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Impact of tillage practices on crop growth and production in cotton under rainfed condition

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Abstract
The field experiment is laidout during rainy season of 2014-15 at Central Research Station (CRS) of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. To evalutate the impact of tillage practices on crop growth and production and economics in cotton. Layout of plots with six different treatments are Conservation tillage (1 blade harrow before sowing) (T_1), Conservation tillage (1 Tyne + 1 blade harrow) (T_2), Sub- surface tillage (90 cm H.I + 2 Tyne + blade harrow) (T_3). Economical sub-surface tillage (1 sub surface + 1 tyne + 1 blade harrow) (T_4), 1 Ploughing + 2 Tyne + 1 blade harrow (T_5), Across the slope cultivation with opening of BBF after two row + 2 tyne + 1 blade harrow (T_6). T3 (6.66q/ha) was more prominent and favorably influenced the growth, production and cost benefit ratio followed by T_4(6.31q/ha), T_6(5.83t/ha), T_5(5.47t/ha), T_2(5.22t/ha), T_1(4.70t/ha).It can be summarized that sub surface tillage is one of the easily adaptable tillage practice for better crop growth and production under rainfed condition.

Keywords: Conservation tillage, crop growth, yield, production

1. Introduction
Indian agriculture mostly depends upon the monsoon rains receiving during June to September. Water is crucial input for augmenting agricultural production towards sustainability. Water is most limiting natural source in arid and semiarid region. In most of the areas source of irrigation is rain water. The sustainability in the productivity of rainfed agriculture in India is frequently threatened by capricus monsoon creating vargaries in rainfall climatology. The hazard of monsoon vagaries frequently produces extreme weather regimes registering the negative impacts on farm productivity and adversely affects the farmer economy.

Soil and water are of our most precious natural resources. Proper soil management is a key to sustainable agricultural production. Soil management involves six essential practices: proper amount and type of tillage, maintenance of soil organic matter, maintenance of a proper nutrient supply for plants, avoidance of soil contamination, maintenance of the correct soil acidity, and control of soil loss (erosion). All of these practices depend on soil type, soil texture, and slope as well as on the crops that are grown.

Cotton is one of the most important fiber and cash crop of India and plays a dominant role in the industrial and agricultural economy of the country. It provides the basic raw material (cotton fibre) to cotton textile industry. Cotton in India provides direct livelihood to 6 million farmers and about 40 -50 million people are employed in cotton trade and its processing.

There are four cultivated species of cotton viz. *Gossypium arboreum*, *G. herbaceum*, *G. hirsutum* and *G. barbadense*. The first two species are diploid (2n=26) and are native to old world. They are also known as Asiatic cottons because they are grown in Asia. The last two species are tetraploid (2n=52) and are also referred to as New World Cottons. *G. hirsutum* is also known as American cotton or upland cotton and *G. barbadense* as Egyptian cotton or Sea Island cotton or Peruvian Cotton or Tanguish Cotton or quality cotton. *G. hirsutum* is the predominant species which alone contributes about 90% to the global production. Perhaps, India is the only country in the world where all the four cultivated species are grown on commercial scale.

2. Materials and methods
This experiment was conducted at the watershed located at Central Research Station (CRS) of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. Akola is located between 190 51', 21 016' N latitude, 56 0 38 and 770 44' E longitude and an altitude of 307.41 m above MSL. The slope of watershed is approximately 5% and having average slope of 1.6%. Soil type contributing to the field is clay, sandy, sandy loam and pasture land. The region experiences

sub-humid to humid conditions in monsoon season, semi-arid in winter season and arid in summer season. Rains are mostly received from South-West monsoon during June to October with mean annual precipitation of 750 mm.

The experimental design is randomized block design (RBD). The field of size 47 x 24.6 m was selected for experimental studies .The field was divided into six equal plots, each plot representing a single treatment. This single treatment was again divided into four plots of equal size (5.4x7m), and each plot representing a single replication. Likewise we have six treatments with each treatment having four replications randomly arranged. Cotton crop was cultivated during experimental period.

