

Impact of *in situ* soil and water conservation measures on water use and production efficiency for cotton

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■ **ABSTRACT** : A field experiment was conducted during the *Kharif* season 2011-12 at Model Watershed of Agro-Ecology and Environment Centre, College of Agricultural Engineering and Technology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola to study evaluation of *in situ* soil and water conservation measures in terms of improvement in crop growth, production and water use efficiency. There were total six treatments *viz.*, cultivation along the slopes (T_1), cultivation along the slope with opening of tide furrow (30 DAS) (T_2), cultivation across the slope with opening of alternate furrow (30 DAS) (T_3), cultivation across the slope with ridges and furrows (30 DAS) (T_4), contour cultivation with opening of alternate furrow (30DAS) (T_5), contour cultivation with opening of ridges and furrows (30 DAS) (T_6). Biometric observations such as plant height (cm), number of branches were favorably influenced in treatment T_6 followed by treatment T_5 , T_4 , T_3 , T_2 and treatment T_1 . Treatment (T_6) of *in-situ* soil and water conservation measure had maximum B: C ratio of 2.17 followed by 2.10(T_5), 1.99(T_4), 1.86(T_3), 1.74(T_2) and 1.70 for treatment T_1 . Water use efficiency was more dominant in treatment T_6 *i.e.* ($2.63 \text{ kg ha}^{-1} \text{ mm}^{-1}$) followed by 2.57(T_5), 2.34(T_4), 2.18(T_3), 2.01(T_2) and 1.89 in treatment T_1 . Productivity of cotton was favorably influenced by treatment T_6 . The increase in productivity was 38.26 per cent over along the slope cultivation followed by rest of the treatments. The maximum production efficiency for treatment T_6 was maximum $8.10 \text{ kg ha}^{-1} \text{ day}^{-1}$ and Rs. $192.6 \text{ ha}^{-1} \text{ day}^{-1}$, respectively, followed by treatment T_5 , T_4 , T_3 , T_2 and treatment T_1 .

■ **KEY WORDS** : Cotton crop, Cultivation, *In situ*, Rainfed, Water use efficiency

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Soil and water conservation measures are basic resources essential for survival of human kind on earth. Ironically, very few people realize the importance of conservation and judiciously utilizing the soil, the greatest gift of nature. According to Dr. H.H. Bennett, "soil without water is desert and water without soil is useless". Water is most limiting natural resources in semi-arid region. In most of the areas only water available is rain water. Due to inadequate and uneven distribution of rainfall during growth span of crop, it becomes essential to supply water to plant by adopting *in-situ* soil conservation measures for increasing water use efficiency.

Soil and water are our most precious natural resources and maintaining the soil in stage of high productivity on sustainable basis is important for meeting growing food demand of our growing population. The productivity per unit area is also declining due to low inputs, poor management. Ramesh and Devasenapathy (2008) studied the effect of

different *in-situ* soil moisture conservation practices on soil moisture conservation, growth and yield under rainfed conditions. Results showed that moisture conservation through ridges and furrows or tied ridges along with mulching recorded significantly higher growth and yield attributes, grain and haulm yields, nutrient uptake and net returns of cowpea. Significant grain yield of cowpea was obtained under ridges and furrows with mulching (715.9 kg/ha), and tied ridges with mulching (297.4 kg/ha) during 2002 and 2003, respectively.

■ METHODOLOGY

The study was conducted at the agriculture watershed of Agro-ecology and Environment Centre at Central Research Station of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. Akola is located at an altitude of 307.4 m above mean sea level.

The study was conducted to evaluate the *in situ* soil

Sr. No.	Treatments	Description of treatment	Size(m x m)	Area(ha)
1.	T ₁	Cultivation along the slopes	125 x 32	0.40
2.	T ₂	Cultivation along the slope with opening of tide furrow (30 DAS)	129 x 28	0.36
3.	T ₃	Cultivation across the slope with opening of alternate furrow (30 DAS)	125 x 32	0.40
4.	T ₄	Cultivation across the slope with ridges and furrows (30 DAS)	122 x 28	0.34
5.	T ₅	Contour cultivation with opening of alternate furrow (30DAS)	124 x 28	0.35
6.	T ₆	Contour cultivation with opening of Ridges and furrows (30 DAS)	124.49 x 29	0.36

and water conservation effect through various land configurations for cotton (*Gossypium arborium*) crop with following specific objective as evaluation of *in-situ* soil and water conservation measures in terms of improvement in crop growth, production and water use efficiency.

