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Research Article

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Effect of tillage and nutrient management on seed cotton yield and nutrient content of cotton

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Summary

The field experiment was conducted to study the effect of integrated nutrient management on soil quality and cotton productivity under different tillage practices in vertisol at the Research Farm, Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola.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. The seed cotton yield was slightly higher under conservation tillage as compared to conventional tillage. 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}). The macronutrient content was noticed higher in conservation tillage as compared to conventional tillage at square, boll development and harvest stage. The content of N, P and K was observed higher in reproductive parts than that of leaves and stem. Further, it was also observed that the N, P and K content decreased from square initiation to boll development stage in reproductive parts, leaves and stem as the age of the cotton advances towards maturity. The nitrogen content pooled data indicated that 3.08 to 3.10, 2.78 to 2.79 and 1.77 to 1.80 per cent during square initiation stage of study whereas in the boll development stage it ranged from 2.18 to 2.20, 1.88 to 1.89 and 1.37 to 1.40 per cent and in the harvest stage it ranged 1.54 to 1.56, 1.28 to 1.29 and 1.11 to 1.14 per cent in reproductive parts, leaves and stem, respectively.

Key words : Tillage, Nutrient management, Nutrient content, Yield

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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. Cotton seed contains about 15-20 per cent oil and is used as vegetable oil and soap 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. Area under cotton across the world has been sluggish for the past few year; however, production has been increased due to sharp rise in yield. China, India, USA and Pakistan are the major cotton producing countries in the world with share

of 70 per cent each of the world cotton production and area, respectively. India is the largest cotton growing country in the world with an area under cotton around 34 per cent (12.20 m ha) followed by China (5.5 m ha). China and India are the major cotton consuming countries in the world (around 58% of the world cotton consumption).

The stagnation in the production and productivity of different crops for the last few years has become a matter of concern and is posing a serious threat to our national food security. Soil health degradation has emerged as a major factor responsible for stagnation in agricultural production. The degradation of soil health in many cultivated areas is manifested in terms of loss of soil organic matter, depletion of native soil fertility due to imbalanced and unscientific use of fertilizer which is now one of the major constraints in improving crop productivity. In view of the declining soil fertility and reduction in crop productivity the resource conservation becomes a top priority and restoration of precious soil resource by way of innovative means of management is the need of the day.

Resource and Research Methods

The field experiment was carried out to study the effect of integrated nutrient management on soil quality and cotton productivity under different tillage practices in Vertisol on the Research Farm of Department of Soil Science and Agricultural Chemistry, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during 2011-12 and 2012-13. Akola is situated in between 22^0 41' N latitude and 77^0 02' longitudes at an altitude of 307.4 m above mean sea level and has a subtropical climate. The climate is characterized by three distinct seasons *viz.*, summer becoming hot and dry from March to May. The two seperate experiment each in conservation and conventional tillage were conducted on same site and hence, randomization with similar set of nutrient management treatments. In conservation tillage one harrowing and two weeding operations were carried every year. In conventional tillage one ploughing, one harrowing, two hoeing and two hand weeding operations were carried out every year.

Nutrient management treatments
T_1 : 100% RDF (60:30:30 NPK kg ha^{-1})
T_2 : 50% RDF + In situ green manuring (sunhemp)
T_3 : 50% RDF + 50% N (FYM)
T_4 : 50% RDF + 50% N (wheatstraw)
T_5 : 50% RDF + 50% N (GLM)
T_6 : 50% RDF + 25% N (FYM) + 25%N (wheat straw)
T_7 : 50% RDF + 25% N (FYM) + 25%N (GLM)
T_8 : 50% RDF + 25% N (wheat straw) + 25%N (GLM)
Different treatments consisted of balance use of chemical fertilizer along with organic source of nutrient in which 50 per cent N applied through chemical fertilizer and remaining N was applied through various sources like FYM, crop residues (wheat straw) and green manuring (sunhemp). The quantity of P and K supplied through different organics, green manuring and crop residues, the compensation remaining P and K compensated through chemical fertilizers.

