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Effect of Tillage and Nutrient Management on Growth, Seed Cotton Yield and Yield Contributing Characters

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Abstract *: The field experiment was carried outat the Research farm, Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola to study the "Effect of Integrated Nutrient Management on Soil Quality and Cotton Productivity under Different Tillage Practices in Vertisol" The treatments thus involved two main treatments and eight sub treatments. The experiment main plot comprises of two treatments i.e. conservation tillage (CNS) and (CNV). in which one harrowing and two weeding and in conventional tillage (CNV) one ploughing and one harrowing, two hoeing and two hand weeding operations were carried out in eight sub plot treatments of nutrient management. Plant height and dry matter accumulationis higher under conservation tillage as compared to conventional tillage under different growth stages. The seed cotton yield was slightly higher under conservation tillage as compared to conventional tillage and highest seed cotton yieldin conservation tillage (15.00 q ha^{-1}) over conventional tillage (13.07 q ha^{-1}). Highest seed cotton yield was recorded in the treatment receiving 100 % RDF (60 : 30 : 30 NPK kg ha^{-1}(15.57 q ha^{-1}) followed by 50% RDF + 50% N (FYM) (14.84 q ha^{-1}). Significantly highest bolls per plant in conservation tillage (19.95 bolls per plant) than in CNV (17.51 bolls per plant) while bolls per plant was recorded in the treatment receiving 100 % RDF (60 : 30 : 30 NPK kg ha^{-1} (20.38 bolls per plant) followed by 50% RDF + 50% N (FYM) (T_3) (19.47 bolls per plant).Significantly highest boll weight in CNS (3.82 g) and in CNV (3.77 g) whereas highest boll weight was recorded in the treatment receiving 100 % RDF (60 : 30 : 30 NPK kg ha^{-1} (3.86 g) followed by 50% RDF + 50% N (FYM) (3.85 g).*

Keywords *: Tillage, dry matter, seed cotton yield, nutrient management.*

INTRODUCTION

Cotton is one of the important cash as well as fibre crop and play vital role in the history and civilization of mankind, with enormous potential in textile industries and is a means of livelihood for millions of farmers and those concerned with its trade, processing, manufacturing and other allied industries. No agricultural commodity in the world exercised a profound influence on economy as cotton had done from the time immemorial. Therefore, it is popularly known as white gold. Cotton seed contains about 15-20 per cent oil and is used as vegetable oil and soap industries. After extraction of oil, the left over cake is proteinous and used as cattle feed. It is the king among the fibre crops, taking into consideration the economic impact it generates. Besides its vital role in national economy, its contribution in the foreign exchange is tremendous. Nearly one third of India's export earnings are from textile sectors of which cotton alone constitutes nearly 70 per cent of raw material.

Conservation agriculture aims at reversing the process of degradation inherent to the conventional agricultural practices like intensive cultivation and burning and/or removal of crop residues. Aggressive seed bed preparation with heavy machinery lead to declining soil fertility, biodiversity and erosion. The nutrient needs of the Indian agriculture are so large that no single plant nutrient source be it fertilizers, organic manures,

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green manures or biofertilizers is in position to meet the entire plant nutrient demand. Integrated plant nutrient management is an intelligent use of optimum combination of organic, inorganic and biological nutrient sources in specific crop, cropping system and climatic situation so as to achieve and sustain optimum yield and to improve or maintain physical, chemical, and biological properties of soil.Tillage is the mechanical manipulation of soil using implement by loosening it for good germination of seeds, plant growth which also help in soil and water conservation.

EFFECT OF TILLAGE AND NUTRIENT MANAGEMENT ON GROWTH AND SEED COTTON YIELD IN SEED

Plant Height

Data regarding the effect of nutrient management application in combination with inorganic fertilizers on plant height at square initiation, boll development and harvest stage are presented.

(a) Effect of tillage

The findings indicated that the plant height at square initiation stage ranged from 56.96 to 57.89, 77.81 to 78.74 and 52.81 to 53.74 cm during first year of study whereas in the second year it was ranged from 63.49 to 63.56, 83.41 to 84.34 and 58.41 to 59.34 cm in square initiation, boll development and harvest stage respectively. The pooled data indicated that 59.76 to 60.69, 80.61 to 81.54 and 55.61 to 56.54 cm during square initiation, boll development and harvest stage respectively. On examination of data, it could be noticed that the effect of tillage on plant height was found to be significant. This could be ascribed to the higher moisture uptake in the treatment of protective irrigation at critical growth stages which increased availability of plant nutrients and ultimately more growth of the crop. The findings are in accordance with the results reported by Sethi (1988) and Pettigrew (2004).

