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RESEARCH ARTICLE

Study of productivity, runoff, soil and nutrient loss in cotton under contour cultivation practices

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SUMMARY : The study was undertaken at Agro-ecology and Environment Farm, Dr. PDKV, Akola to find the impact of contour cultivation practices on runoff, soil and nutrient loss and physio-chemical properties of soil. The study area was divided into three plots (T_1, T_2 and T_3) under cotton (AKA - 07). The experiments were designed in Randomized Block Design (RBD) with 4 replications. The land slope was maintained at 1.6 per cent in shallow soil. Each plot was treated with different cultivation practices *viz.*, T_1- Along the slope cultivation with opening of the tide, T_2 – contour cultivation with opening of alternate furrows and T_3 – contour cultivation with opening of furrows (R and F). Runoff was measured by H'flume with automatic stage level recorder installed at outlet of each plot. Amount of soil in runoff samples was determined by oven dry method. The analysis of soil samples was done to find out the nutrient losses (N, P and K) in the soil. Moisture content at 20, 40, 80 DAS and at harvest upto the depth of 60 cm was recorded. Changes in physio-chemical properties of soil were studied during the crop period. Cotton was sown on 2nd July 2012 and harvested by four picking (duration of crop – 152 days). The results of the study showed that the runoff, soil and nutrient loss was found lowest (0.79%) in T_3 followed by T_2 (4.09 %) and T_1 (30.70 %). The moisture levels were also found to be better in T_3 followed by T_2 and T_1. The bulk density was found to be improved in T_3 (1.35) followed by T_2 (1.41) and T_1 (1.54). Field capacity was also found to be increased under T_3 compared to other treatments. While, organic carbon and soil resistance were found to be reduced in T_3 followed by T_2 and T_1. From the study, it was revealed that the treatment T_3 - contour cultivation with opening of furrows (R and F) was effective in controlling runoff, soil and nutrient loss and improving physio-chemical properties of soil compared to other treatments.

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Contour, Nutrient loss, Runoff, Soil, Soil properties

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Several soil and water conservation practices have been recommended to minimize soil erosion and to maintain organic matter, soil moisture aeration and microbial activity. In order to have the sustainable agriculture, maintaining soil properties in favourable proportion for a long time is a problem. The present investigation revealed that the treatment T_3 was more prominent and favourably influenced the reduction in runoff, soil loss and nutrient losses followed by T_2 over treatment T_1. Baird (1964) studied the runoff from treated and untreated watershed.

It was observed that conservation practices reduced peak rate of runoff appreciably. Watershed management is the planning and implementation of proper land use practices to reduce the losses of natural resources, productivity and to improve the quantity and quality of water. In the recent scientific development of land and water resources, watershed is increasingly considered as a unit. Allis (1953) observed changes in both the peak rates and total runoff that may be produced by changes in land use and adoption of soil conservation measures.

Keeping the above facts in views, the present investigation has been planned for cotton crop, as one of the important rainfed cash crops, during *Kharif* season in Vidarbha region. The

study was conducted to evaluate the *in-situ* soil and water conservation effect through various cultivation practices for cotton (*Gossypium arboreum*) crop with the following specific objectives:

–To study the effect of *in-situ* soil and water conservation measures on reduction of runoff, soil loss nutrient losses.

–To study the effect on growth and yield of crop.

EXPERIMENTAL METHODOLOGY

The study was conducted at Agro-ecology and environmental farm, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola to find out the impact of contour cultivation practices on runoff, soil and nutrient loss and physio-chemical properties of soil on cotton. The statistical analysis was carried out by Randomized Block Design with four replications and three treatments *viz.*, T_1- Along the slope cultivation with opening of the tide, T_2 – Contour cultivation with opening of alternate furrows and T_3 – Contour cultivation with opening of furrows (R and F)and land slope of 1.6 per cent. Runoff was measured by H' flume with automatic stage level recorder installed at outlet of each plot. Amount of soil in runoff samples was determined by oven dry method. The soil site selected for this experiment was shallow. The analysis of soil samples was done to find out the nutrient losses (N, P, and K) in the soil. Moisture content at 20, 40, 80 DAS and at harvest upto the depth of 60 cm was recorded. Changes in physio-chemical properties of soil were studied during the crop period.

During the study, the observations on growth and yield of cotton were recorded during the year 2012-13 in view to study the extent of favourable effect of *in-situ* soil and water conservation influenced by cultivation practices *viz.*, along the slope with opening of tide furrows, opening of alternate furrows and opening of furrows (R and F).

Runoff:

The runoff from each plot concentrated at the outlet of runoff plot was measured by H-flume of 0.30 m depth installed as a runoff measuring device. The float type automatic stage level recorder was installed at the outlet of each gauging site. The runoff chart obtained from stage level recorder gives a continuous record of depth of flow over the flume with respect to time. This stage graph will subsequently process to obtain the runoff rates and peak rate of runoff volumes which will later use for further analysis.

