

Effect of Two Types of Tillage and N-Fertilization on Cotton Root Biomass in the Water Shed of Ouri-Yori (Municipality Of Materi)

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Abstract

Management of soil fertility in particular of the tropical degraded ferruginous soils is a key factor for attaining potential crop yield. An experiment was conducted to investigate the effect of different systems of tillage and nitrogen fertilizer on root biomass of cotton (*Gossypium hirsutum*), plant height and leaf area index. The experiment was laid out in a split plot design with tillage systems [conventional tillage (CT) and reduced tillage (RT)], fertilizer rates (0; 60 and 120 Kg N/ha) and mulching [Crop mulching (M) and no mulching (NM)]. Our results showed that at 30, 60 and 120 days after sowing, tillage systems had a significant effect ($P < 0.001$; $P < 0.01$ and $P < 0.05$) on cotton root biomass at 0 - 10 cm; 10 - 20 cm and 30 - 40 cm depth. A significant effect of tillage system was also recorded on plant height at 21, 42 and 63 days after sowing. The highest average plant height (121 ± 1.3 cm) was obtained with the conventional tillage. However, tillage system did not show a significant ($P > 0.05$) effect on the leaf area index. The effect of nitrogen fertilizer was significant ($P < 0.01$ and $P < 0.05$) on root biomass at 90 and 120 days after sowing. The interaction between tillage system and nitrogen fertilization dose significantly ($P < 0.01$ and $P < 0.001$) affected the root biomass. However, the highest number of roots (15.453 ± 3.23 g/plant), plant height and leaf area index was recorded in the conventional tillage with the fertilizer rate of 120 kg N/ha. In addition, tillage system and nitrogen fertilization had a significant effect on the date of flowering of cotton plants. It can be concluded from the study that CT and nitrogen fertilizer boosted root growth, leaf area index and plant height of cotton.

Keywords: Soil tillage, nitrogen fertilizer, tropical ferruginous soil, cotton roots

Résumé

La gestion de la fertilité des sols est une nécessité dans l'atteinte des rendements potentiels des cultures. La présente étude a eu pour but la détermination de l'effet combiné des différents types de travail du sol, du paillage et de la fertilisation azotée sur la biomasse racinaire du coton (*Gossypium hirsutum*), de l'indice de surface foliaire et de hauteur dans la perspective d'accroître la productivité de la plante. Le dispositif expérimental est un split plot avec pour facteurs principal, le système de travail du sol [labour conventionnel (LC) et labour réduit (RT)], et pour facteurs secondaires: la fertilisation azotée à des doses de (0; 60 et 120 kg N/ha) et le paillage [paillage (P) et sans paillage (SP)]. Nos résultats ont indiqué que les systèmes de labour ont été hautement significatifs ($P < 0,001$; $P < 0,01$ et $P < 0,05$) sur la production de biomasse racinaire à 0-10; 10-20 et 30 – 40 cm de profondeur du sol ceci à 30; 60 et 120 jours après semis (JAS). La croissance en

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hauteur des plants a également été significativement ($P < 0,001$ et $P < 0,01$) influencée par les techniques de travail du sol (à 21 ; 42 et 63 JAS). La plus forte valeur moyenne de la hauteur des plantes ($121,19 \pm 1,31$ cm) est obtenue dans le traitement LC. Cependant, les techniques de travail du sol ont eu un effet non significatif ($P > 0,05$) sur l'indice de la surface foliaire (ISF). L'effet de la fertilisation azotée a été significativement ($P < 0,01$ et $P < 0,05$) plus marqué sur la production de biomasse racinaire (à 0-10 ; 0 – 30 et 0 – 10 cm de profondeur du sol) ceci à 90 et 120 JAS, mais non significatif ($P > 0,05$) à 30 et 60 JAS. L'effet significatif ($P < 0,01$ et $P < 0,001$) de l'interaction n'apparaît sur la biomasse racinaire qu'à 90 et 120 JAS respectivement dans les profondeurs de prélèvement de 10 – 20 cm et 30 – 40 cm. En effet, le système de labour (LC) a produit significativement ($P < 0,05$) plus de biomasse des racines ($15,453 \pm 3,23$ g/plant) avec la dose 120 N kg/ha comparativement au système RT. Des effets similaires ont été observés sur la hauteur des plants et l'ISF. On peut conclure que le labour conventionnel et la fertilisation azotée améliorent la prolifération des racines et la hauteur des plants du cotonnier.