Table 1: Treatment details

Sr.no	Treatment	Description of treatment	Size(m x m)	Area(ha)
1	T_1	Conservation tillage (1 blade harrow before sowing)	5.4x7	0.0037
2	T_2	Conservation tillage (1 tyne + 1 blade harrow)	5.4x7	0.0037
3	T_3	Sub- surface tillage (90 cm H.I + 2 tyne + blade harrow)	5.4x7	0.0037
4	T_4	Economical sub-surface tillage (1 sub surface + 1 tyne +1 blade harrow)	5.4x7	0.0037
5	T_5	1 ploughing + 2 tyne +1 blade harrow	5.4x7	0.0037
6	T_6	Across the slope cultivation with opening of BBF after two row + 2 tyne + 1 blade harrow	5.4x7	0.0037

Cotton (*Gossypium arborium*) was sown on 8th august 2014 at 30 × 45 cm spacing one picking was done on 16th December 2014 with 154 days crop duration.

2.1 Biometric observation

Monthly replication wise biometric observations were recorded for each treatment. Five plants were selected for observations from 5.4m × 7m size of main treated plot. This treatment wise biometric observations viz. height of plant, number of bolls and number of branches were recorded.

2.2 Economics and Cost Analysis

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

1. Net return = Gross Monetary return − Cost of cultivation
2. Benefit Cost Ratio = (Gross monetary returns) / (Cost of cultivation)
3. Production efficiency (kg $ha^{-1}day^{-1}$) = $\frac{\text{Yield of Cotton(kgha}^{-1})}{\text{Crop duration(days)}}$
4. Production efficiency (Rs $ha^{-1}day^{-1}$) = $\frac{\text{Net returns(Rs/ha)}}{\text{crop durations(days)}}$

2.3 Productivity

During the season, treatment and picking wise yield of the Cotton crop was recorded from the plot of size 5.4 m × 7 m selected earlier for recording the biometric observations.

3. Results and discussion

3.1 Biometric Observations

The Biometric observations of the cotton crop involve the plant height, number of branches and number of bolls developed. These show the impact and response of the tillage practices and moisture conservation measures on the growth and yield of the cotton crop. The observations were recorded from the date of sowing to the date of harvesting with the interval of 30 days.

Table 2: Impact of tillage practices on plant height

Treatment	30 DAS	60 DAS	90 DAS	120 DAS	At harvest
T1	7.900	27.25	37.9	41.25	41.35
T2	8.063	27.52	38.27	41.75	42.17
T3	8.750	28.82	39.92	43.97	44.45
T4	8.550	28.5	39.42	43.3	43.62
T5	8.225	27.85	38.65	42.37	42.6
T6	8.363	28.17	39.05	42.87	43.15
F-test	Sig.	Sig.	Sig.	Sig.	Sig.
S.E	0.03	0.08	0.083	0.094	0.14
CD at 5%	0.1	0.24	0.25	0.28	0.42
CV (%)	0.79	0.57	0.42	0.44	0.65

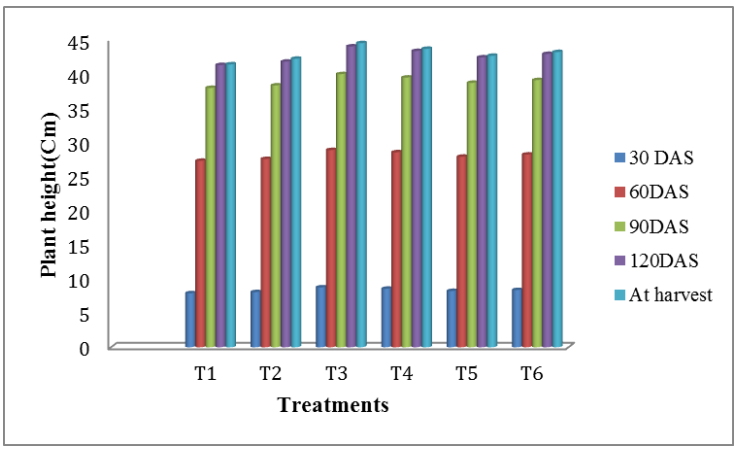

Fig 1: Impact of tillage practices on plant height (cm)

3.2 Impact of tillage practices on number of branches

Figure 1. shows the impact of tillage practices on the number of branches at the harvest for the different land treatments. From the data it was revealed that the average number of branches of the cotton crop was highly influenced by the treatment T_3 (2.9) followed by treatment T_4 (2.7) over the treatment T_6 (2.5), T_5 (2.2), T_2 (1.9) and T_1 (1.5) at harvest. Minimum number of branches were found in treatment T_1 (1.5) than the treatment T_3, T_4, T_5, T_6, T_2. Treatment T_3 was more effective followed by treatment T_4, T_5, T_6, T_2 over T_1.