Morphological study of watershed

Climate :

Agro-ecologically the watershed area lies in sub region (Eastern Maharashtra Plateau, hot, moist, semi-arid with medium black soils, medium to high available water holding capacity). The climate is semi dried masonic characterized by three distinct seasons *viz.*, summer, rainy and winter.

Crop growth :

Monthly replication wise biometric observations were recorded for each treatment. For that five plants were selected from 2m x 2m size sub plot of main treated plot. This treatment wise biometric observations *viz.*, height of plant, number of bolls and number of branches were recorded.

Productivity :

During the season, treatment and picking wise yield of the Cotton crop was recorded from the plot of size 2m x 2m selected earlier for recording the biometric observations.

The net return, benefit cost ratio and production and water use efficiency values were calculated with following formulae :

Net return was calculated by following formula :

Net return (Rs) =Gross monetary return (Rs.) - Cost of cultivation (Rs.)

Production efficiency was calculated by following formula

$$\text{Production efficiency (kg ha}^{-1} \text{ day}^{-1}) = \frac{\text{Yield of cotton (kg ha}^{-1})}{\text{Crop duration (days)}}$$

$$\text{Production efficiency (Rs. ha}^{-1} \text{ day}^{-1}) = \frac{\text{Net returns (Rs. ha}^{-1})}{\text{Crop duration (days)}}$$

Water use efficiency :

Water use efficiency for each treatment was calculated on the basis of economic yield of the crop and the total rain

water use by that crop (Michael and Ojha, 1983).

$$\text{Water use efficiency (kg. ha}^{-1} \text{ mm}^{-1}) = \frac{\text{Yield of cotton (kg. ha}^{-1})}{\text{Total water applied (mm)}}$$

RESULTS AND DISCUSSION

The experimental findings obtained from the present study have been discussed in following heads:

Plant height:

Monthly replication wise biometric observation was recorded for each treatment. For that five plants were selected from 2m x 2m size sub plot of main treated plot. The treatment wise biometric observations *viz.*, height of plant was recorded and incorporated in Table 1.

Table 1 and Fig. 1 indicate that the height of cotton crop was highly influenced by treatment T₆ followed by T₅, T₄, T₃, and T₂ over treatment T₁, 30 days after sowing. Plant height varied from 18.65 cm to 93.08 cm from sowing to the harvesting in treatment T₆.

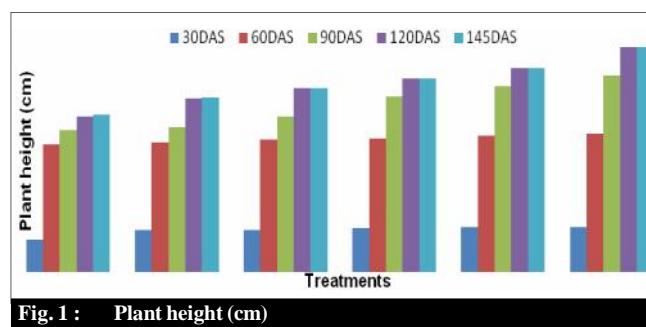
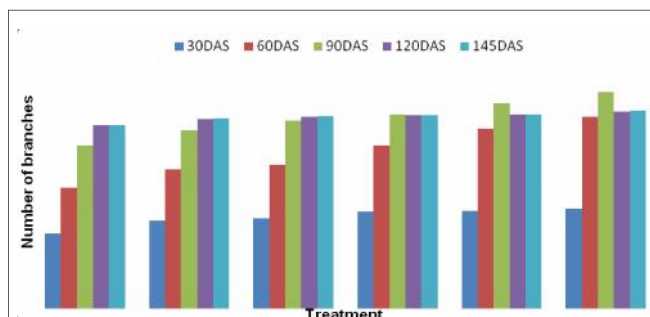


Fig. 1 : Plant height (cm)

Number of branches:

Monthly replication wise biometric observation was recorded for each treatment. For that five plants were selected from 2m x 2m size sub plot of main treated plot. The treatment wise biometric observations *viz.*, Number of branches were recorded and incorporated in Table 2.

