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RESEARCH ARTICLE :

Leaf area index and yield of cotton -maize cropping systems influence by tillage and land configuration

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SUMMARY : : A field experiment with differenttillage practices and land configurations in cotton - maize cropping systems was conducted at TNAU, Coimbatoreduring 2011-12 and 2012-13. Totally there were 8 treatments which were replicated thrice in a Randomized Block Design.The treatments consisted of three tillage practices *viz.*, conventional tillage, reduced tillageand zero tillage and three types of land configurations *viz.*, flat bed and furrow irrigated raised bed (FIRB) which were compared with the existing practice of ridges and furrows. The result of two cropping cycles revealed that the growth parameters and seed cotton yield of cotton were higher in the reduced tillage to both cotton and maize and planting on FIRB which was on par with conventional tillage to both cotton and maize and planting on ridges and furrows (existing practice as check), conventional tillage to both cotton and maize and planting on FIRB, reduced tillage to both cotton and maize and planting on FIRB and reduced tillage once to cotton alone and planting on FIRB. In maize, better growth, improved yield parameters and higher yield were recorded in the reduced tillage to both cotton and maize and planting on FIRB.The lowest yield of cotton and maize was recorded in the zero tillage to both the crops and planting on flat bed. In the cotton-maize system, cotton equivalent yield (CEY) was almost similar in reduced tillage to both cotton and maize and planting on FIRB (4784 kg/ha), existing practice of conventional tillage to both cotton and maize and planting in ridges and furrows (4755 kg/ha) and conventional tillage to cotton alone and planting both cotton and maize on the FIRB (4750 kg/ha).

KEY WORDS :
FIRB, Flat bed, Conventional tillage, Minimum tillage, Zero tillage

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BACKGROUND AND OBJECTIVES

Cotton (*Gossypium hirsutum* L.), the king of fibre crops, is being the most important commercial crop of India (117.73 lakh ha with a production of 365.1 lakh bales of lint and productivity of 496.39 kg ha^{-1} in 2012-13) contributes to around 80% of the raw material to the textile industry and provides employment to nearly 60 million people. Maize (*Zea mays* L.) is the third most important cereal crop next to rice and wheat in India and also a predominant cereal in global agricultural economy. It is used both as food for human and feed for livestock especially in poultry industry. It has got immense yield potential and is therefore called as "miracle crop" and also "queen of cereals". Cotton-

maize sequence is one of the most remunerative systems with high productivity levels. Both cotton and maize, with different rooting pattern responds to tillage differently. According to several reports conventional agriculture mainly characterized by intensive tillage has contributed to soil degradation through loss of organic matter, soil erosion and compaction. This has led to negative effects on soil, water and air qualities, global climate, wildlife and biodiversity. Poor soil tilth lowers the infiltration and percolation rates, nutrient movement and free air transport within the soil profile and the contribution of soil fertility to crop growth is hampered. Conservation agriculture has wide range of benefits including improvement in soil fertility, reduction in soil erosion, carbon accumulation, savings in time and energy (fuel), and increase in biodiversity (Reicosky and Saxton, 2007).In this context, conservation agriculture practices which include no-tillage, reduced tillage/ minimum tillage are being focused in recent times. The minimum tillage not only helps to suppress germination and growth of weeds but also increase water use efficiency and provides saving of labour and fuel. The use of herbicides combined with minimum tillage will helps to reduce the cost of cultivation and thereby resulting in increased returns. Adoption of appropriate land configuration to crops results in better crop and water productivity, besides good weed management. In this context an experiment was conducted during 2011-2013 to study the impact of tillage and land configuration on the growth parameter of cotton and maize and productivity of the cotton - maize cropping systems.