Mots clés : Fertilité du sol, fertilisation azoté, labour, biomasse racinaire, Coton, Bénin.

1. Introduction

Scenarios of climate change are of growing importance especially in agriculture. According to the predictions and the estimated effects developing nations are the most vulnerable to the manifestations of climate change. Recently, several authors have focused on different simplified cultivation techniques (SCT) with respect to tillage to mitigate these harmful impacts (Mrabet, 1993; Mrabet, 2001 and FAO, 2010).

Tillage is an ancient practice which one of the first objectives is to create a favorable environment for plant growth and root development (Klute, 1982; Chopart and Nicou, 1976 and Köller, 2003). Certainly, various definitions are assigned to plowing. According to Lal (1979, 1983), it is defined as the physical, chemical or biological soil handling in order to optimize the conditions for germination, establishment of the bed of seedlings and plants growth. Soil preparation can significantly change the nutritional status and the changes can be manifested by good or bad performance of crops.

Due to the degraded state of agricultural land in Benin, which extreme irregularities of climate added to, one of the problems that need to be solved for the operator would be the development of strategies that best contributed to promote their exploitation. Turning to these threats, many studies or research has been conducted in various soil and climatic conditions (Unger et al, 1991; Arshad, 1996; Gómez et al., 1999; Dercon et al., 2010a, 2010b). It was established positive correlations between total root weight and peanut yields, maize and sorghum (Chopart and Nicou 1989). Generally, the obtaining of optimal performance remains mixed regarding certain factors, such as land degradation, erratic rainfall and the adoption of new tillage practices.

To better understand the impacts of tillage patterns and nitrogen fertilization on the development of cotton root system, this research was initiated, especially in an increasingly important climate change context. It essentially aims to: (1) determine the effect of two types of tillage on root biomass production; (2) assess the levels of nitrogen in the amount of produced root and then, (3) determine the effect of the types of tillage and N-fertilization on the height and leaf area index (LAI) of cotton plants.

Materials and Methods

Area of study

The experimental site is located in the northwest of Benin ($10^{\circ}38' - 11^{\circ}4'$ North latitude and $0^{\circ}48' - 1^{\circ}10'$ East longitude). The average annual temperature hovers around $32,3^{\circ}\text{C}$ and average rainfall is 1000 mm/year. The experimental plots were installed during the 2013 crop year on a ferruginous tropical soil leached moderately deep. The plots were sown of cotton (*Gossypium hirsutum*) and covered by maize crop residues (*Zea mays*) from the previous year (2012).

Tillage system and root samples

Two tillage types were compared: Conventional Tillage (CT) and Reduced tillage (RT). Conventional tillage was performed using an imaltraction in the first fort night of May 2013 and reduced tillage has not undergone any form of tillage before cotton sowing (*Gossypium hirsutum*) to June 26/2013.

These plots (RT) were treated with the herbicide to a week of the sowing. Subplots size was 10 x 5 m² and experience was organized following the split plot design of six treatments with four repetitions. Four different depths of soil [0-10; 10-20; 20-30; 30-40 cm] were examined for the evaluation of the total root biomass (Nicou and Chopart, 1976) at various stages of plant development.

