International Journal of
Environmental Sciences & Natural Resources
ISSN: 2572-1119

Juniper PUBLISHERS
key to the Researchers

Research Article
Volume 19 Issue 5 - June 2019
DOI: 10.19080/IJESNR.2019.19.556023

Int J Environ Sci Nat Res

Effect of Different Tillage Practices on Production of Soya Bean - Maize (*Zea mays l. - Glycine max l.*) in Clay Loam of Assosa, Ethiopia

Obsa Adugna*

Ethiopian Institute of Agricultural Research, Ethiopia

Submission: January 28, 2019; **Published:** June 04, 2019

***Corresponding author:** Obsa Adugna, Ethiopian Institute of Agricultural Research, Ethiopia

Abstract

Conservation agriculture is a newly emerging technology having significant impact on soil characteristics and crop production. Conservation tillage like no tillage had been reported to improve the properties of the soil and in turn crop production. Thus, the study had been carried out at Assosa Agricultural research center with the aim of determining the effect of different tillage methods on crop yield of both sole maize and soya bean including their intercropping. Eighteen experimental runoff plots of 8m long and 3m wide each were framed with corrugated iron sheets. The experimental design used was randomized complete block design (RCBD) with six treatment in factorial combinations vis-à-vis three cropping systems (sole maize, sole soya bean and intercropping of maize with soya bean), with tillage system (no tillage and convectional tillage), that were replicated three times. Conventional tillage showed the greater result on yield and yield traits of all cropping systems than no tillage. Conventional tillage gave the difference of 992 and 694.7kg/ha than no tillage under sole and intercropping of maize respectively. Also, the yield of soya bean has shown the difference of 331.6 and 131.3kg/ha under conventional tillage for sole and intercropping respectively than no tillage. Land equivalent ratio (LER) calculation of no tillage and conventional tillage were 1.18 and 1.27 showing 18% and 27% more land for monocrop respectively which shows the more productivity of conventional tillage than no tillage.

Keywords: Maize yield; Soya bean yield; No tillage; Conventional tillage

Introduction

Maize (*Zea mays*) and Soyabean (*Glycine max*) are the most important cereal and oil crops of Ethiopia respectively and is well adapted to its soil and climatic condition. Soil tillage is among the important factors affecting soil physical properties and crop yield. Among the crop production factors, tillage contributes up to 20% (Khurshid et al. 2006). Tillage method affects the sustainable use of soil resources through its influence on soil properties [1]. The proper use of tillage can improve soil related constrains, while improper tillage may cause a range of undesirable processes, e.g. destruction of soil structure, accelerated erosion, depletion of organic matter and fertility, and disruption in cycles of water, organic carbon and plant nutrient [2]. Use of excessive tillage is often harmful to soil. Therefore, currently there is a significance interest and emphasis on the shift to the conservation and no-tillage methods for the purpose of controlling erosion process [3].

Conventional tillage practices modify soil structure by changing its physical properties such as soil bulk density, soil penetration resistance and soil moisture content. Annual disturbance and pulverizing caused by conventional tillage produce a finer and loose soil structure as compared to conservation and no-tillage method which leaves the soil intact [4]. This difference results in a change of number, shape, continuity and size distribution of the pores network, which controls the ability of soil tostore and transmits air, water and agricultural chemicals. This in turn controls erosion, runoff and crop performance [5].

On the other hand, conservation tillage methods often result in decreased pore space (Hill, 1990), increased soil strength (Bauder et al.1981) and stable aggregates [6]. The pore network in conservationally tilled soil is usually more continues because of earthworms, root channels and vertical cracks [7]. Therefore, conservation tillage may reduce disruption of continues pores. Whereas, conventional tillage decreases soil penetration resistance and soil bulk density [8]. This also improves porosity and water holding capacity of the soil. Continuity of pore network is also interrupted by conventional tillage, which increases the tortuosity of soil. This all leads to a favorable environment for crop growth and nutrient use [5]. However, the results of no-tillage are contradictory [3].

Currently, government and nongovernmental organizations are is being promoting the conservation agriculture in Ethiopia without evaluating their effects on crop yield. Therefore, the study was planned to determine the effect of different tillage methods on crop yield of both sole maize and soya bean including their intercropping.