Stage hydrograph analysis:

Stage hydrograph is graphical representation of instantaneous discharge of field plots plotted with time. After the storm commences, the initial losses like interception and infiltration are met and then the surface flow begins. The stage hydrograph gradually rises and reaches its peak value after a time measured. Thereafter, it declines and there is a change of slope at inflection point, *i.e.* there was inflow of the rains up to this point. By this time, the ground water tables were built up by the infiltrating and percolating water and now the ground water contributes more into the stream flow than the beginning of storm, but thereafter ground water declines and the stage hydrograph again goes on depleting in the curve. If a second storm occurs now, again the stage hydrograph starts rising till it reaches the new peak and then falls and the ground water recession begins (Raghunath, 1999). According to the reference of Bos (1978), stage hydrograph gives free flow discharge through H-flume in LPS ($m^3/sec*10^{-3}$).

The intensity of rainfall is inversely proportional to its duration of occurrence and directly proportional to return period. The relationship between rainfall and peak runoff was represented by many empirical formulae. The rational formula (Flavert *et al.*, 1955), which is one of the representatives of such formula, is in use for estimating runoff to be expected from small drainage areas. The rational formula requires rainfall intensity for duration equal to the time of concentration and for particular recurrence interval. The total surface runoff and are calculated by following formulae:

$$\text{Total surface runoff (m)} = \frac{\text{Accumulated runoff } (m^3)}{\text{Area of runoff plot } (m^2)}$$

$$\text{Peak runoff rate}\left(\frac{(m^3)}{\text{sec}}/\text{ha}\right) = \frac{\text{Maximum runoff rate taken from runoff hydrograph } (m^3)/\text{sec}}{\text{Area of runoff plot (ha)}}$$

Soil loss:

The soil samples from the runoff were collected during the season. After each storm, the runoff samples were collected manually. Stirred 100 ml of runoff water each from individual sample were taken into aluminium box.

The weight of dry soil from 100 ml runoff water was determined by weighing. The soil loss in total runoff volume was expressed in t ha^{-1}.

$$\text{Soil loss (t/ha)} = \frac{\text{(Cumulative runoff volume (ml) * soil loss in 100 ml)}}{100}$$

Nutrient loss:

Nutrient losses from various treatment plots were calculated by chemical analysis conducted in Soil testing laboratory, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola.

Available N:

It was determined by alkaline potassium permanganate

method as described by Subbiah and Asija (1956). Kel plus distillation unit was used for nitrogen estimation.

Available P:

It was determined by Olsen's method using 0.5 M Sodium bicarbonate pH 8.5 as extract Darco G-60 free from soluble phosphorus was used to absorb the dispersed organic matter and make the filtrate colourless for further colorimetric analysis by Jackson (1967). Spectrophotometer was used for phosphorus estimation.

Available K:

It was determined by flame photometer using 1N ammonium acetate pH (7.0) as an extractant as described by Jackson (1967).

EXPERIMENTAL FINDINGS AND DISCUSSION

Data pertaining to soil physio-chemical properties given in Table 1 indicate that the bulk density was found to be improved in T_3 (1.35 Mg m^3) followed by T_2 (1.41 Mg m^3) and T_1 (1.54 Mg m^3). Field capacity was also found to be increased under T_3 compared to other treatments. While, organic carbon and soil resistance was found to be reduced in T_3 followed by T_2 and T_1.

Growth and productivity:

Data pertaining to growth and seed yield of cotton (AKA-7) were given in Table 2 which indicated favourable effect of contour cultivation with opening of furrows (R and F) in shallow soil.

Higher mean plant height (57.22 cm), number of branches/plant(11.80), picked bolls /plant (7.25), wt. of picked bolls/ plant (17.76 g), seed cotton yield per plot (0.418 kg), seed cotton yield (10.46 q/ha) and average depth of root (24.36 cm) was observed in T_3 followed by T_2 and minimum in T_1.

The increase in seed yield of cotton recorded under T_3 and T_2 was 40.26 and 23.24 per cent, respectively over T_1. The increase in average depth of root in cotton recorded

Table 1: Physico-chemical analysis of soils

Sr.No.	Particulars	Treatments		
		T_1	T_2	T_3
1.	Depth, (cm)	20	20	20
2.	Bulk density, (mg m-3)	1.54	1.41	1.35
3.	Field capacity, (%)	21.58	24.34	25.79
4.	PWP, (%)	10.35	12.20	13.50
5.	Infiltration rate, (cm hr-1)	11.43	12.14	12.29
6.	Free lime, (%)	3.0	3.35	3.27
7.	pH	7.80	7.87	8.32
8.	EC, (ds m-1)	0.11	0.14	0.16
9.	Organic carbon, (g kg-1)	2.50	3.5	3.56
10.	Available P, (kg ha-1)	11.15	10.95	10.12
11.	Available K, (kg ha-1)	246.4	221.1	208.8
12.	Soil resistance (K-pa) 0-15 cm depth	4831	3907	3382