Nitrogen levels and mulching

Three nitrogen levels were also tested. N1 and N2 treatments represent respectively the average treatment rates (N1= 60 Kg/ha) and the high or N2 =120 Kg/ha followed by the witness treatment (N0 = 0 Kg/ ha). Maize crop residues of year 2012 were used for the mulching of subplots. The single mineral fertilizers used for fertilization plots were in the form of urea (46% N), triple superphosphate (46% P₂O₅) and potassium chloride (60% K₂O). Application of nitrogen was done in two identical fractions, the first fraction was made 20 days after sowing as well as all of P and K, the second half of nitrogen was applied 40 day's after sowing.

Table1: Characteristics of different applied fertilizer formulas

Nitrogen level (kg N/ha)	Nutrient in take (kg / ha)			Amount		
	N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O
0	0	60	40	0 (0)	300 (650)	200 (330)
60	60	60	40	300 (652)	300 (650)	200 (330)
120	120	60	40	600(1304)	300 (650)	200 (330)

Values in parenthesis is represent the amounts of urea, triple superphosphate and potassium chloride applied to each elementary field.

Statistical analysis

Data were subjected to ANOVA and mean values separated using Fisher's least significant difference test at P <0.05. The multiple comparison test was carried out with Fisher's least significant difference (LSD). All statistical analyzes different variables were performed by SAS 9.2 general linear model procedure.

Results and Discussion

Influence of the type's of tillage systems on cotton plants growth data

Root Biomass: The root biomass of the cotton plants for each type of tillage is shown in Table 3. At the end of the study, the analysis of variance showed significant differences in root biomass at the depth 0 – 10 to 30 cm this 30 DAS and depths 0 – 10 cm; 10 – 20 cm at 60 DAS (Table 2) between the different tillage treatments except for those obtained in periods of 90 and 120 days after sowing (DAS).

Indeed, the CT treatment has positively affected the root's production at 30 and 60 DAS compared to RT treatment (Table 3 and Table 2). Despite the insignificant effect tillage types on root biomass 90 and 120 DAS, CT treatment shows average values relatively greater than the RT process singonallexamined depths. In particular, the depth from 30 to 40 cm is provided in root biomass in the CT treatment and 12% greater than the RT processing one. This means that the cotton plants in the CT treatment have a high capacity to take water and basement nutrients elements what make them less susceptible to the vagaries of rainfall and climate change. These results are similar to Chopart, (1993) who observed adequate growth of the root system in the tilled plots in comparison with the untilled land Senegal. Carman and al. (1997); Wright and al. (2008) have noticed that the reduced tillage has lead to upper layers compaction and there by reduces the root development speed. According to Nelson (1974), incertain lowered plowing condition, counting of the soil becomes detrimental to the proliferation of roots. In addition, the root cotton production is closely influenced by the strength of the soil.

Table 2: Analysis of Variance Table to three factors (F-value) of the root biomass considering tillage, nitrogen fertilization and mulching.

Under Variation	dof	Fisher value															
		Root biomass (g / plant)															
		30 DAS				60 DAS				90 DAS				120 DAS			
		0-10	10-20	20-30	30-40	0-10	10-20	20-30	30-40	0-10	10-20	20-30	30-40	0-10	10-20	20-30	30-40
Tillage	1	41,40**	14,56**	11,97*	15,27**	0,97ns	2,06ns	0,32ns	1,12ns	1,10ns	0,77ns	0,50ns	6,29*	1,34ns			
Nitrogen	2	1,89ns	0,62ns	0,01ns	0,49ns	7,12**	2,83ns	0,04ns	7,86**	3,42*	0,95ns	1,57ns	0,29ns	2,97ns			
Mulching	1	0,01ns	0,95ns	0,51ns	0,98ns	0,43ns	8,64**	0,48ns	0,84ns	0,05ns	0,69ns	3,00ns	13,48**	0,43ns			
Tillage*Nitrogen	2	0,18ns	0,68ns	1,28ns	0,81ns	1,49ns	0,55ns	3,08ns	2,09ns	4,30*	5,23*	1,92ns	1,19ns	5,16*			
Tillage*Mulching	1	0,70ns	0,05ns	0,07ns	0,02ns	6,49*	2,88ns	0,04ns	6,95*	0,04ns	0,00ns	1,02ns	6,66*	0,09ns			
Nitrogen*Mulchi	2	0,79ns	0,06ns	0,22ns	0,05ns	0,14ns	1,32ns	0,71ns	0,03ns	0,57ns	0,96ns	0,98ns	0,18ns	0,70ns			
Tillage*Nitrogen	2	0,03ns	1,01ns	0,76ns	1,08ns	1,09ns	0,24ns	1,27ns	0,91ns	1,18ns	0,05ns	1,18ns	1,29ns	0,78ns			