Research Findings and Discussion

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Seed cotton yield :

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

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}) (Table 1). In Vertisols, the RT systems have been reported to yield equal to or better than the CT systems (Blaise *et al*., 2005 and Constable *et al*., 1992). 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) and Patil *et al*. (2004) Table 1.

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) (Table 1). 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 resulting into highest yield of cotton. The conservation tillage along with glyricidia green leaf manuring also recorded yields which were at 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 al*. (2003); Deshmukh *et al*. (2004) and Patil *et al.* (2004). 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*.(2004a and b); Hongal *et al*.(2004); Praharaj *et al*. (2004) and Hulihalli and Patil (2006). Similar findings were reported by Sethi (1988).

Table 1: Effect of tillage and nutrient management on seed cotton yield

Treatments	Seed cotton yield (q ha^{-1})		
Tillage	2011-12	2012-13	Mean
Set I :Conservation tillage	14.25	15.00	14.63
Set II :Conventional tillage	12.39	13.07	12.73
S.E.±	0.31	0.34	0.32
C.D. (P=0.05)	0.90	1.01	0.95
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
S.E.±	0.62	0.68	0.65
C.D. (P=0.05)	1.85	2.02	1.92
Interaction effect	Sig.	Sig.	Sig.

Macronutrient content:

Nitrogen:

The data on nitrogen content in cotton at square initiation, boll development and harvest stages are reported.

Effect of tillage:

The results indicated that the nitrogen content at square initiation stage ranged from 3.06 to 3.08, 2.76 to 2.78 and 1.76 to 1.78 per cent during first year of study whereas in the second year it ranged from 3.09 to 3.11, 2.80 to 2.81 and 1.77 to 1.81 per cent in reproductive parts, leaves and stem, respectively (Table 2). As regards the nitrogen content at boll development stage varied from 2.16 to 2.18, 1.86 to 1.88 and 1.36 to 1.38 per cent during first year of study whereas in the second year it ranged from 2.19 to 2.21, 1.90 to 1.91 and 1.37 to 1.41 per cent in reproductive parts, leaves and stem, respectively (Table 3). Whereas the nitrogen content at harvest stage ranged from 1.53 to 1.55, 1.26 to 1.28 and 0.95 to 0.98 per cent during first year of study whereas in the second year it ranged from 1.56 to 1.58, 1.30 to 1.31 and 1.27 to 1.30 per cent in reproductive parts, leaves and stem, respectively (Table 4). The content of nitrogen during square initiation, boll development and harvest stage was influenced significantly during both the years of study. The pooled data indicated that 3.08 to 3.10, 2.78 to 2.79 and 1.77 to 1.80 per cent during square initiation stage of study whereas in the boll development stage it was ranged from 2.18 to 2.20, 1.88 to 1.89 and 1.37 to 1.40 per cent and in the harvest stage it ranged 1.54 to 1.56, 1.28 to 1.29 and 1.11 to 1.14 per cent in reproductive parts, leaves and stem, respectively (Table 2,3 and 4).

The content of N was noticed higher in conservation tillage as compared to conventional tillage at square, boll development and harvest stage. The content of N was observed higher in reproductive parts than that of leaves and stem. Further, it was also observed that the N content decreased from square initiation to boll development stage in reproductive parts, leaves and stem as the age of the cotton advances towards maturity. This may be attributed to the dilution effect of the cellulosic fibre which is known to be very poor in nitrogen. The decline in the concentration of N after flowering stage may be due to heavy accumulation in floral parts and developing bolls of the cotton plant. These findings are in close proximity with the results reported by Khare *et al*. (1970); Thompson *et al*. (1976); Sharma *et al*. (1993); Taneja *et al*. (1997) and Wankhade *et al*. (1997b). Higher nitrogen content was observed in reproductive parts followed by