(b) Effect of nutrient management

The results indicated that the plant height at square initiation stage ranged from 50.85 to 63.08, 71.70 to 83.43 and 46.70 to 58.93 cm during first year of study whereas in the second year it was ranged from 56.45 to 68.08, 77.30 to 89.53 and 52.30 to 64.53 cm in square initiation, boll development and harvest stage respectively. The pooled data indicated that 53.65 to 65.88, 74.50 to 86.53 and 49.53 to 61.73 cm during square initiation, boll development and harvest stage respectively. On examination of data, it could be noticed that the effect of tillage on plant height was found to be significant. This could be ascribed to the higher nutrient uptake in the treatment which increased availability of plant nutrients and ultimately more growth of the crop. The findings are in accordance with the results reported by Sethi (1988) and Pettigrew (2004).

Dry Matter Accumulation

Data pertaining to the effect of tillage and nutrient management application in combination with inorganic fertilizers alone on dry matter accumulation per plant at square initiation, boll development and harvest stage are presented.

(a) Effect of tillage

The results indicated that the dry matter accumulation at square initiation stage ranged from 4.84 to 5.14, 15.00 to 16.00 and 8.17 to 8.94 g plant^{-1} during first year of study whereas in the second year it was ranged from 5.24 to 5.44, 16.99 to 16.01and 9.34 to 9.94 g plant $^{-1}$ in reproductive parts, leaves and stem respectively. As regards the dry matter accumulation at boll development stage varied from 60.29 to 61.04, 27.04 to 29.62 and 27.59 to 28.43 g plant $^{-1}$ during first year of study whereas in the second year it was ranged from 61.84 to 62.02, 29.62 to 30.62 and 30.02 to 30.86 g plant $^{-1}$ in reproductive parts, leaves and stem respectively.

The dry matter accumulation at harvest stage ranged from 32.33 to 32.89, 27.02 to 28.02 and 28.73 to 28.83 g plant^{-1} during first year of study whereas in the second year it was ranged from 35.66 to 35.86, 28.53 to 29.53 and 28.93 to 29.13 g plant^{-1} in reproductive parts, leaves and stem respectively. The dry matter accumulation during square initiation, boll development and harvest stage was influenced significantly during both the years of study. This can be ascribed to the immediate availability of readily assimilable form of dry matter accumulation in fertilizer treatment by plants, while in organic treatments dry matter accumulation availability is initially less due to immobilization

Table 1
Effect of tillage and nutrient management on plant height of cotton at various growth stages

	Plant height (cm)								
	Square initiation			*Boll development*			*Harvest*		
Treatments	*2011–12*	*2012–13*	*Pooled*	*2011–12*	*2012–13*	*Pooled*	*2011–12*	*2012–13*	*Pooled*
(a) Tillage									
Set I : Conservation tillage	57.89	63.49	60.69	78.74	84.34	81.54	79.26	85.99	83.20
Set II : Conventional tillage	56.96	62.56	59.76	77.81	83.41	80.61	78.12	84.28	82.37
SE (m) ±	0.33	0.35	0.33	0.40	0.43	0.42	0.44	0.46	0.43
CD at 5 %	0.98	1.03	0.99	1.19	1.25	1.23	1.24	1.33	1.19
(b) Nutrient management									
T_1 : 100% RDF (60:30:30 NPK kg ha^{-1})	63.08	68.68	65.88	83.93	89.53	86.73	86.29	92.14	89.73
T_2 :50% RDF + *In situ* GM (sunhemp)	50.85	56.45	53.65	71.70	77.30	74.50	74.45	80.10	77.49
T_3 : 50% RDF + 50% N (FYM)	61.67	67.27	64.47	82.52	88.12	85.32	85.21	91.75	88.91
T_4 : 50% RDF + 50% N (WS)	54.87	60.47	57.67	75.72	81.32	78.52	78.27	84.22	81.17
T_5 : 50% RDF + 50% N (GLM)	51.65	57.25	54.45	72.50	78.10	75.30	75.14	81.19	78.99
T_6 :50% RDF + 25%N (FYM) + 25% N (WS)	61.12	66.72	63.92	81.97	87.57	84.77	84.20	90.33	87.29
T_7 : 50% RDF + 25% N (FYM) + 25% N (GLM)	60.07	65.67	62.87	80.92	86.52	83.72	83.16	89.47	86.17
T_8 : 50% RDF + 25% N (WS) + 25% N (GLM)	56.08	61.68	58.88	76.93	82.53	79.73	82.17	85.39	82.87
SE (m) ±	0.67	0.69	0.67	0.80	0.85	0.83	0.82	0.87	0.85
CD at 5 %	2.05	2.09	2.05	2.35	2.45	2.40	2.41	2.53	2.38
(c) Interaction effect	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*

