

Research Paper :

Comparative evaluation of land management practices and cropping systems in relation to runoff soil loss and yield of cotton

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Accepted : July, 2009

ABSTRACT

A field experiment on medium soil with land slope of 1 per cent was conducted with the treatments of land management practices and intercropping systems during *kharif* season of year 2000 at Instructional cum-Research farm of Department of Soil and Water Conservation Engineering with a view to find the effect of these practices on runoff soil loss and yield of cotton. The land management practices *viz.*, broad bed and furrow (BBF) and ridges and furrow across the slope with cotton (90 x 50 cm spacing) recorded total runoff of 8.115 cm and 6.669 cm, respectively and soil loss of 1.158 tonnes ha⁻¹ and 1.004 tonnes ha⁻¹, respectively. Between these two treatments ridges and furrow recorded 55.51 per cent reduction in runoff and 59.77 per cent reduction in soil loss over the control. The intercropping system *viz.*, cotton + soybean, cotton + green gram and cotton black+gram in 1:1 ratio recorded total runoff of 17.332 cm, 8.033 cm, 12.668 cm, respectively. Among these treatments cotton + green gram intercropping system has most pronounced effect on reduction of runoff and soil loss as 46.41 per cent and 49.31 per cent, respectively. The average yield of these three intercropping system *viz.* 462.82 kg ha⁻¹, 478.81 kg ha⁻¹ and 424.51 kg ha⁻¹ are found to be more as compared to rest of the treatments. The cotton + green gram intercropping system is found beneficial in reducing total runoff (8.033 cm) and total soil loss (1.265 tonnes ha⁻¹) with better improvement in the yield (478.10 kg ha⁻¹). It also resulted in good monetary return of Rs 2793.33 ha⁻¹.

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Key words : Runoff, Land management practice, Cropping system

Soil and water, are two major natural resources essential for crop growth and production. They are meagre and limited. The erratic rainfall and soil erosion are major handicaps faced by the farmers. The farming system aims at best use of natural resources and minimization of soil and water losses. The range of cropping system depends upon climate, soils crop characteristics and precipitation (Bonde *et al.*, 1998; Karad *et al.*, 1991). Presently rainfed agriculture in India contributes 40 per cent of food grain production and supports 40 per cent of total population.

Marathwada region of Maharashtra grows cotton over an area of approximately 6.45 lakh ha of which about 97 per cent crop is rainfed resulting in low yield. Cotton crop is major component of cropping pattern both under dry land and irrigated conditions of Maharashtra state. Presently large numbers of high yielding varieties/hybrids of cotton are being grown. It is important to note that any single practice is insufficient to increase the productivity of the crops and strategy needs modification with integrated approach of *in situ* soil and moisture conservation, adoption of crop management practices and land management practices for stabilizing productivity.

The attitude of farmers is changing towards the combination of cultural practices like land management practices and cropping systems. It is reported that formation of ridges and furrow at sowing reduces runoff, soil loss and increase yield as compared to conventional practice (Mittal, 1998).

METHODOLOGY

Experimental site :

A field experiment on medium soil with land slope of 1 per cent was conducted during *kharif* season of year 2000 at Instructional cum-Research farm of the Department of Soil and Water Conservation Engineering, College of Agricultural Engineering, Marathwada Agricultural University, Parbhani.

Climate and weather conditions :

Geographically Parbhani is situated at 19° 16' North latitude and 76° 47' East longitude with an elevation of 409 m above mean sea level. Parbhani has sub tropical climate with an average annual rainfall of 830 mm and is distributed over the monsoon period. The rainfall is mainly contributed due to South West monsoon extending from

June-September in the region and the rainy days ranges from 40 to 50 which is quite suitable for growth during *kharif* season.

The study was conducted with ten treatments with each plot of size 3 x 45 m. Treatment wise observations were recorded and effect on various aspect were worked out.

Treatments :

T₁ - Sole cotton planted across the slope with 60 cm x 45 cm spacing.

T₂ - Sole cotton planted along the slope with 90 cm x 50 cm spacing.

T₃ - Intercropping system of cotton + soybean in 1:1 ratio

T₄ - Intercropping system of cotton + green gram in 1:1 ratio

T₅ - Intercropping system of cotton + black gram in 1:1 ratio

T₆ - Sole cotton planted on flat soil with 90cm x 50 cm spacing. (control)

T₇ - Sole cotton planted across the slope with 90cm x 50 cm spacing.

T₈ - Sole cotton planted on broad bed and furrow across the slope with 90cm x 50 cm spacing.