RESOURCES AND METHODS

Field experiments were conducted during winter and summer seasons of 2011-12 and 2012-13 at Tamil Nadu Agricultural University, Coimbatore to study the influence of tillage and land configuration on the growth, productivity and economics of cotton - maize cropping systems. The experiment with cotton - maize (NK 6240) cropping system was laid out in a Randomized Block Design with eight treatments replicated thrice. The treatment combinations were, T_1: Conventional tillage to both cotton and maize and planting on flat bed, T_2: Conventional tillage to both cotton and maize and planting on furrow irrigated raised bed (FIRB), T_3: Conventional tillage once to cotton alone and planting on FIRB, T_4: Reduced tillage to both cotton and maize and planting on flat bed, T_5: Reduced tillage to both cotton and maize and planting on FIRB, T_6: Reduced tillage once to cotton alone and planting on FIRB, T_7: Zero tillage and planting on flat bed and T_8: Conventional tillage to both cotton and maize and planting on ridges and furrows (existing practice as check). The soil of the experimental site was sandy loam in texture. The soil was alkaline and has low to medium soluble salt content and low in available N (224 kg/ha), medium in available P (15 kg/ha) and high in available K (450 kg/ha).Cotton hybrid (Bunny Bt.) with duration of about 160-170 days was raised during winter irrigated season (August to February) and maize hybrid (NK 6240) of 100-105 days duration was grown during March- June.

For cotton crop, after marking plots, in the conventional method of tillage and ridges and furrows, two ploughings with five tyne duck foot cultivator and then two ploughing with 11 tyne cultivator followed by one rotavator ploughing were given. In the reduced tillage system, one ploughing with five tyne duck foot cultivator, one 11 tyne cultivator followed by one rotavator were provided. Totally five ploughings were given in the conventional tillage and three ploughings in the reduced tillage system. In zero tillage, there was no mechanical disturbance to the soil. Only herbicides were used to control weeds in the zero tillage plots and treatments received tillage (either conventional tillage or reduced tillage) only once *i.e.*, cotton alone. After ploughing operations, individual plots were thrown into flatbeds, FIRB and ridges and furrows as per the treatment structure. In FIRB, raised beds of 105 cm to a height of 15 cm were formed with furrow width of 30 cm. Flat beds were formed with a bullock drawn bund former to the required size and beds were levelled manually. By engaging tractor drawn ridge plough, ridges were formed 90 cm apart. Delinted Bt bunny seeds with a seed rate of 1.5 kg ha^{-1} were dibbled at the rate of one seed per hill with a spacing of 90 x 60 cm. Refuge seeds were planted along the border plots (outs) all around the experimental field. Recommended fertilizer dose of 150: 75: 75 kg NPK ha^{-1} was applied for hybrid cotton (Bt bunny).First irrigation was given immediately after sowing followed by life saving irrigation on third day. Based on the soil moisture condition and rainfall, subsequent irrigations were scheduled at 10-15 days interval.

After the harvest of the first crop cotton, without disturbing the layout, the field was prepared as per treatment schedule and the second crop maize was raised.

As done for cotton, in conventional method of tillage totally five ploughings, two five tyne cultivator, two 11 tyne cultivator followed by one ratavator ploughing were given. Three ploughings (one five tyne duck foot cultivator, one 11 tyne cultivators followed by one ratavator) were adopted in reduced tillage system. In T_3 and T_6, where tillage was restricted to only once in the sequence *i.e.*, cotton alone and in zero tillage plots, there was no mechanical disturbance to the soil. The weeds present in the plots were controlled with total herbicide Glyphosate after the harvest of cotton. Before sowing maize, weeds present, if any, were removed and the flat beds/ FIRB were rectified manually. Maize hybrid NK 6240 with seed rate of 15kg ha^{-1} was adopted and one seed per hill was dibbled at spacing of 60 cm between rows and 25 cm within the row.The recommended fertilizer dose of 150: 75: 75 kg NPK ha^{-1} was applied to maize (NK 6240). All the recommended package of practices we the important bio metric observations on growth and yield parameters were recorded. The seed cotton (kapas)from the fully opened bolls was harvested from the net plot area. The kapas obtained from each harvest was weighed and the yield of all pickings were added and expressed as kg ha^{-1}. The cotton stalk in the net plot area were cut, sun dried and the weight was recorded in kg ha^{-1}. In the case of maize, the cobs from the net plot area were harvested, sheaths removed and the grains were shelled. The kernel weight of each treatment was recorded at 14 per cent moisture and expressed in kg ha^{-1}. Stover yield was recorded after sun drying for three days in the field and expressed in kg ha^{-1}. The data collected were analysed statistically and results presented.