which is released subsequently, thereby, ensured availability throughout the growing period. The pooled data indicated that 5.04 to 5.29, 15.50 to 16.50 and 8.76 to 9.44 g plant^{-1} during square initiation stage of study whereas in the boll development stage it was ranged from 61.06 to 61.54, 28.33 to 30.12 and 28.79 to 29.90 g plant^{-1} and in the harvest stage it was ranged 34.00 to 34.38, 27.78 to 28.78 and 28.83 to 28.98 g plant^{-1} in reproductive parts, leaves and stem respectively.The favourable results has been reported by several workers including Moursi *et al.* (1978), Sethi (1988) and Pettigrew (2004).

(b) Effect of nutrient management

The findings indicated that the dry matter accumulation at square initiation stage ranged from 4.62 to 5.55, 14.83 to 16.03 and 7.55 to 9.80 g plant^{-1} during first year of study whereas in the second year it was found to range from 4.97 to 5.90, 15.83 to 17.03 and 8.40 to 11.00 g plant^{-1} in reproductive parts, leaves and stem respectively. The dry matter accumulation at boll development stage varied from 59.89 to 61.31, 27.06 to 29.23 and 28.13 to 29.81 g plant^{-1} during first year of study whereas in the second year it was ranged from 61.28 to 62.50, 28.57 to 31.12 and 29.03 to 31.42 g g plant^{-1} in reproductive parts, leaves and stem respectively. The dry matter accumulation at harvest stage ranged from 30.05 to 35.41, 23.84 to 31.61 and 29.44 to 31.15 g plant^{-1} during first year of study whereas in the second year it was ranged from 34.23 to 36.59, 27.16 to 31.93 and 29.69 to 31.40 g plant^{-1} in reproductive parts, leaves and stem respectively. The dry matter accumulation during square initiation, boll development and harvest stage was influenced significantly during both the years of study. Highest dry matter

Table 2
Effect of tillage and nutrient management on dry matter accumulation in different plant parts of cotton at square initiation stage

	Dry matter accumulation (g $plant^{-1}$)								
	Reproductive parts			*Leaves*			*Stem*		
Treatments	*2011–12*	*2012–13*	*Pooled*	*2011–12*	*2012–13*	*Pooled*	*2011–12*	*2012–13*	*Pooled*
(a) *Tillage*									
Set I : Conservation tillage	5.14	5.44	5.29	16.00	16.99	16.50	8.94	9.94	9.44
Set II : Conventional tillage	4.84	5.24	5.04	15.00	16.01	15.50	8.17	9.34	8.76
SE (m) ±	0.08	0.10	0.09	0.03	0.05	0.04	0.13	0.14	0.16
CD at 5 %	0.24	0.30	0.27	0.09	0.15	0.12	0.39	0.42	0.47
(b) *Nutrient management*									
T_1 : 100% RDF (60:30:30 NPK kg ha^{-1})	5.55	5.90	5.73	16.03	17.02	16.53	9.80	11.00	10.40
T_2 :50% RDF + *In situ* GM (sunhemp)	4.62	4.97	4.79	14.83	15.84	15.33	7.55	8.40	7.98
T_3 : 50% RDF + 50% N (FYM)	5.12	5.47	5.29	16.00	17.01	16.50	9.27	10.50	9.88
T_4 : 50% RDF + 50% N (WS)	4.92	5.27	5.09	15.10	16.09	15.60	8.03	9.07	8.55
T_5 : 50% RDF + 50% N (GLM)	4.68	5.03	4.86	14.97	15.96	15.47	7.85	8.90	8.38
T_6 :50% RDF + 25%N (FYM) + 25% N (WS)	5.08	5.43	5.26	15.87	16.75	16.37	9.03	10.33	9.68
T_7 : 50% RDF + 25% N (FYM) + 25%N (GLM)	5.05	5.40	5.23	15.77	16.78	16.27	8.53	9.60	9.07
T_8 : 50% RDF + 25% N (WS) + 25% N (GLM)	4.92	5.27	5.09	15.43	16.44	15.93	8.38	9.33	8.86
SE (m) ±	0.17	0.20	0.18	0.05	0.09	0.08	0.26	0.28	0.27
CD at 5 %	0.51	0.60	0.54	0.15	0.27	0.24	0.77	0.84	0.80
(c) *Interaction effect*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*