dof : degree of freedom ; ns : P > 0,05 ; * : P < 0,05 ; ** : P < 0,01 ; *** : P < 0,001

Table 3: Evolution of the production of cotton plants root biomass based on tillage techniques

Number of days after sowing	Root biomass plant cotton (g / plant)		
	Depths (cm)	Conventional Tillage (CT)	Reduced Tillage (RT)
30	0-10	0,05±0,00a	0,02±0,00b
	0-10	0,81±0,07a	0,11±0,01a
60	10-20	0,45±0,00b	0,05±0,00b
	0-10	4,20±0,03a	3,85±0,23a
90	10-20	0,38±0,04a	0,31±0,03a
	20-30	0,18±0,01a	0,16±0,04a
120	0-10	8,05±0,98a	6,95±0,58a
	10-20	2,09±0,36a	1,74±0,21a
	20-30	0,47±0,10a	0,39±0,04a
	30-40	0,31±0,04a	0,19±0,01b

Values followed by the same alphabetical letter of the same character and the same factor are not significantly different ($P > 0.05$) according to the LSD test.

Height: Figure 1 shows the results of the effect of different types of tillage on the growth of the cotton plant height. ANOVA showed significant effect of tillage techniques on plant height, this to 21; 42; and 63 days after sowing (Table 4). The highest average heights are obtained in the CT treatment (11.98 cm; 32.13 cm; 67.89 cm) compared to treatment RT which indicated lower values (9.63 cm; 23.68 cm; 55.61 cm)

These results are similar to those of Kayode and Ademiluyi (2004) which observed low heights corn plants in the non-tilled plots compared with tilled plots in South-West of Nigeria. Khurshid et al. (2006) also achieved great heights of the plants in the conventional tillage system compared with tillage system reduces plots in Faisalabad in Pakistan. Aikins and Afuakwa (2010) also found the greatest heights of the Cowpea plants in tilled plots in comparison with non-tilled plots. Indeed, the combined effect of three factors (tillage types, soil mulching and nitrogen) was significant ($P < 0.05$) only in the first measurement (Table 4). Thus, it is obvious that different tillage methods play a key role in the growth and development of the cotton plants.

Table 4: Analysis of Variance Table to three factors (F-value) of the root biomass considering tillage, nitrogen fertilization and mulching

Fisher Value Under variation	dof	Height				
		21 DAS	42 DAS	63 DAS	84 DAS	115 DAS
		Tillage	1	66,27***	44,41***	11,64**
Nitrogen	2	1,28ns	1,71ns	2,93ns	7,84**	22,27***
Mulching	1	7,21*	5,91*	1,99ns	0,59ns	0,46ns
Tillage*Nitrogen	2	1,41ns	1,68ns	0,55ns	1,69ns	2,15ns
Tillage*Mulching	1	1,00ns	0,11ns	0,28ns	0,04ns	0,10ns
Nitrogen*Mulching	2	0,45ns	0,53ns	0,01ns	0,08ns	0,50ns
Tillage*Nitrogen*Mulching	2	4,23*	0,73ns	0,72ns	0,27ns	1,04ns

dof: degree of freedom ; ns : $P > 0,05$; * : $P < 0,05$; ** : $P < 0,01$; *** : $P < 0,001$