Table 2: Effect of tillage and nutrient management on nitrogen content in different plant parts of cotton at square initiation stage

Treatments	Nitrogen content (%)								
Tillage	Reproductive parts			Leaves			Stem		
	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled
Set I : Conservation tillage	3.08	3.11	3.10	2.78	2.81	2.79	1.78	1.81	1.80
Set II : Conventional tillage	3.06	3.09	3.08	2.76	2.80	2.78	1.76	1.77	1.77
S.E. ±	0.002	0.005	0.004	0.003	0.005	0.006	0.005	0.006	0.007
C.D. (P=0.05)	0.006	0.015	0.012	0.006	0.015	0.018	0.014	0.017	0.021
Nutrient management									
T_1 : 100% RDF (60:30:30 NPK kg ha^{-1})	3.11	3.14	3.13	2.81	2.84	2.82	1.81	1.83	1.82
T_2 :50% RDF + *In situ* GM (sunhemp)	3.03	3.06	3.05	2.73	2.76	2.74	1.73	1.75	1.74
T_3 : 50% RDF + 50% N (FYM)	3.10	3.13	3.12	2.80	2.83	2.81	1.80	1.82	1.81
T_4 : 50% RDF + 50% N (WS)	3.05	3.08	3.07	2.75	2.78	2.76	1.75	1.77	1.76
T_5 : 50% RDF + 50% N (GLM)	3.04	3.07	3.06	2.74	2.77	2.75	1.74	1.76	1.75
T_6 :50% RDF + 25%N (FYM) + 25% N (WS)	3.09	3.12	3.11	2.79	2.82	2.80	1.79	1.81	1.80
T_7 : 50% RDF+25% N (FYM)+25% N (GLM)	3.08	3.11	3.10	2.78	2.81	2.79	1.78	1.80	1.79
T_8 : 50% RDF+25% N (WS) + 25% N (GLM)	3.07	3.10	3.09	2.77	2.80	2.78	1.77	1.79	1.78
S.E. ±	0.004	0.010	0.009	0.007	0.009	0.011	0.010	0.012	0.014
C.D. (P=0.05)	0.012	0.029	0.026	0.020	0.026	0.032	0.027	0.035	0.039
Interaction effect	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS= Non-significant

leaves and stem.

Effect of nutrient management :

The results indicated that the nitrogen content at square initiation stage ranged from 3.03 to 3.11, 2.73 to 2.81 and 1.73 to 1.81 per cent during first year of study whereas in the second year it ranged from, 3.06 to 3.14,2.76 to 2.84 and 1.75 to 1.83 per cent in reproductive parts, leaves and stem, respectively (Table 2).

As regards the nitrogen content at boll development stage varied from 2.13 to 2.21, 1.83 to 1.91 and 1.33 to 1.41 per cent during first year of study whereas in the second year it ranged from, 2.16 to 2.24, 1.86 to 1.94 and 1.35 to 1.43 per cent in reproductive parts, leaves and stem, respectively (Table 3). The nitrogen content at harvest stage ranged from 1.44 to 1.62, 1.23 to 1.31 and 0.92 to 1.01 per cent during first year of study while in the second year it ranged from, 1.47 to 1.65, 1.26 to 1.34 and 1.25 to 1.33 per cent in reproductive parts, leaves and stem, respectively (Table 4). The content of nitrogen during square initiation, boll development and harvest stage was influenced significantly during both the years of study. Highest content of N 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 N content 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 nitrogen in fertilizer treatment by plants, while in organic treatments N availability is initially less due to immobilization which is released subsequently, thereby, ensured availability throughout the growing period.

The pooled data indicated that 3.05 to 3.13, 2.74 to 2.82 and 1.74 to 1.82 per cent during square initiation stage of study whereas in the boll development stage it ranged from 2.15 to 2.23, 1.84 to 1.92 and 1.34 to 1.42 per cent and in the harvest stage it ranged1.45 to 1.64, 1.24 to 1.32 and 1.09 to 1.17 per cent in reproductive parts, leaves and stem, respectively.