accumulation was observed in the treatment of 100 per cent recommended dose of fertilizer (T_1) followed by 50 % N (FYM) + 50% RDF (T_3) and both these treatments were significantly superior over 50% RDF + In situ GM (sunhemp) (T_2) and these treatments were at par with the rest of the treatments of crop residues. Application of inorganic fertilizers (T_1) recorded higher dry matter accumulation than application of crop residues in combination with 50 per cent RDF in reproductive parts, leaves and stem during critical stages. This can be ascribed to the immediate availability of readily assimilable form of dry matter accumulation in fertilizer treatment by plants, while in organic treatments dry matter accumulation availability is initially less due to immobilization which is released subsequently, thereby, ensured availability throughout the growing period.

The pooled data indicated that 4.79 to 5.73, 15.33 to 16.53 and 7.98 to 10.40 g $plant^{-1}$during square initiation stage of study while in the boll development stage it was ranged from 60.59 to 61.91, 27.81 to 30.18 and 28.58 to 30.62 g $plant^{-1}$and in the harvest stage it was ranged 32.14 to 36.00, 25.50 to 31.77 and 29.57 to 31.28 g $plant^{-1}$ in reproductive parts, leaves and stem respectively. Dry matter accumulation per plant at square initiation influenced significantly and it ranged from 4.62 to 17.03 g per plant. Dry matter accumulation at boll development and harvest stage influenced statistically and varied from 27.06 to 62.50 and 23.84 to 36.59 g per plant during first and second years of experimentation. It could be noticed that dry matter accumulation per plant increased from square initiation to boll development stage. The findings are in close agreement with those reported by

Table 3
Effect of tillage and nutrient management on dry matter accumulation in different plant parts of cotton at boll development stage

	Dry matter accumulation (g plant^{-1})								
	Reproductive parts			*Leaves*			*Stem*		
Treatments	*2011–12*	*2012–13*	*Pooled*	*2011–12*	*2012–13*	*Pooled*	*2011–12*	*2012–13*	*Pooled*
(a) Tillage									
Set I : Conservation tillage	61.04	62.02	61.54	29.62	30.62	30.12	28.93	30.86	29.90
Set II : Conventional tillage	60.29	61.84	61.06	27.04	29.62	28.33	27.59	30.02	28.79
SE (m) ±	0.07	0.09	0.08	0.11	0.13	0.12	0.20	0.15	0.16
CD at 5 %	0.21	0.27	0.24	0.33	0.39	0.36	0.60	0.45	0.48
(b) Nutrient management									
T_1 : 100% RDF (60:30:30 NPK kg ha^{-1})	61.31	62.50	61.91	29.23	31.12	30.18	29.81	31.42	30.62
T_2 :50% RDF + *In situ* GM (sunhemp)	59.89	61.28	60.59	27.06	28.57	27.81	28.13	29.03	28.58
T_3 : 50% RDF + 50% N (FYM)	61.04	62.34	61.69	28.78	30.60	29.69	28.98	30.90	29.94
T_4 : 50% RDF + 50% N (WS)	60.63	61.85	61.24	28.26	29.93	29.10	27.30	30.23	28.77
T_5 : 50% RDF + 50% N (GLM)	60.10	61.29	60.70	27.70	29.67	28.68	28.28	29.97	29.12
T_6 :50% RDF + 25%N (FYM) + 25% N (WS)	60.86	62.22	61.54	28.74	30.55	29.64	28.59	30.85	29.72
T_7 : 50% RDF + 25% N (FYM) + 25% N (GLM)	60.82	62.18	61.50	28.44	30.27	29.35	27.63	30.57	29.10
T_8 : 50% RDF + 25% N (WS) + 25% N (GLM)	60.67	61.87	61.27	28.42	30.23	29.33	27.38	30.53	28.96
SE (m) ±	0.15	0.17	0.16	0.21	0.25	0.24	0.41	0.30	0.31
CD at 5 %	0.45	0.51	0.48	0.63	0.75	0.72	1.22	0.85	0.90
(c) Interaction effect	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*

Wankhade *et a*l. (2001), Babalad and Itnal (2004), Patil *et al.* (2004[b]), Bhalerao *et al.* (2007) and Katkar (2008).