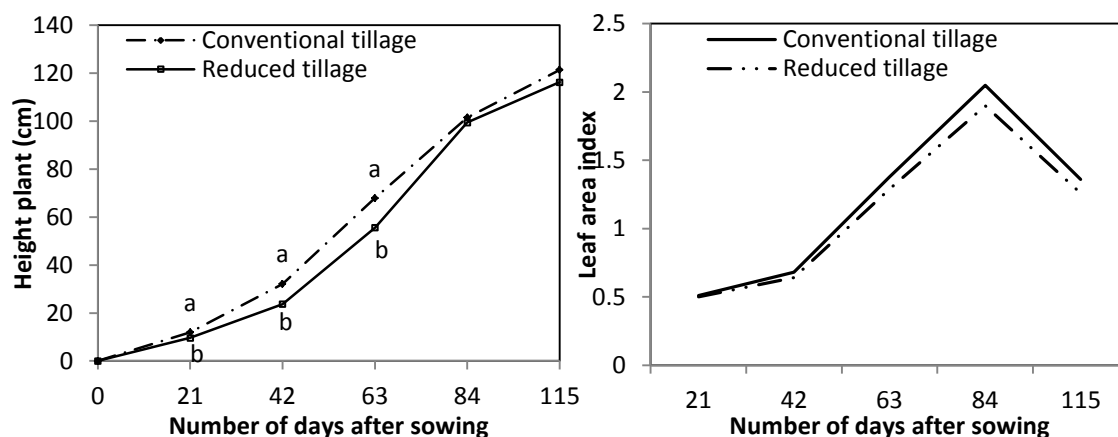
The leaf area index: The development of leaf area of cotton plants is important for photosynthesis and for yield. The photosynthetic capacity of crops is a function of leaf area. The role of leaf area is crucial for crops in the interception of light rays and thus has a large impact on crop yields (Dwyer and Stewart, 1986). Figure 2 shows effect of tillage systems on the evolution of the leaf area index (LAI) of cotton plants during the experiment. There is no significant effect of tillage systems on the LAI during the experimental period (Table 5). But the best LAI were observed in the tilled plots throughout the growing season in comparison with the RT. Thus, the RP treatment produced plants with reduced leaf area and then did not allow a better development of the aerial biomass.

Table 5: Analysis of Variance Table to three factors (F-value) of the leaf area index regarding tillage, nitrogen fertilization and mulching

Fishervalue Undervariation	dof	Leaf area index				
		21 DAS	42 DAS	63 DAS	84 DAS	115 DAS
		Tillage	1	0,07ns	0,13ns	0,91ns
Nitrogen	2	0,55ns	0,54ns	0,22ns	5,50**	5,50**
Mulching	1	2,48ns	0,05ns	0,03ns	0,13ns	0,13ns
Tillage*Nitrogen	2	4,64*	0,02ns	0,27ns	0,40ns	0,40ns
Tillage*Mulching	1	2,22ns	0,29ns	0,01ns	0,02ns	0,02ns
Nitrogen*Mulching	2	0,11ns	0,99ns	0,02ns	0,48ns	0,48ns
Tillage*Nitrogen*Mulching	2	2,23ns	0,41ns	3,02ns	1,44ns	1,44ns

dof : degree of freedom ; ns : $P > 0,05$; * : $P < 0,05$; ** : $P < 0,01$; *** : $P < 0,001$

As a matter of fact, the peak was observed at 12 weeks after planting in both tillage techniques (CT = 2.05) and (RT=1.90). But decreases at the end of the growing season. This would be related to Senescence and falling leaves of the plants.