Table 2 and Fig. 2 indicate that the number of branches of cotton crop was highly influenced by treatment T₆ followed by T₅, T₄, T₃, and T₂ over treatment T₁ after 30DAS from 9.32 to 20.15 up to 145 DAS. Minimum branches in


Fig. 2 : No. of branches

treatment T₆ at 30 DAS were 9.32 while at 145 DAS it reached up to 18.4, which were 1.9 times more in T₆ than control treatment T₁.

Growth and yield of cotton (AKA-7) :

Replication wise two cotton pickings were carried out in each treatment. First picking was from 4th November to 10th November while second was from 29th Nov to 2nd Dec. The total yield from the area of 2m wide x 2m long was taken

into consideration to know the effect of soil moisture content on seed cotton yield (Table 3).

On the basis of 2m x 2m=4 m² area, per hectare seed cotton yield was calculated and tabulated in Table 3. The highest cotton yield of 11.75 q ha⁻¹ was in treatment T₆ followed by 11.25 q ha⁻¹ (T₅), 10.50 q ha⁻¹ (T₄), 9.75 q ha⁻¹ (T₃), 9 q ha⁻¹ (T₂) and 8.50 q ha⁻¹ (T₁).

Productivity and production efficiency :

During rainy season, cotton gave maximum seed yield of 1175 kg ha⁻¹ (Table 4) under contour cultivation with opening of ridges and furrows (T₆) system of rain water management closely followed by contour cultivation with opening of alternate furrows (T₅) system of rain water management (1125 kg ha⁻¹).

The highest cotton yield of 1175 kg ha⁻¹ was in treatment T₆ followed by T₅, T₄, T₃, T₂ and T₁. The production efficiency value was worked out on seed cotton yield basis and reported in (Table 4). Production efficiency value in terms of kg ha⁻¹ day⁻¹ was significantly higher under contour cultivation with opening of ridges and furrows (T₆) practice over control plot

Table 1 : Plant height (cm)

Sr. No.	Treatments	Plant height (DAS)				
		30	60	90	120	145
1	T ₁	13.30	52.70	58.68	64.20	65.10
2	T ₂	17.15	53.55	59.72	71.8	71.90
3	T ₃	17.19	54.85	64.08	76.00	76.08
4	T ₄	18.12	55.00	72.60	80.00	80.06
5	T ₅	18.38	56.15	76.70	84.20	84.30
6	T ₆	18.65	57.20	81.10	93.0	93.08

Table 2: Number of branches

Treatments	Number of branches (DAS)					Avg. square formation per plant
	30	60	90	120	145	60
T ₁	7.0	11.30	15.20	17.08	17.10	7.75
T ₂	8.2	12.95	16.60	17.62	17.70	8.25
T ₃	8.4	13.40	17.54	17.84	17.90	9.70
T ₄	9.0	15.20	18.08	17.98	18.00	10.15
T ₅	9.12	16.76	19.12	18.06	18.10	10.20
T ₆	9.32	17.84	20.15	18.32	18.4	12.10

Table 3 : Effect of *in-situ* SWC measures on growth and yield of cotton

Treatments	Avg. picked bolls per plant	Avg. weight of picked bolls per plant(g)	Seed cotton yield/plot (kg)	Seed cotton yield (qha ⁻¹)	Increase in yield over T ₁
T ₁	6.21	12.54	0.34	8.50	-
T ₂	6.35	13.02	0.36	9.00	5.88
T ₃	6.51	13.60	0.39	9.75	14.70
T ₄	6.72	14.25	0.42	10.50	23.53
T ₅	6.91	14.85	0.40	11.25	32.35
T ₆	7.15	15.58	0.47	11.75	38.23