OBSERVATIONS AND ANALYSIS

The results obtained from the present study as well as discussions have been summarized under following heads:

Leaf area index and yield of cotton :

The growth parameters like leaf area index (LAI) in cotton were significantly influenced by the different tillage and land configuration methods. The cotton LAI at 90 DAS was significantly higher in the conventional tillage to both cotton and maize and planting on furrow irrigated raised bed during 2011-12 and 2012-13(Table 1). The lower LAI was recorded in the zero tillage with flat planting.

Seed cotton (kapas) and stalk yield were significantly influenced by tillage practices with different land configuration during 2011-12 and 2012-13. Reduced tillage to both cotton and maize and planting on FIRB registered higher cotton yield of 2887 kg/ha which was statistically on par with conventional tillage to both cotton

Table 1: Effect of tillage and land configuration on leaf area index of cotton

Treatments	Leaf area index					
	2011-12			2012-13		
	45 DAS	90 DAS	120 DAS	45 DAS	90 DAS	120 DAS
T_1	0.61	2.15	2.68	0.21	1.83	2.54
T_2	0.86	2.89	3.16	0.30	2.33	3.24
T_3	0.88	2.75	3.43	0.32	2.11	3.54
T_4	0.63	2.05	2.99	0.21	1.72	2.82
T_5	0.91	2.78	3.54	0.35	2.04	3.91
T_6	0.83	2.66	3.06	0.32	2.06	3.41
T_7	0.61	1.88	2.62	0.19	1.69	2.36
T_8	0.89	2.72	3.49	0.34	2.11	3.72
S.E.±	0.06	0.24	0.23	0.02	0.13	0.26
C.D. (P=0.05)	0.12	0.50	0.49	0.05	0.27	0.54

T_1 : Conventional tillage (CT) to both cotton and maize and planting on flat bed
T_2 : CT to both cotton and maize and planting on furrow irrigated raised bed (FIRB)
T_3 : CT once to cotton alone and planning on permanent FIRB
T_4 : Reduced tillage (RT) to both cotton and maize and planting on flat bed
T_5 : RT to both cotton and maize and planting on FIRB
T_6 : RT once to cotton alone and planting on permanent FIRB
T_7 : Zero tillage and planting on flat bed
T_8 : CT to both cotton and maize and planting on ridges and furrows (existing farmers practice as check)

and maize and planting on ridges and furrows (2802 kg/ha), conventional tillage once to cotton alone and planting on FIRB (2746 kg/ha) and conventional tillage to both cotton and maize and planting on flat bed (2698 kg/ha) during the first year of experimentation (Table 3). The same trend was followed in the second year also. The higher plant density, growth parameters and yield parameters in the above treatments leads to the higher cotton kapas yield. Similar results were reported by Abaye *et al*. (1995) and Aydin *et al*. (2005). The cotton kapas yield was lesser when zero tillage or conventional tillage practices adopted with flat surface planting.

Leaf area index and yield of maize :

Tillage and land configuration had significantly influenced the growth, and yield in maize. The LAI at 60 DAS was significantly higher in the conventional tillage once to cotton alone and planting on FIRB during 2011-12 and in 2012-13, conventional tillage to both cotton and maize and planting on ridges and furrows registered higher LAI (Table 2).

Maize grain and straw yield were significantly influenced by tillage practices with different land configuration during 2011-12 and 2012-13. Conventional tillage once to cotton and planting on FIRB registered higher grain yield of 8084 kg/ha which was statistically on par with conventional tillage to both cotton and maize and planting on ridges and furrows (7794 kg/ha), conventional tillage to both cotton and maize and planting on flat bed (7687 kg/ha), and reduced tillage to both cotton and maize and planting on FIRB (7610 kg/ha) during 2011-12 (Table 3). Whereas in 2012-13, conventional tillage to both cotton and maize and planting on ridges and furrows registered higher grain yield of 6638 kg/ha followed by conventional tillage once to cotton and planting on FIRB(6558 kg/ha), reduced tillage to both