Influence of nitrogen fertilization on cotton growth data

Root biomass: The effect of nitrogen fertilizer on the production of root biomass is shown in Table 6. The influence of different rates of nitrogen was positively significant ($P < 0.01$) at sampling depths 0-10 cm and 0-30 cm DAS 90 and significantly ($P < 0.05$) to DAS 120 at the sampling depth of 0 – 10 cm (Table 2). The dose 120 kgN /ha (8.68 ± 1.24 g/plant) produced the large amount of root biomass compared to other treatments to 120 days. Only the witness treatment induces low producing root (5.58 ± 0.58 g/plant). However, in the depth from 30 to 40 cm differences between the witness treatment and nitrogen rates are very low (Table 6). This shows that the nitrogen fertilizers rates not contribute to an increase in root density in the basement and to a better removal of the water and nutrients of lower layers.

The increase in root biomass by doses of nitrogen is only a reflection of the poor soil conditions of study area in nitrogen. These results emphasize the effectiveness of nitrogen and its role in the development of the whole plant (aerial and underground portion) than in the availability of other nutrients in favor of the plant. It has been demonstrated that the nitrogenous nutrition positively affects the proliferation and distribution of the roots and improves soil humidity (Asghar and Kanehiro, 1977). The efficient use of nitrogen not only depends on the rooting depth, but also on the adopted tillage technique.

Table 6: Effect of addition of nitrogenous fertilizer on root biomass production of the plants of cotton

Root biomass plant cotton (g/plant)		Nutrient N-rates (kg / ha)		
Number of days after sowing (DAS)	Depths Cm	0	60	120
30	0-10	0,04±0,00a	0,04±0,04a	0,03±0,00a
	0-30	0,56±0,06a	0,68±0,11a	0,65±0,08a
60	10-20	0,08±0,01a	0,09±0,01a	0,08±0,01a
	0-10	3,27±0,25b	4,89±0,39a	3,90±0,28b
90	10-20	0,28±0,26b	0,42±0,06a	0,33±0,03ab
	20-30	0,16±0,06a	0,18±0,01a	0,17±0,02a
	0-10	5,58±0,58b	8,24±0,89a	8,68±1,24a
120	10-20	1,53±0,21a	2,18±0,27a	2,04±0,53a
	20-30	0,29±0,03a	0,49±0,06a	0,51±0,15a
	30-40	0,25±0,04a	0,27±0,04a	0,23±0,05a

Values followed by the same alphabetical letter of the same character and the same factor are not significantly different ($P > 0.05$) according to the LSD test.

Plant Height: The height difference between the different applied doses of nitrogen was significant in the development stages of the plant (Table 3). The results show that the effect of nitrogen application is significant ($P < 0.05$) during the growth periods from 63, 84 and 115 DAS (Figure 3). The cumulative effect of the CT and the different applied rates of nitrogen appears significant ($P < 0.05$) on plant height 21 and 84 (DAS).

On the contrary the effect of the interaction of RT treatment and various nitrogen levels becomes significant ($P < 0.05$) from 42 and 84 DAS. The favorable effect of nitrogen fertilization was noticed throughout the growth of plants.

In general the average values of the highest height in the growth are observed at rates 60 and 120 kg N /ha (124.675 ± 3.05 cm and 126.806 ± 2.23 cm) compared to the witness treatment (0 kg N/ ha) with a significantly lower value (104.837 ± 2.50 cm) at the end of the cycle (Figure 3). So, it is a proven fact that the application of nitrogen boosts the growth and development of plants. These results are in agreement with those of Rochester and al. (2001) who showed that the height of the cotton plants is related to the level of nitrogen in the soil.

The leaf area index: The effect of nitrogen application on the evolution of the leaf area index (LAI) is shown in Figure 4. The analysis of variance showed the significant effect of the nitrogen intake ($P < 0.01$) on the evolution of the leaf area index (LAI) of cotton plants only 84 DAS (Table 4).