SEED COTTON YIELD AND YIELD CONTRIBUTING CHARACTERS

Seed Cotton Yield

Data in respect of the effect of crop residues application in combination of with inorganic fertilizers on seed cotton yield are presented.

(a) Effect of tillage

Seed cotton yield was influenced significantly during both the seasons. The effect of tillage on seed cotton yield was found to be significant. However, in the first year slightly higher values of seed cotton yield (14.25 q ha^{-1}) were observed in conservation tillage as compared to conventional tillage (12.39 q ha^{-1}). In the second year higher values of seed cotton yield (15.00 q ha^{-1}) were observed in conservation tillage as compared to conventional tillage (13.07 q ha^{-1}). In pooled mean analysis higher values of seed cotton yield (14.63 q ha^{-1}) were observed in conservation tillage as compared to conventional tillage (12.73 q ha^{-1}). In Vertisols, the RT systems have been reported to yield equal to or better than the CT systems (Blaise *et al*., 2005; Constable *et al*., 1992; Hulugalle *et a*l., 2004).The findings are in conformity with the results reported by Kochetkov (1976), Moursi *et al.* (1978), Patil *et al.* (1977), Selvaraj and Palaniappan (1977), Sethi (1988), Deshmukh and Dahatonde (1999), Sarode *et al*. (2003), Ogunwole *et al*. (2003), Deshmukh *et al*. (2004), Patil *et al.* (2004[a]).

Table 4
Effect of tillage and nutrient management on dry matter accumulation in different plant parts of cotton at harvest stage

	Dry matter accumulation (g $plant^{-1}$)								
	Reproductive parts			*Leaves*			*Stem*		
Treatments	*2011–12*	*2012–13*	*Pooled*	*2011–12*	*2012–13*	*Pooled*	*2011–12*	*2012–13*	*Pooled*
(a) Tillage									
Set I : Conservation tillage	32.89	35.86	34.38	28.02	29.53	28.78	28.83	29.13	28.98
Set II : Conventional tillage	32.33	35.66	34.00	27.02	28.53	27.78	28.73	28.93	28.83
SE (m) ±	0.33	0.10	0.20	0.48	0.31	0.39	0.35	0.40	0.37
CD at 5 %	0.99	0.30	0.60	1.44	0.93	1.17	1.04	1.20	1.11
(b) Nutrient management									
T_1 : 100% RDF (60:30:30 NPK kg ha^{-1})	35.41	36.59	36.00	31.61	31.93	31.77	31.15	31.40	31.28
T_2 :50% RDF + *In situ* GM (sunhemp)	30.05	34.23	32.14	23.84	27.16	25.50	29.44	29.69	29.57
T_3 : 50% RDF + 50% N (FYM)	33.96	36.05	35.00	29.50	30.82	30.16	29.85	30.10	29.98
T_4 : 50% RDF + 50% N (WS)	31.90	35.70	33.80	26.49	27.81	27.15	26.84	27.09	26.97
T_5 : 50% RDF + 50% N (GLM)	31.76	35.69	33.73	26.29	27.61	26.95	29.47	29.72	29.60
T_6 :50% RDF + 25%N (FYM) + 25% N (WS)	33.45	35.99	34.72	28.75	30.07	29.41	29.10	29.35	29.23
T_7 : 50% RDF + 25% N (FYM) + 25% N (GLM)	32.32	35.97	34.14	27.06	28.88	27.97	27.41	27.66	27.54
T_8 : 50% RDF + 25% N (WS) + 25% N (GLM)	32.02	35.90	33.96	26.63	27.95	27.29	26.98	27.23	27.11
SE (m) ±	0.65	0.20	0.60	0.96	0.62	0.78	0.69	0.80	0.75
CD at 5 %	1.96	0.60	1.75	2.87	1.86	2.36	2.08	2.40	2.25
(c) Interaction effect	NS	NS	NS	NS	NS	NS	NS	NS	NS