Material and Method

Description of the study area

The study was conducted at the Assosa Agricultural Research Center (ASARC), which is in Assosa District at Benishangul-Gumuz Regional State (BGRS). The ASARC is in the western part of Ethiopia from 10º 01' 25'' to 10º 02' 50'' north latitude and from 34º 33' 50'' to 34º 34' 35'' east longitude. The study area covers a total land area of 202.5ha with geology of Tarmabe basalt, sometimes porphyritic of the Miocene to Pliocene period [9]. The Assosa District is characterized by hot to warm moist lowland plain with uni-modal rainfall pattern. The rainy season starts at the early May and lasts at the end of October with maximum rainfall in the months of June, July, and August. The total annual average (2000-2007) rainfall is 1316mm. The annual mean minimum and mean maximum temperatures of the District for the periods from 2000 to 2008 were 16.75 and 27.92 OC, respectively. The soil type of the study area was characterized as Nitisol (Figure 1 & 2).

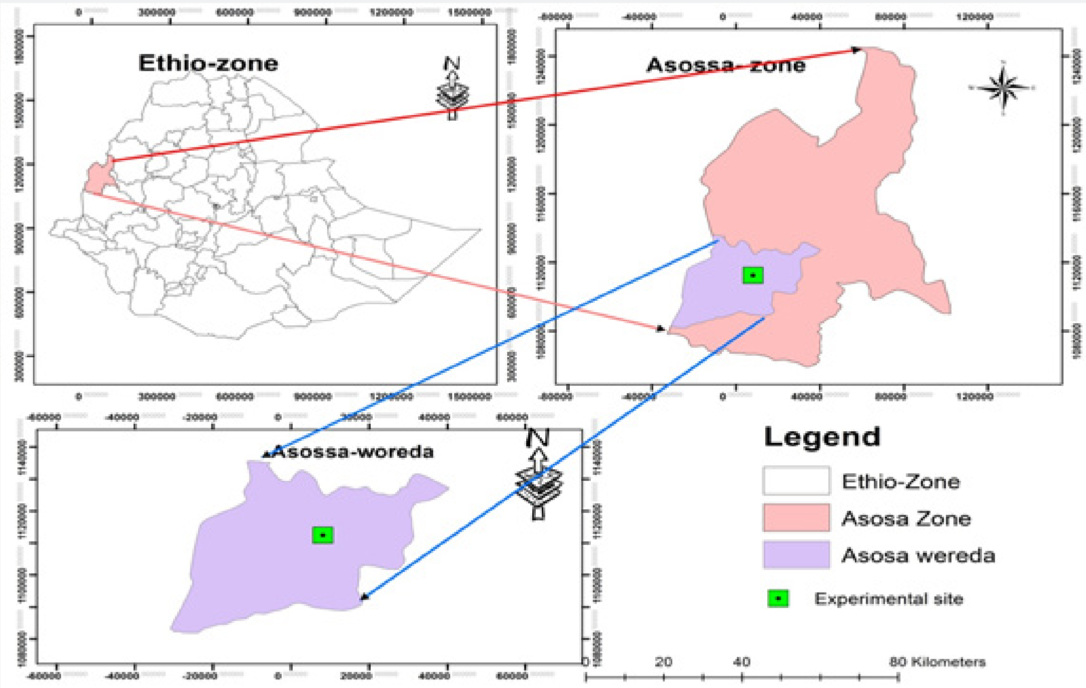

Figure 1: Location map of experimental site.

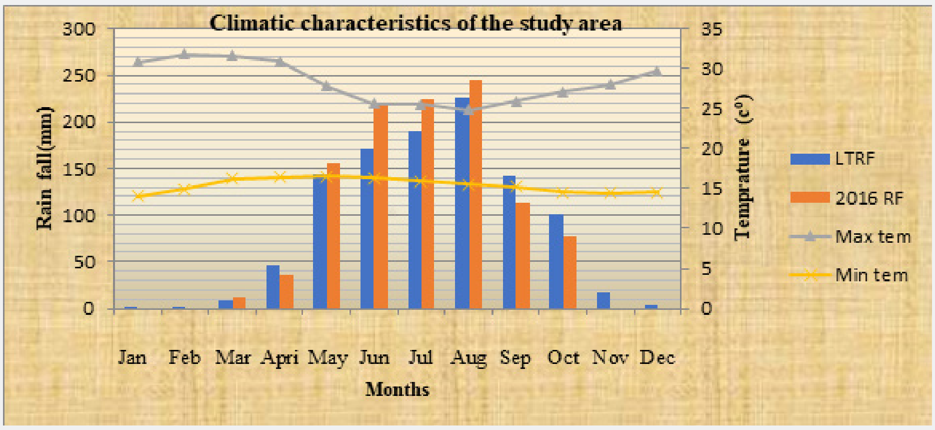

Figure 2: Long term (1983-2016) average rainfall and temperature and one-year (2016) rainfall of Assosa Agricultural Research Center (1983 -2016).
LTRF= Long term rainfall, Max term= maximum temperature, Min term= minimum temperature, rf = rain fall.