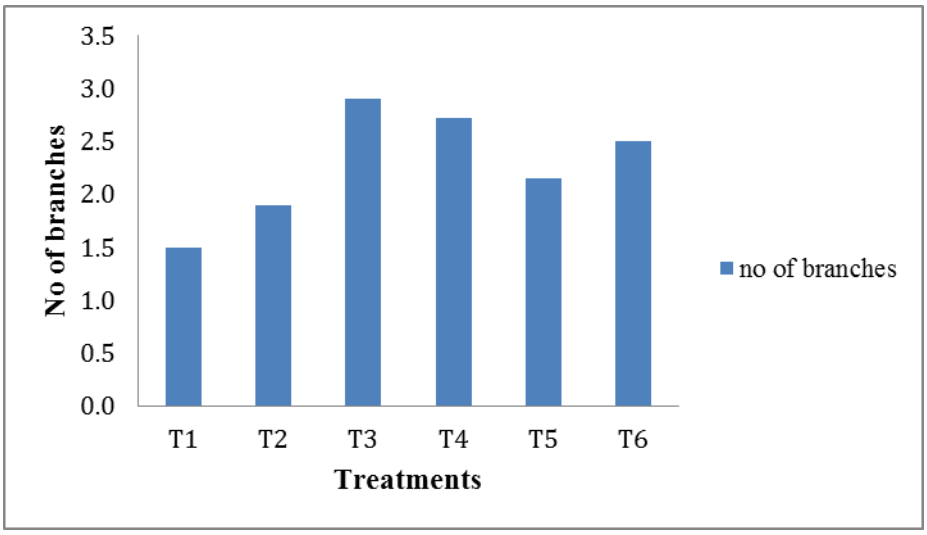

Fig 2: Impact of tillage practices on number of branches

3.3 Growth and yield of cotton (AKH-081)

Table 3 shows the impact of different tillage practices on crop growth, rooting depth and yield of cotton. One picking was carried out replication wise picking was done on 16th December 2014. The total yield from the plot of 5.4 m ×7m long of each treatment was taken into consideration to know the impact of tillage practices on seed cotton yield.

Seed cotton yield was calculated per hectare and is presented in table 3. It revealed that the treatment T_3 showed the maximum seed cotton yield (6.7q ha^{-1}) followed by treatment T_4 (6.31 q ha^{-1}), treatment T_6 (5.83 q ha^{-1}), T_5 (5.47 q ha^{-1}), T_2 (5.22 q ha^{-1}) and T_1 (4.7 q ha^{-1}). Treatment T_3 showed the highest percentage increase in cotton yield (41 %) followed by treatment T_4 (34 %), T_6 (23%), T_5 (16%), T_2 (10%) over treatment T_1.

Table 3: Impact of tillage practices on crop yield

Treatment	Root length	Seed cotton Yield (gms)	Seed cotton Yield (q/ha)
T1	30.46	177.75	4.703
T2	31.02	197.5	5.22
T3	33.92	252	6.66
T4	32.45	238.5	6.31
T5	31.3	207	5.47
T6	31.87	220.5	5.83
F-test	S	S	S
CD at 5%	0.32	11.85	0.31
CV (%)	0.66	3.65	3.64