(b) Effect of nutrient management

The seed cotton yield content varied from 11.45 to 14.82, 11.93 to 15.57 and 11.69 to 15.20 q ha^{-1} during first year, second year and pooled mean respectively. Seed cotton yield was influenced significantly due to integrated nutrient management. In the first year seed cotton yield (14.82 q ha^{-1}) was found significantly higher in the treatment of 100% RDF (60 : 30 : 30 NPK kg ha^{-1}) followed by, 50% N through FYM + 50% RDF(14.09 q ha^{-1}) and 50%RDF+25%N (FYM)+ 25% N (WS) (13.85 q ha^{-1}) which were found to be at par with each other. In the second year seed cotton yield (15.57 q ha^{-1}) was found significantly higher in the treatment of 100% RDF (60 : 30 : 30 NPK kg ha^{-1}) followed by, 50% N through FYM + 50% RDF(14.84 q ha^{-1}) , 50% RDF + 25% N (WS) + 25% N (GLM) (14.60 q ha^{-1}), which were found to be at par with each others. The lowest seed cotton yield (11.93 q ha^{-1}) was recorded in treatment 50% RDF + In situ GM (sunhemp). In the pooled mean data seed cotton yield (15.20 q ha^{-1}) was found significantly higher in the treatment of 100% RDF (60 : 30 : 30 NPK kg ha^{-1}) followed by, 50% N through FYM + 50% RDF(14.47 q ha^{-1}) and 50%RDF+25%N (FYM)+ 25% N (WS) (14.11 q ha^{-1}) these treatment were found to be at par with each others.

The lowest Seed cotton yield (11.69 q ha^{-1}) was recorded in treatment 50% RDF + In situ GM (sunhemp). This could be ascribed to the effect of applied fertilizer and mineralization of organic sources or through solublization of the nutrients from the native sources during the process of decomposition. The interaction of conservation tillage with FYM was found most beneficial and recorded highest yield of cotton.This can be attributed to the combined effect of conservation tillage in improving soil properties along with FYM

Table 5
Effect of tillage and nutrient management on seed cotton yield

	Seed cotton yield (q ha^{-1})		
Treatments	*2011-12*	*2012-13*	*Mean*
(a) Tillage			
Set I : Conservation tillage	14.25	15.00	14.63
Set II : Conventional tillage	12.39	13.07	12.73
SE (m) ±	0.31	0.34	0.32
CD at 5 %	0.90	1.01	0.95
(b) Nutrient management			
T_1 : 100% RDF (60 : 30 : 30 NPK kg ha^{-1})	14.82	15.57	15.20
T_2 : 50% RDF + *In situ* GM (sunhemp)	11.45	11.93	11.69
T_3 : 50% RDF + 50% N (FYM)	14.09	14.84	14.47
T_4 : 50% RDF + 50% N (WS)	13.30	14.25	13.78
T_5 : 50% RDF + 50% N (GLM)	11.94	12.69	12.32
T_6 : 50% RDF + 25%N (FYM) + 25% N (WS)	13.85	14.36	14.11
T_7 : 50% RDF + 25% N (FYM) + 25% N (GLM)	13.61	14.6	14.10
T_8 : 50% RDF + 25% N (WS) + 25% N (GLM)	13.50	14.05	13.79
SE (m) ±	0.62	0.68	0.65
CD at 5 %	1.85	2.02	1.92
(c) *Interaction effect*	*Sig*	*Sig*	*Sig*

resulting into highest yield of cotton. The conservation tillage along with glyricidia green leaf manuring also recorded yields which whereat par with FYM which also signifies the importance of conservation tillage with organics.This could be attributed to the intercrop competition with the cotton crop for moisture and nutrients availability throughout the crop growing period. Similar results were observed by Sethi (1988). The findings are in conformity with the results reported by Kochetkov (1976), Moursi *et al.* (1978), Patil *et al.* (1977), Selvaraj and Palaniappan (1977), Sethi (1988), Deshmukh and Dahatonde (1999), Sarode *et al.* (2003), Ogunwole *et a*l. (2003), Deshmukh *et al.* (2004), Patil *et al.* (2004[a]). This may be ascribed to the improvement in the soil physical, chemical and biological properties due to the incorporation of organics along with 50 per cent recommended dose of fertilizers which might have hastened the nutrient availability as well as better soil condition for root penetration. The results are in close agreement with the findings reported by Subramanian *et al.* (2000), Basavanneppa and Biradar (2002), Babalad and Itnal (2004), Hulihalli and Patil (2004), Halemani *et al.* (2004[a]), Halemani *et al.* (2004[b]), Hongal *et al.* (2004), Praharaj *et al.* (2004[b]) and Hulihalli and Patil (2006[a]). Similar findings were reported by Sethi (1988).

YIELD CONTRIBUTING CHARACTERS

Bolls Per Plant

The data regarding the effect of tillage and nutrient management in combination with inorganic fertilizers on bolls per plant are presented.