The content of nitrogen 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 nitrogen in fertilizer treatment by plants, while in organic treatments N availability is initially less which is released subsequently, thereby, ensured availability

Table 3 : Effect of tillage and nutrient management on nitrogen content in different plant parts of cotton at boll development stage

Treatments	Nitrogen content (%)								
Tillage	Reproductive parts			Leaves			Stem		
	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled
Set I : Conservation tillage	2.18	2.21	2.20	1.88	1.91	1.89	1.38	1.41	1.40
Set II : Conventional tillage	2.16	2.19	2.18	1.86	1.90	1.88	1.36	1.37	1.37
S.E.±	0.003	0.004	0.005	0.006	0.005	0.004	0.004	0.005	0.006
C.D. (P=0.05)	0.009	0.011	0.014	0.017	0.015	0.011	0.012	0.013	0.018
Nutrient management									
T_1 : 100% RDF (60:30:30 NPK kg ha^{-1})	2.21	2.24	2.23	1.91	1.94	1.92	1.41	1.43	1.42
T_2 :50% RDF + *In situ* GM (sunhemp)	2.13	2.16	2.15	1.83	1.86	1.84	1.33	1.35	1.34
T_3 : 50% RDF + 50% N (FYM)	2.20	2.23	2.22	1.90	1.93	1.91	1.40	1.42	1.41
T_4 : 50% RDF + 50% N (WS)	2.15	2.18	2.17	1.85	1.88	1.86	1.35	1.37	1.36
T_5 : 50% RDF + 50% N (GLM)	2.14	2.17	2.16	1.84	1.87	1.85	1.34	1.36	1.35
T_6 :50% RDF + 25%N (FYM) + 25% N (WS)	2.19	2.22	2.21	1.89	1.92	1.90	1.39	1.41	1.40
T_7 : 50% RDF+25% N (FYM) + 25% N (GLM)	2.18	2.21	2.20	1.88	1.91	1.89	1.38	1.40	1.39
T_8 : 50% RDF + 25% N (WS) + 25% N (GLM)	2.17	2.20	2.19	1.87	1.90	1.88	1.37	1.39	1.38
S.E.±	0.007	0.008	0.009	0.010	0.009	0.008	0.007	0.009	0.010
C.D. (P=0.05)	0.020	0.024	0.027	0.029	0.026	0.022	0.021	0.027	0.028
Interaction effect	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS= Non-significant

throughout the growing period. These findings are in close proximity with the results reported by Wankhade *et al.* (1997a) and Mehata *et al.* (2009). The 50% RDF + *in situ* GM (sunhemp) recorded lowest N content at all the growth stages. In general, similar trends were also noticed in boll development and harvest stages during both years. Further more, it was also observed that the concentration of N decreased from square initiation to boll development stage as the age of crop advances to maturity reported by Katkar (2008).