T₉ - Sole cotton planted on Ridges and furrow with 90cm x 50 cm spacing.

T₁₀ - Sole cotton planted with 90cm x 50 cm spacing with mulching.

Runoff :

Each treatment plot of 3 m x 45 m size on 1 per cent slope was considered as unit for measurement of runoff and soil loss. For measurement of runoff combination of stage level recorder (daily type) and 6 inch 'H' flume was installed in the center of down stream boundary bund of the treatment plot. Runoff water collected at the flume and flowing through 'H' flume, was recorded on the graph of stage level recorder. Storm wise runoff was recorded for each treatment. The graphs were analysed by separating the segments of runoff line with constant runoff. Using rating tables provided for 'H' flumes, corresponding discharge rates were worked out. From these ordinates of hydrograph, runoff in centimeter was calculated using standard method. Runoff for the season was obtained by adding storm wise runoff depths over the period. Storm wise runoff for the season was recorded and analyzed.

Soil loss :

Storm wise soil losses were measured for all treatments under study. For measurement of soil loss

runoff samples from each treatment was collected during the process of runoff in sampling bottles. Samples were kept in oven for evaporation of water from the samples. The samples after drying were weighted with sensitive weight balance to determine the weight of soil contained in sample. The treatment - wise total soil loss in tones ha⁻¹ for the storm and season are calculated and analyzed.

Crop yield :

Four cotton picking were carried out in each replication and total cotton yield in kg ha⁻¹ from each replication was recorded. Yield of intercrop (soybean, green gram and black gram) in each replication were also recorded. After harvest of intercrop replication wise yield of intercrop were converted into cotton crop yield by grain equivalent method. Recorded yield in kg ha⁻¹ is statistically analyzed considering simple randomized block design (RBD). The monitory returns of each treatment was worked out and compared.

RESULTS AND DISCUSSION

The results obtained from the present investigation are presented below:

Effect of land management practices and cropping systems on runoff:

Storm wise runoff and total runoff is presented in Table 1. Runoff under land management practice *i.e.* ridges and furrow across the slope (T₉) reduced runoff to the extent of 55.51 per cent over control treatment of sole cotton planted flat, across the slope. (T₆).

Reduction in runoff under broad bed and furrow (T₈) treatment was 45.86 per cent compared to flat sowing (T₆). Among broad bed and furrow and ridges and furrow treatment, later treatment was found to be superior over the former. Ridges and furrow (T₉) was found to be effective in reducing runoff by 17.81 per cent over broad bed and furrow. This reduction in runoff was due to more time of concentration and good vegetative growth of cotton crop in the month of August. It was concluded that land management practices *viz.* broad bed and furrow and ridges and furrow were found to be most effective in reducing runoff.

Effect of intercropping systems on runoff:

Data on runoff with three intercropping systems with cotton *viz.*, cotton + soybean (T₃), cotton + green gram (T₄) and cotton + black gram (T₅) in 1:1 ratio reveals that introduction of intercropping systems in the cropping pattern with cotton reduced runoff in the range of 15.49 to 46.41 per cent, over the control *i.e.* sole cotton planting

Table 1 : Total runoff (cm) from different treatments in the year 2000

Date	Rainfall (mm)	T ₁ 60x45	T ₂ 90x50	T ₃ 90x50 (C+S)	T ₄ 90x50 (C+G)	T ₅ 90x50 (C+B)	T ₆ 90x50	T ₇ 90x25	T ₈ 90x50 (BBF)	T ₉ 90x50 (R&F)	T ₁₀ 90x50
10/8/00	54.00	Nil	1.180	1.552	Nil	Nil	0.847	0.292	Nil	Nil	1.271
11/8/00	77.20	1.167	2.690	3.080	2.150	3.370	2.624	2.731	Nil	Nil	1.817
24/8/00	125.00	3.504	4.243	5.690	2.665	3.999	4.695	4.183	3.676	3.021	3.600
25/8/00	34.00	0.462	1.180	0.386	0.981	1.919	1.698	1.157	0.214	0.671	1.180
27/8/00	27.20	0.069	0.940	1.080	0.140	1.180	0.925	0.180	0.653	0.347	0.640
28/8/00	102.00	2.730	3.145	3.381	1.497	1.260	3.467	2.601	3.042	2.210	2.022
29/8/00	21.60	0.977	0.750	2.549	0.600	0.940	0.734	0.102	0.530	0.420	0.508
Total		9.413	14.128	17.332	8.033	12.668	14.990	11.246	8.115	6.669	11.03
		37.2%	5.75%	15.56%	46.41%	15.49%		24.97%	45.86%	55.51%	26.4%