(a) Effect of tillage

Data indicated that bolls per plant were significantly influenced with tillage during both the years of experimentation. Bolls per plant was influenced significantly during both the seasons. The effect of tillage on bolls per plant was found to be significant. However, in the first year slightly higher of bolls per plant (15.50 bolls per plant) were recorded in conservation tillage as compared to conventional tillage (13.57 bolls per plant). In the second year higher values of bolls per plant (19.95 bolls per plant) were observed in conservation tillage as compared to conventional tillage (17.51 bolls per plant). In pooled mean analysis higher values of bolls per plant (17.71 bolls per plant) were observed in conservation tillage as compared to conventional tillage (15.53 bolls per plant).

Total harvestable boll numbers were significantly affected by tillage systems, differences between treatments were not significant treatment Reduced tillage produced 62.3 bolls and was significantly greater than the number of bolls produced on the CT plots 58.9 bolls Significantly higher bolls produced on the RT plots were observed in an earlier study with the upland cotton (Blaise and Ravindran, 2003). The treatment of organics recorded significantly higher bolls per plant during both the seasons of study. The pooled data also revealed that reduced tillage increased the bolls per plant beneficial forrainfed condition. This can be ascribed to the higher availability of moisture in the treatment at critical growth stages which also increased the availability of plant nutrients in the soil. The findings are in consonance with the results reported by Sethi (1988), Deshmukh and Dahatonde (1999), Deshmukh *et al.* (2004), Patil *et al.* (2004[a]), Pettigrew (2004) and Hulihalli and Patil (2006[b]).

(b) Effect of nutrient management

The bolls per plant were significantly influenced during both the years of investigation. It is evident from the results that number of bolls varied from 12.43 to 16.07 and 16.87 to 20.38 during first and second year respectively. The pooled observed to be varied from 14.62 to 18.20 bolls per plant. Bolls per plant was influenced significantly due to integrated nutrient management. In the first year bolls per plant (16.07 bolls per plant) was found significantly higher in the treatment of 100% RDF (60 : 30 : 30 NPK kg ha^{-1}) followed by, 50% N through FYM + 50% RDF(15.34 bolls per plant) and 50% RDF + 25%N (FYM) + 25% N (WS) (15.10 bolls per plant) these treatment were found to be at par with each others.

The lowest Bolls per plant (12.43 bolls per plant) was recorded in treatment 50% RDF + In situ GM (sunhemp). In the second year bolls per plant (20.38bolls per plant) was found significantly higher in the treatment of 100% RDF (60 : 30 : 30 NPK kg ha^{-1}) followed by, 50% N through FYM + 50% RDF (19.47 bolls per plant) , 50% RDF + 25% N (WS) + 25% N (GLM) (19.41 bolls per plant), which were found to be at par with each others. The lowest bolls per plant (16.87 bolls per plant) was recorded in treatment 50% RDF + In situ GM (sunhemp). In the pooled mean data bolls per plant (18.20 bolls per plant) was found significantly higher in the treatment of 100% RDF (60 : 30 : 30 NPK kg ha^{-1}) followed by, 50% N through FYM + 50% RDF(17.39bolls per plant) and 50%RDF+25% N (FYM)+ 25% N (WS) (17.24bolls per plant). The lowest bolls per plant (14.62bolls per plant) was recorded in treatment 50% RDF + In situ GM (sunhemp). This could be attributed to the effect of applied fertilizer and mineralization of organic sources or through solublization of the nutrients from the native sources during the process of decomposition. Sethi (1988) also reported the similar findings.

Table 6
Effect of tillage and nutrient management on number of bolls

Treatments	*No. of bolls/plant* 2011-12	2012-13	Pooled
(a) Tillage			
Set I : Conservation tillage	15.50	19.95	17.71
Set II : Conventional tillage	13.57	17.51	15.53
SE (m) ±	0.33	0.35	0.34
CD at 5 %	0.98	1.04	1.02
(b) Nutrient management			
T_1 : 100% RDF (60 : 30 : 30 NPK kg ha^{-1})	16.07	20.38	18.20
T_2 : 50% RDF + *In situ* GM (sunhemp)	12.43	16.87	14.62
T_3 : 50% RDF + 50% N (FYM)	15.34	19.47	17.39
T_4 : 50% RDF + 50% N (WS)	14.55	19.13	16.83
T_5 : 50% RDF + 50% N (GLM)	13.19	17.63	15.40
T_6: 50% RDF + 25%N (FYM) + 25% N (WS)	15.10	19.41	17.24
T_7: 50% RDF + 25% N (FYM) + 25% N (GLM)	14.86	19.37	17.11
T_8: 50% RDF + 25% N (WS) + 25% N (GLM)	14.75	19.21	16.97
SE (m) ±	0.65	0.70	0.68
CD at 5 %	1.95	2.08	2.03
(c) Interaction effect	*Sig*	*Sig*	*Sig*