It was found that the index of leaf area of the plant increases gradually as the growth cycle increases before reaching its peak at 84 and decreases to 115 DAS reflecting there by the leaf senescence and physiological maturity. Indeed, the evolution of the LAI in time depends on the soil and nitrogen fertilization. The dose 60 kg N/ha has exacerbated the LAI (2.28 ± 0.10) elucidating good development of aerial biomass. These results are due to the quality and quantity of nutrients in the fertilizer because Mengel and Kirkby (1978) have shown that the nitrogen and phosphorus induce the growth of leaves and therefore increases of the LAI in the most part of the plants.

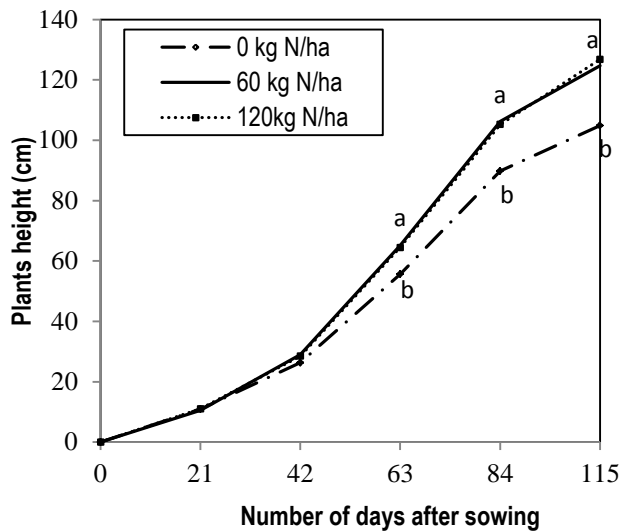


Fig 3: Evolution of plant height as a function of various doses of nitrogen

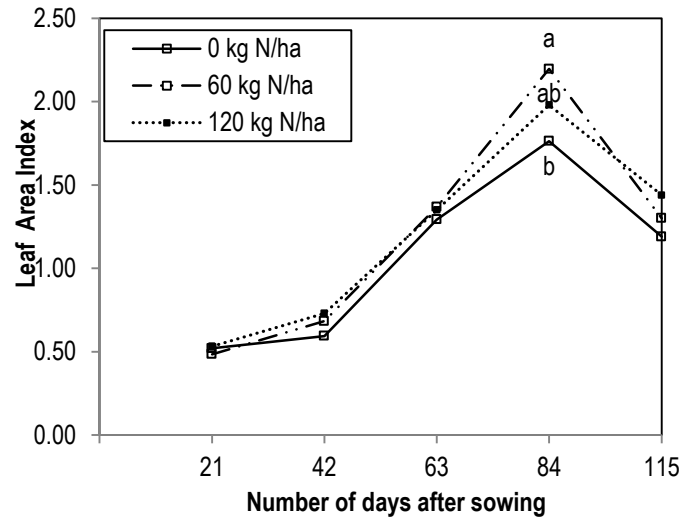


Fig 4: Evolution of the leaf is an index of plants considering the various doses of nitrogen

Interaction between tillage and nitrogen rates on root biomass plant cotton

The results of the analysis of variance showed that the combined effect of tillage methods and nitrogen fertilization was significant ($P < 0.05$) at 120 days after sowing (DAS) and this at 0-10 cm; 10 to 20 cm depth (Table 2). The effect of nitrogen and tillage become insignificant as the sampling depth increases. In fact, growth and root development not only depend on the soil type of work but also on the amount of available nitrogen in the soil. The best root biomass production was obtained with the combination of CT-treatment and the high rate of nitrogen (120 kg/ha), resulting thereby a good colonization of the soil by the roots and better development of root front. However, the difference was significant (LSD 0.05) between treatments (CT and 120 kg N/ha) and (RT and 120 kg N/ha) on the root biomass in the layers 0-10; 10-20; 20-30; 30-40 cm depth with positive effect of CT on root biomass production (Table 7).