(T₆) treatment. Among intercropping systems, cotton + green gram treatment (T₄) was found superior over the intercropping systems of cotton + black gram (15.49) per cent and cotton + soybean (15.49) per cent. Inter cropping systems of cotton + green gram was found equally efficient in reducing runoff to land management practices (broad bed and furrow and ridges and furrow). Runoff under intercropping systems of cotton + soybean (17.33 cm) was more than the runoff in control (T₆) treatment. The poor performance of intercropping systems of cotton + black gram and cotton + soybean in reducing runoff may be due to slow growth of black gram and soybean compared to green gram. Thus it is concluded that intercropping system of cotton + green gram in the ratio 1:1 is most efficient in reducing runoff.

Effect of land management practices and cropping system on soil loss:

Treatment wise soil loss is presented in the Table 2 which reveals that soil loss was minimum in land management practices viz., broad bed and furrow (T₈), ridges and furrow (T₉) and were found to be most

effective in reducing soil loss, compared to intercropping and other systems. The result indicates that treatments of ridges and furrow (T₉) and across the slope sowing (T₆) with cotton 90 x 50 cm spacing reduced the soil loss to the extent of 81.82 per cent (1.004 tones ha⁻¹) and 59.7 per cent (1.004 tones ha⁻¹), respectively over the treatment sole cotton planted along the slope with 90 x 50 cm spacing (5.542 tones ha⁻¹) T₂. Similarly, it was found that treatment of broad bed and furrow with 90 x 50 cm spacing of cotton planted across the slope reduced soil loss to the extent of 79.03 per cent (1.158 tones ha⁻¹) over the treatment 90 x 50 cm T₆ with across the slope sowing. Ridges and furrow system was found to be more effective than broad bed and furrow system with 13.29 per cent less soil loss.

Effect of intercropping systems on soil loss:

It was found that intercropping systems reduced the soil loss in the range of 42.06 per cent of 82.28 per cent (1.265 tones ha⁻¹) over the sole cotton sowing (T₆) (2.496 tones ha⁻¹). Among intercropping systems, cotton + green gram was found superior over that of Cotton +

Table 2 : Soil loss from each treatment, tones ha⁻¹

Date	Rainfall (mm)	T ₁ 60x45	T ₂ 90x50	T ₃ 90x50 (C+S)	T ₄ 90x50 (C+G)	T ₅ 90x50 (C+B)	T ₆ 90x50	T ₇ 90x25	T ₈ 90x50 (BBF)	T ₉ 90x50 (R&F)	T ₁₀ 90x50
10/8/00	54.00	Nil	0.461	0.232	Nil	Nil	0.141	0.043	Nil	Nil	1.216
11/8/00	77.20	0.680	1.052	0.462	0.339	0.385	0.437	0.409	Nil	Nil	0.309
24/8/00	125.00	1.27	1.660	0.853	0.420	0.457	0.782	0.627	0.525	0.453	0.612
25/8/00	34.00	0.188	0.461	0.057	0.154	0.219	0.283	0.188	0.030	0.100	0.200
27/8/00	27.20	0.028	0.367	0.162	0.022	0.134	0.154	0.027	0.093	0.052	0.108
28/8/00	102.00	1.112	1.230	0.507	0.236	0.144	0.577	0.390	0.435	0.331	0.344
29/8/00	21.60	0.398	0.293	0.382	0.094	0.107	0.122	0.015	0.075	0.063	0.086
Total		3.833	5.524	2.655	1.265	1.446	2.496	1.699	1.158	1.004	1.875
		-54%	-121.3%	-6.37%	49.31%	42.06%		31.93%	53.60%	89.77%	24.87

black gram and cotton + soybean. Soil loss was reduced with cotton + black gram intercropping system by 42.06 per cent (1.446 tons ha⁻¹) over the sole cotton cropping (T₆).

Effect of land management practices and cropping systems on yield of cotton:

There was slightly low cotton yield under land management practices over the control T₆ (Table 3). The average cotton yield in broad bed and furrow was 255.35 kg ha⁻¹ and in ridges and furrow was 226.23 kg ha⁻¹. Comparing two land management practices the lowest cotton yield was received in ridges and furrow which was at par with broad bed and furrow. However the cotton yield recorded in both land management practices was lower than the flat sowing T₆.