This can be justified further in view of readily available nutrients at RDF during the first year of experimentation and efficient nitrogen use. However wheat straw did not record desirable results due to its wider C : N ratio. The results of present investigation on number of bolls per plant are in conformity with the findings by Awasya *et al.* (2006), Bhalerao *et al.* (2007) and Mehta *et al.* (2009).

Weight Per Boll

The data pertaining to the effect of crop residues incorporation in combination with inorganic fertilizers on weight per boll along with pooled results are presented in Table 7.

(a) Effect of tillage

The boll weight was non significant influenced by tillage during both the years of experimentation. However, in the first year, slightly higher values of bolls per plant (3.69 g per boll) were observed in conservation tillage as compared to conventional tillage (3.68 g per boll).

In the second year higher values of bolls per plant (3.82 bolls per plant) were observed in conservation tillage as compared to conventional tillage (3.77 g per boll). In pooled mean data higher values of bolls per plant (3.75 g per boll) were observed in conservation tillage as compared to conventional tillage (3.72 g per boll). The findings corroborate with the results reported by Sethi (1988), Deshmukh and Dahatonde (1999), Patil *et al*. (2004[a]), Pettigrew (2004), Hulihalli and Patil (2006[b]).

Table 7
Effect of tillage and nutrient management on boll weight

	Boll weight (g)		
Treatments	*2011-12*	*2012-13*	*Pooled*
(a) Tillage			
Set I : Conservation tillage	3.69	3.82	3.75
Set II : Conventional tillage	3.68	3.77	3.72
SE (m) ±	0.0035	0.0091	0.0073
CD at 5 %	NS	NS	NS
(b) Nutrient management			
T_1 : 100% RDF (60 : 30 : 30 NPK kg ha^{-1})	3.74	3.86	3.8
T_2 : 50% RDF + *In situ* GM (sunhemp)	3.64	3.75	3.7
T_3 : 50% RDF + 50% N (FYM)	3.69	3.85	3.77
T_4 : 50% RDF + 50% N (WS)	3.68	3.78	3.73
T_5 : 50% RDF + 50% N (GLM)	3.66	3.76	3.71
T_6 : 50% RDF + 25%N (FYM) + 25% N (WS)	3.69	3.82	3.75
T_7 : 50% RDF + 25% N (FYM) + 25% N (GLM)	3.69	3.79	3.74
T_8 : 50% RDF + 25% N (WS) + 25% N (GLM)	3.67	3.79	3.73
SE (m) ±	0.038	0.040	0.030
CD at 5 %	NS	NS	NS
(c) Interaction effect	*NS*	*NS*	*NS*

(b) Effect of nutrient management

The weight per boll was significantly influenced during both the years of investigation including pooled results and ranged from 2.67 to 2.95, 2.83 to 3.17 2.75 to 3.06 g per boll respectively. During first year of study, data indicated that, treatment of 100% RDF (60 : 30 : 30 NPK kg ha^{-1}) (3.74 g per boll) (T_1) followed by, 50% N through FYM + 50% RDF (T_3) recorded significantly higher boll weight over 50% RDF + In situ GM (sunhemp) and at par with all other treatments itwas followed by 50% RDF + 25%N (FYM) + 25% N (WS) (T_6) (3.69 g per boll). The boll weight during second year was found higher in treatment of 100% RDF (60 : 30 : 30 NPK kg ha^{-1}) followed by 50% RDF + 50% N (FYM) (T_3) (3.86 g per boll) followed by 50% RDF + 25%N (FYM) + 25% N (WS) (T_6) (3.82 g per boll). The pooled results showed that, 100% RDF (60 : 30 : 30 NPK kg ha^{-1}) followed by 50% RDF + 50% N (FYM) (T_3) recorded significantly higher boll weight over 50% RDF + In situ GM (sunhemp) and at par with all other treatments. The findings are in agreement with the results reported by Basavanneppa and Biradar (2002), Halemani *et al.* (2004[b]), Hongal *et al.* (2004), Hulihalli and Patil (2006[a]) and Bhalerao *et al.* (2007).

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