Table 7: Effect of conjugated tillage type and nitrogen fertilization on cotton root biomass

Depths (cm)	Root biomass plant cotton (g / plant) to 120 DAS					
	Nutrient N-Rates (kg / ha)					
	0		60		120	
	CT	RT	CT	RT	CT	RT
0-10	5,43±0,93b	5,73±0,76b	7,36±1,26ab	9,12±1,27a	11,36±2,16a	6,00±0,37b
10-20	1,42±0,26a	1,63±0,35b	1,73±0,39a	2,62±0,34a	3,12±0,92a	0,96±0,17b
20-30	0,26±0,04a	0,32±0,06ab	0,45±0,08a	0,54±0,09a	0,70±0,30a	0,31±0,05b
30-40	0,35±0,06a	0,14±0,02b	0,30±0,07a	0,24±0,03a	0,26±0,11a	0,19±0,03ab

CT Conventional tillage; RT: Reduced tillage; Values followed by the same alphabetical letter of the same character and the same factor are not significantly different ($P > 0.05$) after the LSD test

Interaction of the tillage type and mulching on root biomass plant cotton

Tables 8 and 9 indicate the cumulative effect of the tillage system and mulching on the root amount produced by the cotton plants. Through the analysis of variance, its result showed that the interaction was significant ($P < 0.05$) on root biomass in the sample layer 0-10 and 0-30 cm DAS 90 and 30 - 40 cm DAS 120 (Table 2). The influence of the interaction was significant positively (LSD 0.05) in the combinations "without mulching" and "RT" compared to treatment "without mulching" and "CT" (Table 8) in the first two layers excavated. These variations in root biomass must be dependent on tillage type. At that time the RT was favorable to the development of the root system. The same pattern was also observed with the CT and treatment "without mulching" in the last depths (Table 9).

Table 8: Combined effect of the tillage type and mulching on cotton root biomass

Root biomass(g / plant) 90DAS				
Depths (cm)	Mulching		Without mulching	
	CT	RT	CT	RT
	0-10	4.53±0.54a	3.28±0.24a	3.86±0.38a
10-20	0.35±0.03a	0.20±0.01a	0.41±0.07a	0.42±0.04b
20-30	0.17±0.03a	0.20±0.08a	0.14±0.02a	0.16±0.02a

CT: Conventional tillage; RT: Reduce tillage; Values followed by the same alphabetical letter of the same character and the same factor are not significantly different ($P > 0.05$) after the LSD test

Table 9: Combined effect of the tillage type and mulching on cotton root biomass

Root biomass (g / plant) to 120 DAS				
Depths (cm)	Mulching		Without mulching	
	CT	RT	CT	RT
	0 - 10	7.83±1.09a	6.93±0.82a	8.27±1.68a
10 - 20	1.92±0.51a	1.57±0.31a	2.26±0.53a	1.90±0.31a
20 - 30	0.32±0.03a	0.35±0.06a	0.62±0.20a	0.43±0.06a
30 - 40	0.16±0.02a	0.16±0.01a	0.45±0.07b	0.21±0.03a

CT: Conventional tillage; RT: Reduce tillage; Values followed by the same alphabetical letter of the same character and the same factor are not significantly different ($P > 0.05$) after the LSD test

Conclusion

This study examined the effect of two types of tillage and nitrogen application on root biomass, height and leaf area index of the cotton plant. The results of the different treatments suggest that the effect of tillage method has a significant influence on the dynamics of root production. The analysis of the effect of plowing types reveals an increasing development of root biomass with conventional tillage system (CT). Low values were observed with the reduced tillage technique (RT). Similar observations were made on height growth and Leaf Area Index of the cotton plants.

Overall, the contribution of different nitrogen doses significantly improved the production of root biomass, height and leaf area index of plants. It should be noted that besides the benefits induced by conventional tillage, reduced tillage system (RT) seems more advantageous to producers due to lower expenses related to labor and time saver that it promotes.

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