Table 3 : Cotton crop yield. (kg ha⁻¹)

Treatments	Replications			Mean
	1	2	3	
T ₁	330.00	402.48	338.68	357.05
T ₂	290.57	314.64	256.15	287.12
T ₃	464.91	510.84	421.71	462.82
T ₄	511.08	509.60	415.75	478.81
T ₅	443.39	407.48	422.68	424.51
T ₆	310.13	251.53	291.17	284.27
T ₇	193.97	209.55	189.48	197.66
T ₈	316.77	209.20	240.08	255.35
T ₉	272.08	229.97	176.66	226.23
T ₁₀	247.95	205.80	175.11	209.62
S.E.±	19			
C.D. (P=0.05)	57			

Effect of cropping systems on cotton yield:

The cotton yield recorded in three intercropping systems are presented in the Table 3. The average cotton yields recorded in cotton + soybean, cotton + green gram and cotton + black gram were 462.82 kg ha⁻¹, 478.81 kg ha⁻¹ and 424.51 kg ha⁻¹, respectively. Cotton yield is obtained by converting corresponding yield of intercrops, (soybean, green gram and black gram) into cotton yield by grain equivalent method. It is observed that among the intercropping systems, the lowest mean yield of 424.51 kg ha⁻¹ was recorded in treatment of cotton + black gram and it was at par with cotton + soybean and cotton + green gram. Cotton + green gram and cotton + black gram were significantly superior over the sole cropping.

Monetary returns of cotton:

The data on monetary return presented in Table 4

Table 4 : Monetary return of cotton crop, Rs ha⁻¹

Treatments	Replications			Mean
	1	2	3	
T ₁	3393	4870	4098	4120.33
T ₂	3515	3807	3099	3473.65
T ₃	5625	6181	5102	5636.00
T ₄	6184	6166	5030	5793.33
T ₅	5365	4930	5114	5136.33
T ₆	3752	3040	3523	3439.33
T ₇	2347	2535	2292	2391.33
T ₈	3832	2531	2904	3089.00
T ₉	3292	2782	2137	2737.00
T ₁₀	3000	2490	2118	2536.00
S.E.±	265			
C.D. (P=0.05)	787			

Cost/kg as,

Cotton - 12.10 Rs/kg

Soybean - 8.00 Rs/kg

Green gram - 9.00 Rs/kg

Black gram - 9.00 Rs/kg

revealed that the lowest monetary return of Rs. 2391 ha⁻¹ was received in the treatment of sole cotton planted with 90 x 25 cm spacing (44,444 plants ha⁻¹) (T₇) and this was at par with the treatments of broad bed and furrow (T₈), ridges and furrow (T₉) and sole cotton with 90 x 50 cm spacing (T₁₀). The highest monetary return of Rs. 5793 ha⁻¹ was obtained in the intercropping system of cotton + green gram (T₄) followed by cotton + soybean (T₃) (5636 Rs ha⁻¹). It was also found that treatment of cotton + green gram (T₄) was significantly superior over the rest of the treatments. Intercropping systems of soybean, green gram and black gram with cotton were found to be most profitable systems as compared to sole cotton crop and it was found that there was increase in monetary return by more than 1.5 times over sole cropping.

Conclusion:

The land management practices viz., broad bed and furrow (BBF) and ridges and furrow across the slope with cotton (90 x 50 cm spacing) recorded total runoff of 8.115 cm and 6.669 cm, respectively and soil loss of 1.158 tonnes ha⁻¹ and 1.004 tonnes ha⁻¹, respectively. Between these two treatments ridges and furrow recorded 55.51 per cent reduction in runoff and 59.77 per cent reduction in soil loss over the control.

The intercropping system viz., cotton + soybean, cotton + green gram and cotton + black gram in 1:1 ratio recorded total runoff of 17.332 cm, 8.033 cm, 12.668 cm, respectively. Among these treatments cotton + green gram intercropping system had most pronounced effect on reduction of runoff and soil loss as 46.41 per cent and 49.31 per cent, respectively. The average yield of these

three intercropping system viz. 462.82 kg ha⁻¹, 478.81 kg ha⁻¹ and 424.51 kg ha⁻¹ were found to be more as compared to rest of the treatments. The cotton + green gram intercropping system was found beneficial in reducing total runoff (8.033 cm) and total soil loss (1.265 tonnes ha⁻¹) with better improvement in the yield (478.81 kg ha⁻¹). It also resulted in good monetary return of 5793.33 Rs ha⁻¹.

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