Table 4 : Effect of *in-situ* SWC measures on productivity and production efficiency

Treatments	Yield of cotton (kg ha ⁻¹)	Duration of crop (days)	Production efficiency	
			(Kg ha ⁻¹ day ⁻¹)	(Rs ha ⁻¹ day ⁻¹)
T ₁	850	145	5.86	106.43
T ₂	900	145	6.20	116.77
T ₃	975	145	6.72	137.46
T ₄	1050	145	7.24	158.8
T ₅	1125	145	7.75	179.5
T ₆	1175	145	8.10	192.6

Table 5 : Effect of *in-situ* SWC measures on cotton yield, B: C ratio and water use efficiency

Treatments	Yield kg ha ⁻¹	Cost of cultivation (Rs)	Gross monetary returns (Rs.)	Net return (Rs.)	B:C ratio	Water use efficiency kg ha ⁻¹ mm ⁻¹
T ₁	850	21967	37400	15433	1.70	1.89
T ₂	900	22667	39600	16933	1.74	2.01
T ₃	975	22967	42900	19933	1.86	2.18
T ₄	1050	23167	46200	23033	1.99	2.34
T ₅	1125	23467	49500	26033	2.10	2.57
T ₆	1175	23767	51700	27933	2.17	2.63

i.e. cultivation along the slope (T₁). Similar trend was also found in production efficiency value in terms of Rs. ha⁻¹ day⁻¹. The Production efficiency in treatment T₆ in terms of (kg ha⁻¹day⁻¹) and (Rs ha⁻¹day⁻¹) was 8.10 and 192.6, respectively which was significantly superior than control one (T₁).

Yield and economics :

The yield, B:C ratio and water use efficiency of various soil and water conservation practices were calculated and presented in (Table 5). The expenditure of Rs. 23767 was incurred on the treatment of contour cultivation with opening of ridges and furrows (T₆), while Rs. 21967 was invested on the cultivation along the slope (T₁). The maximum net profit of Rs. 27933 was obtained for T₆ treatment, while Rs. 15433 gained from cultivation along the slope (T₁). In case of benefit cost ratio and water use efficiency, treatment T₆ was dominated with 2.17 and 2.63 in kg ha⁻¹mm⁻¹, respectively over treatment T₁. It simplifies that in treatment T₁ farmers are able to obtain the benefit of Rs. 1.70 behind expenditure of Rs. 1 while in treatment T₆ at same condition net benefit is of Rs. 2.17.

Thus, it shows that water use efficiency in treatment T₆ was improved 1.4 times over treatment T₁, while 1.36 times in T₅, 1.23 times in T₄, 1.15 times in T₃ and 1.06 times in treatment T₂ over the treatment T₁.

Conclusion :

- Biometric observations such as plant height (cm), number of branches were favorably influenced in treatment T₆ followed by treatment T₅, T₄, T₃, T₂ and treatment T₁.
- Treatment (T₆) of *in-situ* soil and water conservation

measure had maximum B: C ratio of 2.17) followed by 2.10 (T₅), 1.99 (T₄), 1.86 (T₃), 1.74 (T₂) and 1.70 for treatment T₁.

- Water use efficiency was more dominant in treatment T₆ *i.e.* 2.63 kg ha⁻¹ mm⁻¹ in T₆ followed by 2.57 (T₅), 2.34 (T₄), 2.18 (T₃), 2.01 (T₂) and 1.89 in treatment T₁.

- Productivity of cotton was favorably influenced by treatment T₆. The increase in productivity was 38.26 per cent over along the slope cultivation followed by rest of the treatments.

- The maximum production efficiency for treatment T₆ was maximum *i.e.* 8.10 and 192.6 kg ha⁻¹ day⁻¹ and Rs. ha⁻¹ day⁻¹, respectively, followed by treatment T₅, T₄, T₃, T₂ and treatment T₁.

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