How to cite this article: Obsa Adugna. Effect of Different Tillage Practices on Production of Soya Bean - Maize (*Zea mays l. - Glycine max l.*) in Clay Loam of Assosa, Ethiopia. Int J Environ Sci Nat Res. 2019; 19(5): 556023. DOI: 10.19080/IJESNR.2019.19.556023

Experimental set up

The experiment had 6 treatments combinations and three replications with the total experimental plots of 18. The experimental plots were applied to runoff plots of 3m x 8m dimension that was laid out by completely randomized block design (RCBD) in factorial combination. The treatments were:

a) T1: Conventional tillage (the farmers local tillage practice to sow maize) + sole crop (maize)

b) T2: No tillage (tilling the place where to put the seed only, (2.5t/ha)) + sole crop (maize)

c) T3: Conventional tillage (the farmers local tillage practice for both test crops) + Intercropping (maize +soybean)

d) T4: No tillage (tilling the place where to put the seed only, (2.5t/ha) + Intercropping (maize +soybean)

e) T5: Conventional tillage (the farmers local tillage practice to sow soya bean was used) + sole soybean)

f) T6: No tillage (tilling the place where to put the seed only, (2.5t/ha) + sole crop (soybean) (Figure 3).

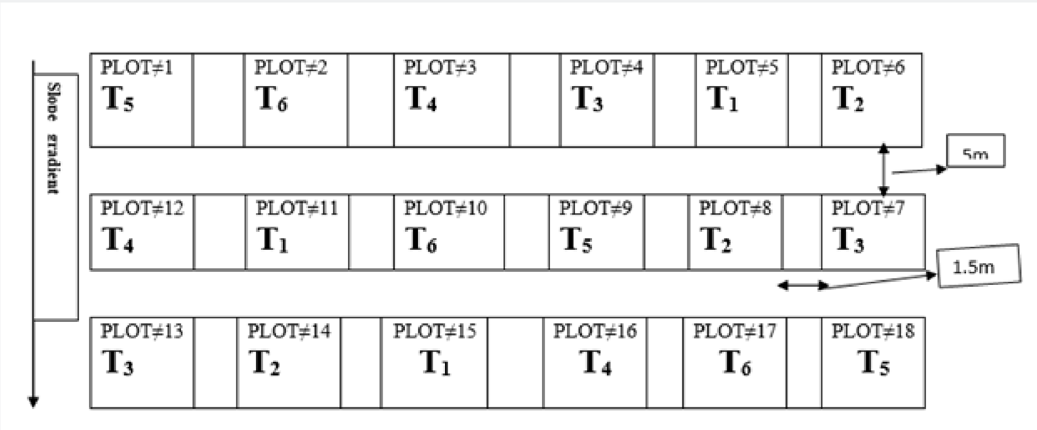

Figure 3: Layout of experimental plots.

Test plots arrangement and management techniques

The study was carried out by using RCBD in factorial combination with different surface management practices and cropping system as the experimental factors on 7% slope of land. It had 6 treatment combinations with three replications. There were two tillage practices (no tillage along with 5tonnes of soya bean straw mulch, conventional tillage (the farmers local practice for the test crop) and three cropping system (sole maize, sole soya bean, and intercropping of maize and soya bean). Blanket recommendation of fertilizer of the area was added to both test crops (46kg/ha P_2O_5 & 18kg/ha N for soya bean & 92kg/ha N & 46kg/ha P_2O_5 for maize). The study was carried out in hydrologically isolated experimental runoff plots of 3m x 8m.

The inter and intra spacing of maize and soya bean for the area was 75cm x 30cm and 40cm x 5cm respectively. The total rows for sole maize and sole soya bean were 9 and 17 rows respectively, whereas the total rows for intercropping were 9 and 8 rows for maize and soya bean respectively. The total harvestable rows for sole maize and sole soya bean were 7 and 10 rows, whereas, 7 and 7 rows for intercropping of maize and soya bean respectively. The total number of plants in sole maize and sole soya bean were 72 and 1020 plants and in intercropping the number of maize and soya bean were 72 and 480.