It was observed that the nitrogen concentration decreased from square initiation to boll development and harvest stage as the age of cotton advances towards the maturity. This may be attributed to dilution effect of the cellulosic fibre which is known to be very poor in nitrogen (Khare *et al.*,1970). The sudden fall in the nitrogen concentration in cotton plant from square initiation to boll development indicates a greater need of nitrogen during this period which is the peak period of cotton growth and development. The nitrogen concentration at the fertilizer levels under study appears to be adequate even at lower fertilizer dose and it is higher than the optimum concentration of nitrogen (2.20-4.50 %) reported in cotton by Kalra (1998). The decline in the concentration of nitrogen after square initiation stage may be due to heavy accumulation in floral parts and developing bolls of cotton plants. This results consonance with finding reported by Thompson *et al.* (1976).Wankhade *et al.* (1997a) reported that the nitrogen concentration at square initiation stage ranged from 2.80 to 2.78 per cent which further decreased at boll development (1.64%) and harvest (1.27 %). It has been reported that deficiency of nutrients, high temperature during day coupled with low temperature at nights, water stress or water logging are the factors attributed to reddening in plants. During boll development stage the nitrogen concentration in plant in the present study was reduced. The demand for assimilate by the developing bolls was high and Bt cotton crop was heavily laden with developing bolls at this stage. Plants were not able to meet the demands of nitrogen from reduced N levels in plant at this stage. This affects uptake of Mg from soil by the plant leading to N induced deficiency in plants. Both these treatments were significantly superior over 50% RDF + *in situ* GM (sunhemp) and these treatments were at par with the rest of the treatments of organics. Application of 100 % RDF (60:30:30 NPK kg ha^{-1}) (T_1) followed by FYM in combination with 50 per cent RDF inorganic fertilizers (T_3) recorded higher N content than in reproductive parts, leaves and stem during critical stages. This can be ascribed to the immediate availability of readily assimilable form of nitrogen in fertilizer treatment by plants, while in

Table 4 : Effect of tillage and nutrient management on nitrogen content in different plant parts of cotton at harvest stage

Treatments	Nitrogen content (%)								
Tillage	Reproductive parts			Leaves			Stem		
	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled
Set I : Conservation tillage	1.55	1.58	1.56	1.28	1.31	1.29	0.98	1.30	1.14
Set II : Conventional tillage	1.53	1.56	1.54	1.26	1.30	1.28	0.95	1.27	1.11
S.E.±	0.001	0.002	0.002	0.001	0.002	0.001	0.004	0.004	0.003
C.D. (P=0.05)	0.002	0.004	0.006	0.003	0.006	0.004	0.011	0.013	0.009
Nutrient management									
T_1 : 100% RDF (60:30:30 NPK kg ha^{-1})	1.62	1.65	1.64	1.31	1.34	1.32	1.01	1.33	1.17
T_2 :50% RDF + *In situ* GM (sunhemp)	1.44	1.47	1.45	1.23	1.26	1.24	0.92	1.25	1.09
T_3 : 50% RDF + 50% N (FYM)	1.59	1.62	1.60	1.30	1.33	1.31	0.99	1.32	1.16
T_4 : 50% RDF + 50% N (WS)	1.50	1.53	1.52	1.25	1.28	1.26	0.95	1.27	1.11
T_5 : 50% RDF + 50% N (GLM)	1.50	1.53	1.52	1.24	1.27	1.25	0.93	1.26	1.10
T_6 :50% RDF + 25%N (FYM) + 25% N (WS)	1.57	1.60	1.58	1.29	1.32	1.30	0.98	1.31	1.15
T_7 : 50% RDF + 25% N (FYM) + 25% N (GLM)	1.56	1.59	1.57	1.28	1.31	1.29	0.97	1.30	1.14
T_8 : 50% RDF + 25% N (WS) + 25% N (GLM)	1.52	1.55	1.53	1.27	1.30	1.28	0.96	1.29	1.12
S.E.±	0.01	0.02	0.03	0.004	0.003	0.002	0.009	0.008	0.005
C.D. (P=0.05)	0.03	0.04	0.05	0.010	0.009	0.006	0.025	0.024	0.015
Interaction effect	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS= Non-significant

organic treatments N availability is initially less due to immobilization which is released subsequently, thereby, ensured availability throughout the growing period. The lowest N content was observed in 50% RDF + *in situ* GM (sunhemp).The content of N was observed higher in reproductive parts than that of leaves and stem. Further, it was also observed that the N content decreased from square initiation to boll development stage in reproductive parts, leaves and stem as the age of the cotton advances towards maturity. This may be attributed to the dilution effect of the cellulosic fibre which is known to be very poor in nitrogen.

Interaction effect:

Interaction effect of tillage and nutrient management was found non-significant.

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