Table 2: Effect of conservation measures on growth and seed yield of cotton (AKA-07)

Treatments	Plant height (cm)	No. of branches $plant^{-1}$	Picked bolls plant-1 (g)	Wt. of bolls plant-1 (2 x 2 m) (g)	Seed cotton yield $plot^{-1}$ (kg)	Seed cotton yield $qt.ha^{-1}$	Increase in yield over T_1 (%)	Av. depth of root (cm)	Increase av. depth of root over T_1	WUE ($kg\ ha^{-1}$ mm^{-1})
T_1	48.70	8.50	4.75	9.97	0.25	6.25	-	19.32	-	0.95
T_2	54.12	11.00	6.16	14.16	0.326	8.14	23.24	21.48	11.18	1.23
T_3	57.22	11.80	7.25	17.76	0.418	10.46	40.26	24.36	26.08	1.59

under T_3 and T_2 was 26.08 and 11.18 per cent, respectively over T_1.

***In-situ* soil and water conservation:**

Data pertaining to *in-situ* soil and water conservation are given in Table 3 which indicated the favourable effect of contour cultivation with opening of furrows (R and F) in shallow soil.

Surface runoff:

The seasonal surface runoff recorded under T_1 was maximum (30.70%) followed by T_2, (4.09 %) and minimum in T_3 (0.9%) of the rainfall causing runoff.

The maximum reduction in runoff was observed in T_3 (97.07 %) followed by T_2 (86.64%) over along the slope cultivation with opening of tide furrows after 30 days of sowing.

Soil loss:

During the season, maximum soil loss (25.99 t ha^{-1}) recorded in T_1 followed by T_2 (2.4 t ha^{-1}) and minimum in T_3 (0.54 t ha^{-1}).

The reduction in soil loss was observed maximum in T_3 (97.91%) followed by T_2 (90.76%) over T_1.

Soil moisture:

Data pertaining to the soil moisture in Table 4 indicated that the maximum soil moisture content was observed after 20 DAS, 40 DAS, and 80 DAS and at harvest stage up to the depth of 60 cm in T_3 followed by T_2 and minimum in T_1.

The maximum increase in soil moisture was observed in T_3 followed by T_2 and over T_1 at the time of sowing, 20, 40, 60, 80 DAS and at harvest time.

Nutrient losses:

Data pertaining to the nutrient losses in Table 5 indicated the favourable effect of contour cultivation with opening of furrows (R and F) in shallow soil.

NPK conservation was observed in contour cultivation with opening of furrows (R and F) followed by T_2 over T_1.

Table 3: Effect of cultivation practices on surface runoff and soil loss (Cotton AKA-07)

Date	Rainfall causing runoff (mm)	Runoff, mm			Runoff %			Soil loss, t ha^{-1}		
		T_1	T_2	T_3	T_1	T_2	T_3	T_1	T_2	T_3
2/07/12	29.60	18.96	4.09	0.9	64.05	13.81	3.04	13.03	2.4	0.541
7/07/12	38.5	0.38	-	-	0.98	-	-	0.186	-	-
4/09/12	45.4	11.36	-	-	25.02	-	-	12.78	-	-
Total seasonal	113.5	30.70	4.09	0.9	27.04	3.61	0.79	25.996	2.4	0.541
Red. over T_1, %		-	-	-	-	86.64	97.07	-	90.76	97.91

Table 4 : Effect of cultivation practices on soil moisture content in shallow soils

Treatments	Soil moisture (%)				Increase in soil moisture over T_1 (%)			
	15 cm	30 cm	45 cm	60 cm	15 cm	30 cm	45 cm	60 cm
T_1	6.52	8.64	10.80	12.42	-	-	-	-
T_2	9.13	11.12	13.89	15.18	40.03	28.70	28.61	22.22
T_3	11.12	13.52	15.45	17.52	70.55	56.48	43.05	41.06

Table 5: Effect of cultivation practices on nutrient losses, kg ha^{-1}

Date	Rainfall	T_1			T_2			T_3		
	(mm)	N	P	K	N	P	K	N	P	K
2/07/12	29.60	10.94	2.54	26.06	2.44	0.468	9.6	0.59	0.10	2.70
7/07/12	38.50	0.1562	0.036	0.372	-	-	-	-	-	-
4/09/12	45.40	10.73	2.5	25.55	-	-	-	-	-	-
Total seasonal	113.5	21.82	5.076	51.98	2.44	0.468	9.6	0.59	0.10	2.70
Red.over T_1%	-	-	-	-	89.00	90.78	81.53	97.20	98.00	94.00

Conclusion:

From the study it is concluded that the treatment T_3 – Contour cultivation with opening of furrows (R and F) was effective in controlling runoff, soil and nutrient loss and improving physio-chemical properties of soil compared to other treatments *viz.*, T_1- Along the slope cultivation with opening of tide furrows and T_2 - contour cultivation with opening of alternate furrows.

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