The tillage operation used was oxen plow (Maresha) for conventional tillage practice of all cropping systems to a depth of 15cm (triple passes) for maize and 12cm (double passes) for soya bean, whereas pickaxe was used for all no tillage treatments at sowing for maize to a depth of 10cm and hoe for soya bean to a depth of 7cm. The tillage frequency used for soya bean and maize were two and three times as the farmer's local practice of the area for conventional tillage. Hand hoeing was used for weeding for all treatments (Figure 4).

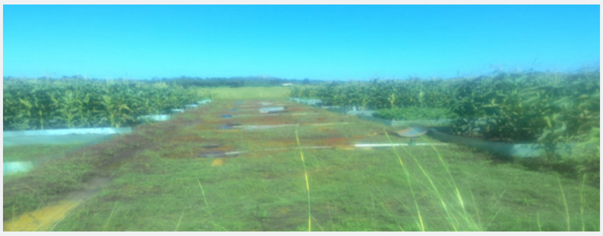

Figure 4: Establishment of runoff plots.
Overview of runoff plots.

Data collection

Yield and yield component data

Agronomic aspects like time and method of planting, seed rate and weeding were carried out according to recommendations for each test crops. Maize and soybean were used as test crops with the blanket recommendation of fertilizer. At physiological maturity agronomic parameters of yield and yield components were collected based on 10 randomly tagged plants in the middle of each test plot.

How to cite this article: Obsa Adugna. Effect of Different Tillage Practices on Production of Soya Bean - Maize (*Zea mays l. - Glycine max l.*) in Clay Loam of Assosa, Ethiopia. Int J Environ Sci Nat Res. 2019; 19(5): 556023. DOI: 10.19080/IJESNR.2019.19.556023

Maize yield parameters

a) Plant height (cm): Plant height was measured in centimeter from ten randomly selected plants as a distance from the ground level to the first tassel branch and then the mean was recorded as height per plant (cm).

b) Ear length (cm): it is the measure of the length of ear from the base to tip of the ear. It was taken from 10 representative plants from the plot and then the means was recorded as ear length (cm).

c) Cob number: is the measure of the number of cobs on maize. It was taken from 10 representative plants from the plot and then the means was recorded as cob number.

d) Cob length (cm): it is the measure of the length of cob from the base to tip of the ear. It was taken from 10 representative plants from the plot and then the means was recorded as cob length (cm).

e) Grain yield (Kg/ha): At harvest, the weight of the ears per plot was recorded and this is adjusted to 12.5% moisture content to estimate grain yield per hectare and the average yield was reported in Kg ha^{-1}.

f) Stand count at harvest: the number of plants per net plot at harvest was counted.

Soybean yield parameters

a) Plant height: Plant height was recorded from ten randomly taken plants from four central rows at physiological maturity from ground to the tip of main stem and then the means was recorded as height per plant (cm).

b) Number of pods per plant: Total pods in ten randomly taken plants from 10 and 7 central rows were counted for sole soya bean and intercropped soya bean respectively at physiological maturity and the means were recorded as number of pods per plant.

c) Number of seeds per pod: Total seeds from the above pods were counted and then total number of seeds is divided by total number of pods to get average number of seeds per pod.

d) Height of first branch fruiting (cm): it is the measure of the height of the first branch fruiting from the ground to first branch and then the means was recorded as Height of first branch fruiting (cm).

e) Stand count at harvest: the number of plants per net plot at harvest was counted

f) Grain Yield (Kg/ha): 10 and 7 central rows for sole and intercropped soybean were threshed to determine grain yield and grain yield was adjusted at the moisture level of 10%.

$$Adjusted\ Grain\ Yield = \frac{(100 - MC) \times\ Unadjusted\ grain\ yield}{100 - 10}$$

Where MC- is the moisture content of soya bean seeds at the time of measurement and 10% is the standard moisture content of soya bean in percent. Finally, yield per plot was converted to per hectare basis and the average yield was reported in Kg ha^{-1}.

Data Analysis

All measured parameters were subjected to statistics' version 8 and treatment means was compared using the least significant difference at the 5% probability level (LSD0.05) where the variance ratio for treatment effects shows significance.

Result and Discussion

Effect of tillage on crop production

Tillage systems and concomitant crop residue management significantly affected maize and soya bean yield and yield traits at Asossa. A tillage impact on crop yield is related to its effects on root distribution and growth [10], water and nutrient use efficiencies (Davis, 1994) and ultimately the agronomic yield [2].