3.4 Impact of tillage practices on productivity and production efficiency

Table 4 shows the impact of tillage practices on productivity and production efficiency of each treatment. The treatment (T_3) i.e. Sub- surface tillage (90 cm H.I+2 Tyne+ blade harrow) showed the maximum yield of cotton of (666 kg ha^{-1}) followed by the treatment (T_4) Economical sub-surface tillage (1 sub surface +1 tyne+1 blade harrow) (631 kg ha^{-1}), treatment (T_6) Across the slope cultivation with opening of BBF after two row+2 tyne +1 blade harrow (583 kg ha^{1}), treatment (T_5) 1 Ploughing + 2 Tyne +1 blade harrow (547 kg ha^{1}), treatment (T_2) Conservation tillage (1 tyne+1 blade harrow) (522 kg ha^{1}) and treatment (T_1) Conservation tillage (1 blade harrow before sowing)showed the minimum yield of 470 kg ha^{-1}. Production efficiency was calculated for each treatment in which the treatment T_3 showed the highest production efficiency (4.32 kg $ha^{-1}day^{-1}$) followed by treatment T_4 (4.09 kg ha^{-1} day^{-1}), T6(3.78 kg ha^{-1} day^{-1}), T5(3.55 kg ha^{-1} day^{-1}), T2(3.38 kg ha^{-1} day^{-1}) and treatment T_1 (3.05 kg $ha^{-1}day^{-1}$). The production efficiency in terms of Rs ha^{-1} day^{-1} was also calculated in which the treatment T_3 showed the maximum efficiency of 244 Rs ha $^{-1}$day $^{-1}$ and was found superior to other two treatments T_4, T_6, T_5, T_2 and T_1.

Table 4: Impact of tillage practices on productivity and production efficiency

Treatment	Yield of cotton (kgha^{-1})	Duration of crop (Days)	Production efficiency	
			(kg ha $^{-1}$day $^{-1}$)	(Rs ha $^{-1}$day $^{-1}$)
T_1	470	154	3.05	236
T_2	522	154	3.38	238
T_3	666	154	4.32	244
T_4	631	154	4.09	242
T_5	547	154	3.55	238
T_6	583	154	3.78	240

3.5. Yield and Economics

The yield and cost of cultivation for each treatment was calculated and presented in table 5. Table 5 shows the cost of cultivation and grain yield returns. From the table it is revealed that the expenditure of Rs. 37520 Sub- surface tillage (90 cm H.I+2 tyne+ blade harrow) (T_3), while Rs. 37200 was incurred on the Economical sub-surface tillage (1 sub surface +1 tyne+1 blade harrow) (T_4) while Rs. 36900 was invested on Across the slope cultivation with opening of BBF after two row+2 tyne+1 blade harrow (T_6) while Rs.36700 was invested on1 ploughing+ 2 tyne +1 blade harrow (T_5) while Rs.36600 was invested on Conservation tillage (1 tyne+1 blade harrow) (T_2) while Rs.36300 was invested on Conservation tillage (1 blade harrow before sowing) (T_1). Due to delayed mansoon the short duration variety of cotton (AKH-081) was sown late on 8Th august 2015.and further due to uneven distribution of rainfall with dry spells crop could not establish satisfactory which resulted into the drastic in yields which accrued the losses.

Table 5: Impact of tillage practices on Cotton yield, monetary returns

Treatment	Cotton Yield (q/ha)	Grain Yield Returns (Rs)	Cost of Cultivation (Rs)
T_1	4.7	19740	36300
T_2	5.2	21840	36600
T_3	6.7	28140	37520
T_4	6.3	26460	37200
T_5	5.5	23100	36700
T_6	5.8	24360	36900

4. Conclusions

Biometric observations such as higher mean plant height (44.45 cm), number of branches plant^{-1} (2.9), picked bolls plant (1.97), seed cotton yield per plot (0.252kg), seed cotton yield (6.67 q ha^{-1}) and average depth of root (33.43 cm) was observed in T_3 followed by T_4, T_5,T_6,T_2 and minimum in T_1.Treatment (T_3) of tillage practice had maximum cost of cultivation 37520 Rs followed by treatment T_4, T_5, T_6, T_2 and treatment T_1. The production efficiency was maximum for treatment T_3 Sub-surface tillage (90 cm H.I+2 Tyne+ blade harrow) i.e. 4.32 kg ha^{-1}day^{-1}and 244 Rs ha^{-1}day^{-1} followed by treatment T_4 (4.09 kg ha^{-1}day^{-1} and 242 Rs ha^{-1}day^{-1}), T_5(3.55 kg ha^{-1}day^{-1} and 238 Rs ha^{-1}day^{-1}), T_6(3.78 kg ha^{-1}day^{-1} and 240 Rs ha^{-1}day^{-1}), T_2(3.38 kg ha^{-1}day^{-1} and 238 Rs ha^{-1}day^{-1}) and treatment T_1(3.05 kg ha^{-1}day^{-1} and 236 Rs ha^{-1}day^{-1}).

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