Table 2: Effect of tillage and land configuration on leaf area index of maize

Treatments	Leaf area index					
	2011-12			2012-13		
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
T_1	2.14	3.18	2.71	1.72	2.58	2.11
T_2	2.94	3.82	3.72	2.45	3.21	2.85
T_3	3.25	3.99	3.80	2.73	3.71	3.04
T_4	2.11	3.01	2.58	1.72	2.73	2.17
T_5	2.56	3.71	3.46	2.60	3.67	2.91
T_6	2.54	3.53	3.39	2.29	3.55	2.67
T_7	2.01	2.99	2.52	1.47	2.54	2.00
T_8	3.23	3.75	3.76	2.77	3.85	3.12
S.E.±	0.20	0.25	0.17	0.29	0.21	0.10
C.D.(P=0.05)	0.41	0.52	0.35	0.60	0.44	0.22

Table 3 : Effect of tillage and land configuration on yield of cotton, grain yield of maize and cotton equivalent yield

Treatments	Crop yield (kg ha^{-1})				Crop equivalent yield (kg ha^{-1})		
	2011-12		2012-13		2011-12	2012-13	Mean
	Kapas yield	Grain yield	Kapas yield	Grain yield	CEY	CEY	Mean CEY
T_1	2307	7419	2192	4966	4533	3627	4080
T_2	2698	7687	2248	6094	5004	4008	4506
T_3	2746	8084	2432	6558	5172	4327	4750
T_4	2424	6968	2205	5615	4514	3827	4171
T_5	2887	7610	2560	6360	5170	4397	4784
T_6	2546	7464	2326	5736	4785	3983	4384
T_7	2039	6631	1886	4928	4028	3310	3669
T_8	2802	7794	2451	6638	5141	4369	4755
S.E.±	107	362	95	265	195	115	155
C.D.(P=0.05)	224	757	202	554	407	240	324

cotton and maize and planting on FIRB (6360 kg/ha) and conventional tillage to both cotton and maize and planting on flat bed (6094 kg/ha). Similar results are reported by Marwat *et al*. (2007) and Allah Wasaya *et al*. (2011).The maize grain yield was lesser when zero tillage or conventional tillage practices adopted with flat surface planting.

Cotton equivalent yield (CEY) :

The maize grain yield was converted into equivalent yield of cotton and cotton equivalent yield (CEY) for the cotton - maize cropping systems was worked out. The CEY was significantly influenced by the tillage and land configuration practices during both the years of study. During 2011-12, conventional tillage once to cotton alone and planting on FIRB (5172 kg/ha) and reduced tillage to both cotton and maize and planting on FIRB (5170 kg/ha) registered identical higher CEY which was statistically on par with conventional tillage to both cotton and maize and planting on ridges and furrows (5141 kg/ha) and reduced tillage once to cotton alone and planting on FIRB (4785 kg/ha) (Table 3). During 2012-13, reduced tillage to both cotton and maize and planting on FIRB registered higher CEY of 4397 kg/ha and it was on par with conventional tillage to both cotton and maize and planting on ridges and furrows (4369 kg/ha) andRT once to cotton alone and planting on FIRB (4327 kg/ha). The lowest CEY was obtained in zero tillage with flat surface planting (4028 and 3310 kg/ha during 2011-12 and 2012-13). Average of the two years resulted that the CEY was almost similar in reduced tillage to both cotton and maize and planting on FIRB (4784 kg/ha), existing practice of conventional tillage to both cotton and maize, and planting in ridges and furrows (4755 kg/ha) and conventional tillage to cotton alone and planting both cotton and maize on the FIRB (4750 kg/ha).

Conclusion :

Conventional tillage once to cotton and planting on FIRB registered higher Leaf area Index, Kapas yield of cotton and grain yield of maize which was statistically on par with conventional tillage to both cotton and maize and planting on ridges and furrows, conventional tillage to both cotton and maize and planting on flat bed and reduced tillage to both cotton and maize and planting on FIRB. Hence, Leaf area index is to directly correlation between yields of the crop.

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