Plant height

Significant difference was observed for plant height of soya bean at $p<0.01$ and maize $p<0.05$. Under no tillage, plant height under sole maize and soya bean were reduced by 5.73% and 4.05% respectively as compared to conventional tillage which is due to the tillage effect on physical and chemical properties of soil which in turn affect maize and soya bean production under uniform management and fertilizer application for both tillage treatments. Also, plant height under no tillage with intercropping of maize and soya bean were reduced by 7.72% and 20.39% respectively as compared to conventional tillage.

Cob Number/Number of Pod

Significant difference was observed for cob number of maize and number of pod of soya bean at $p<0.01$. Under no tillage, cob number of maize and no of pod of soya bean were reduced by 13.43%, and 5.88%, respectively as compared to conventional tillage due to the tillage effect on physical and chemical properties of soil which in turn affect maize and soya bean production under uniform management and fertilizer application for both tillage treatments. Also, cob number and number of pod under no tillage with intercropping of maize and soya bean were reduced by 16.26%, and 2.82%, respectively as compared to conventional tillage [11-15].

Cob length

Significant difference was observed for cob length of maize at $p<0.01$. Under no tillage, cob length of maize was reduced by 22.22% as compared to conventional tillage due to the tillage effect on physical and chemical properties of soil which in turn affect maize production under uniform management and fertilizer application for both tillage treatments. Also, Cob length under no tillage with intercropping of maize was reduced by 6.38%, as compared to conventional tillage.

How to cite this article: Obsa Adugna. Effect of Different Tillage Practices on Production of Soya Bean - Maize (*Zea mays l. - Glycine max l.*) in Clay Loam of Assosa, Ethiopia. Int J Environ Sci Nat Res. 2019; 19(5): 556023. DOI: 10.19080/IJESNR.2019.19.556023

Ear length

Significant difference was observed for ear length of maize at p<0.01. Under no tillage, ear length of maize was reduced by 20.64%, as compared to conventional tillage which is due to the tillage effect on physical and chemical properties of soil which in turn affect maize production under uniform management and fertilizer application for both tillage treatments. Also, ear length under no tillage with intercropping of maize was reduced by 6.38% as compared to conventional tillage [16-20].

Stand count

Significant difference was observed for stand count of soya bean and maize at p<0.01. Under no tillage, stand count of maize and soya bean were reduced by 15.59% and 31.01% as compared to conventional tillage due to the tillage effect on physical and chemical properties of soil which in turn affect maize and soya bean production under uniform management and fertilizer application for both tillage treatments. Also, stand count under no tillage with intercropping of maize and soya bean were reduced by 13.11% and 9.27%, respectively as compared to conventional tillage.

Yield

Significant difference was observed for yield of soya bean at p<0.01 and non- significant variation for maize. Under no tillage, yield of maize and soya bean were reduced by 19.28% and 6.09% as compared to conventional tillage due to the tillage effect on physical and chemical properties of soil which in turn affect maize and soya bean production under uniform management and fertilizer application for both tillage treatments. Also, yield under no tillage with intercropping of maize and soya bean were reduced by 14.74% and 43.48% respectively as compared to conventional tillage. Even though there is no significant difference in the yield of maize, conventional tillage gave the difference of 992 and 694.7kg/ha than no tillage for sole and intercropping of maize with soya bean respectively. Also, the yield of soya bean has shown the difference of 331.6 and 131.3kg/ha under conventional tillage for sole and intercropping respectively than no tillage (Table 1).

Table 1: Effect of surface management practices on yield and yield traits of maize and soya bean.

Treatments	Plant Height (cm)		Cob Number (cm) /No of Pod		Cob Length (cm) /Seed per Pod		Ear Length(cm) /Height of First Branch (cm)		Stand Count		Yield(kg/ha)	
	Maize	Soya	Maize	Soya	Maize	Soya	Maize	Soya	Maize	Soya	Maize	Soya Bean
Conv. till. with mai. (T1)	226.7[a]	-	1.34[a]	-	4.5[a]	-	21.8	-	66.7[a]	-	5142.7	-
No tillage with maize (T5)	213.7[ab]	-	1.16[bc]	-	3.5[b]	-	17.3	-	56.3[bc]	-	4150.7	-
Conv. till. with inter. (T3)	220a	71.6[b]	1.23[ab]	22.3[a]	3.6[b]	2.3[b]	17.9	11	61[ab]	179.3[c]	4710.7	762.6[b]
No till. with intercrop. (T2)	203b	57[c]	1.03[c]	21.6[a]	3.37[b]	2[b]	16.2	11.3	53[c]	162.7[c]	4016	431[c]
No till. with soya bean (T6)	-	78[ab]	-	32[b]	-	3[a]	-	10.7	-	241.7b	-	2024.3[a]
Conv. till. with soya. (T4)	-	81.3[a]	-	34[b]	-	3[a]	-	10.3	-	350.3[a]	-	2155.6[a]
Lsd (0.05)	16.45	6.5	0.14	2.8	0.29	0.57	ns	ns	5.92	59.8	ns	330.14
Cv (%)	3.82	4.5	5.96	5.1	4.03	11.1	8.95	25.5	5.01	12.82	22.26	12.3

