)	*Kapas* yield (kg ha^{-1})	WUC (kg ha mm^{-1})
Irrigation Methods (I)						
I_1 - All furrow	464.3	15.33	3.30	500.6	15.17	3.03
I_2 - Alternate furrow	266.6	14.50	5.44	340.6	15.80	4.64
I_3 - Skip furrow	270.5	12.17	4.50	355.3	13.18	3.71
I_4 - Paired row furrow	265.2	16.13	6.08	327.7	16.91	5.16

yield. Cotton variety MCU 12 was sown with 75 x 30 cm spacing with recommended fertilizer level of 60 : 30 : 30 kg NPK ha^{-1}. The experiment consisted of three modified irrigation methods (alternate furrow, skip furrow and paired row furrow method) with all furrow (normal furrow) and three mulching (composted coir pith, sugarcane trash and polythene sheet) with no mulch in main and sub plots respectively. The experiment was laid out in split plot design with three replications. The soil of the experimental plot was a well drained clay loam with pH 8.6 and the available NPK status were 174, 16 and 405 kg ha^{-1} respectively. The fertilizers were applied through Urea, SSP and MOP, the pH and EC of irrigation water were 8.0 and 0.4 dSm^{-1} respectively.

Results and Discussion

Irrigation methods and mulching on root characters (Table 1, 2 and 3)

Root length of cotton exhibited significant changes due to irrigation and mulching methods. Among the different methods of irrigation, the highest mean root length (55.84 and 58.01 cm in summer 2002 and summer 2003 respectively) was observed in skip furrow method of irrigation (I_3) which was on par with the mean result (54.34 cm) of alternate furrow method of irrigation (I_2). The lesser mean root length (46.62 cm) was recorded in paired furrow method of irrigation (I_4). Mulching methods influenced the root length of cotton significantly. The maximum root length (55.92 56.05 cm in summer 2002 and summer 2003 respectively) was registered in no mulching (M_1) whereas the poor root length was (48.67 cm) observed in polythene sheet mulching (M_4) treatment. When the soil moisture content decreased, the rate of elongation of root was faster. Hence, the skip furrow method of irrigation increased the root length in both the years when compared to other irrigation methods (Hall *et al.* 1990).

The maximum spread or diameter of root column was more (69.43 and 62.12 during summer 2002 and summer 2003 respectively) in paired row furrow and all furrow method of irrigation respectively, which were followed by alternate furrow method of irrigation. Poor root spread (56.52 and 44.77 cm during summer 2002 and summer 2003 respectively) was observed in skip furrow method of irrigation when compared to other irrigation methods. Regarding mulching, the maximum root spread (67.56 and 55.10 cm during summer 2002 and summer 2003 respectively) was noticed in polythene sheet mulching when compared to other methods of mulching. Root spread at harvest was increased under higher frequency of irrigation. The initial momentum in root elongation under lower moisture status was in response to deficit moisture in surface layer. But root spread is generally limited to surface layers only (Alwar Arunachalam, 1994).

The mean root dry weight was significantly higher in paired row furrow method of irrigation (7.65 and 8.10 g pl^{-1} in summer 2002 and 2003 respectively) than all other irrigation methods in both the seasons. However it was comparable with all furrow method of irrigation (7.39 g pl^{-1}) in summer 2002. Regarding the mulching treatment, the root dry weight was significantly higher (7.99 and 7.41 g pl^{-1} during summer 2002 and summer 2003 respectively) in polythene sheet mulching when compared to other method of mulching and resulted on par with each other.

Mean root dry weight was distinctly more at paired row furrow method and polythene sheet mulching in first crop season, which was same in second crop season also. Polythene sheet mulch contributed more in root dry weight in all furrow followed by paired row furrow method of irrigation. Al-Khafaf *et al.* (1985) and Karim *et al* (1986) also established the fact that root growth was curtailed

and the root weight was increased at higher moisture status.

Irrigation and mulching on water use efficiency and water saving (Table 4)

The water use efficiency (WUE) is a tool to assess the productivity of a crop per unit of water used. It is compound taking into the economic yield of a crop divided by the total water use. Accordingly, productivity per unit water use (WUE) was worked out. It was raised in paired row furrow irrigation in both the years. It was followed by alternate furrow and skip furrow methods of irrigation. The productivity efficiency was lesser in all furrow method (3.30 and 3.03 during summer 2002 and summer 2003 respectively) of irrigation. Mukerji *et al* (1990) reported that 50 per cent of irrigation water was used by cotton plant through alternate furrow method of irrigation when compared to normal furrow method of irrigation. Report of Brar and Dalip Singh (1983) also opined that adoption of alternate furrow method of irrigation had saved irrigation water up to 31.7 per cent in cotton.

Irrigation and mulching on yield of seed cotton (kapas) (Table 4)

In irrigation methods, the *kapas* yield in paired row furrow method of irrigation (I_4) was significantly higher producing 16.13 and 16.91 qha^{-1} in summer 2002 and summer 2003 respectively. However, it was found comparable to that in all furrow method of irrigation (15.33 q ha^{-1}) in summer 2002 and in alternate furrow method of irrigation (15.80 q ha^{-1}) in summer 2003. It was calculated that there was an increase of seed cotton yield about 5 and 11 per cent in paired row furrow method of irrigation than that of all furrow method of irrigation during summer 2002 and summer 2003 respectively. Also which had an increase of 33 and 28 per cent over skip furrow method of irrigation.

Regarding the mulching, it had significant influence on *kapas* yield in cotton. Mulching with polythene sheet (M_4) registered significantly higher *kapas* yield (18.84 and 20.09 q ha^{-1} in first year and second year respectively). In the first year crop, the *kapas* yield was significantly lower (12.03 q ha^{-1}) in the sugarcane trash mulched treatment than that in other treatments. In the second year crop, though the control (no mulch) registered significantly lower yield (1291 q ha^{-1}), it was comparable to sugarcane trash mulch (13.28 q ha^{-1}). It was calculated that there was an increase of 42 and 56 per cent of kapas yield by the application of polythene sheet mulching than that of mulching during summer 2002 and summer 2003 respectively.

Increase of growth and yield bearing characters led to increase in seed cotton yield (Mukerji *et al.*, 1990). The same result was also conformed by Pandyan and Iruthayaraj (1991). Similarly Aujla *et al* (1992) supported that compared to every furrow method of irrigation, alternate furrow slightly reduced the seed cotton yield whereas the water economy was more. It is confirmed by Magar (1995) and Kittad *et al* (1995) who reported that in sugarcane, paired row furrow method of irrigation gave better cane yield.

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