Land equivalent ratio (LER) calculation of no tillage and conventional tillage were 1.18 and 1.27 showing 18% and 27% more land for monocrop respectively showing the more productivity of conventional tillage than no tillage for the cropping season. Tillage can affect the bulk density, porosity and root growth those have direct relationship with crop productivity. Thus, as some studies conducted at different countries revealed, no tillage can compact the soil and then reduce the porosity, bulk density and root growth which plays vital role on yield result on the first year of the study [21-25].

Howeler et al. 1993, also revealed that, surface soil compaction can increase with no-till, which may inhibit root growth as well as prevent adequate drainage and soil aeration which could reduce crop yield under no-till compared to conventional tillage practices. Yield reduction under no till for this study in line with the studies at different countries, that have been attributed to water logging and poor crop establishment (Halvorson et al. 2006), restricted root growth due to compaction (Iragavarapu and Randall, 1995). However, in a longer-term study, Jat et al. (2014b) found that no-till plus residue retention initially resulted in lower yields compared to conventional tillage with residue removed in a rice-wheat rotation in India yields higher in the no-till system after 6 years.

References

1. Hammel JE (1989) Long term tillage and crop rotation effects on bulk density and soil impedance in northern Idaho. Soil Sci Soc Amer J 53: 1515-1519.

How to cite this article: Obsa Adugna. Effect of Different Tillage Practices on Production of Soya Bean - Maize (*Zea mays l. - Glycine max l.*) in Clay Loam of Assosa, Ethiopia. Int J Environ Sci Nat Res. 2019; 19(5): 556023. DOI: 10.19080/IJESNR.2019.19.556023

2. Lal R (1993) Tillag eeffects on soil degradation, soil resilience, soil quality and sustainability. Soil and Tillage Res 27(1-4): 1-8.
3. Iqbal M, Hassan AU, Ali A, Rizwanullah M (2005) Residual effect of tillage and farm manure on some soil physical properties and growth of wheat (*Triticum aestivum* L.). Int J Agri Biol 1: 54-57.
4. Rashidi M, Keshavarzpour F (2007) Effect of different tillage methods on grain yield and yield components of maize (*Zea mays* L.). Int J Agri Biol 9(2): 274-277.
5. Khan FUH, Tahir AR, YuleI JI (2001) Intrinsic implication of different tillage practices on soil penetration resistance and crop growth. Int J Agri Biol 3(1): 23-26.
6. Horne DJ, Ross CW, Hughes KA (1992) Ten years of maize/oats rotation under three tillage systems on a silt loam soil in New Zealand. 1. A comparison of some soil properties. Soil and Tillage Res 22(1-2): 131-143.
7. Cannel RQ (1985) Reduced tillage in north-west Europe- a review. Soil and Tillage Res 5(2): 129-177.
8. Khan FUH, Tahir AR, Yule IJ (1999) Impact of different tillage practices and temporal factor on soil moisture content and soil bulk density. Int J Agri Biol 3: 163-166.
9. Tefera M, Cherenet T, Haro W (1996) Explanation of the geological map of Ethiopia (2nd edn). Ethiopian Institute of Geological Surveys. Addis Ababa, Ethiopia. 72(1): 50-55.
10. Barron J, Rockström J, Gichuki F, Hatibu N (2003) Dry spell analysis and maize yields for two semi-arid locations in east Africa. Agric For Met 117(1-2): 23-37.
11. Bahrani MJ, Raufat MH, Ghadiri H (2007) Influence of wheat residue management on irrigated corn grain production in a reduced tillage system. Soil and Till Res 94(2): 305-309.
12. Baver LD (1972) Soil Physics. (4th edn), John Wiley & Sons, Inc., New York, USA, pp. 116-120.
13. Campell DJ, Henshall JK (1991) Bulk density. In: Smith KA, Mullins CE (Eds.), Soil analysis. Physical methods. Marcel Dekker, New York, USA, pp. 329-366.
14. During RA, Thorsten H, Stefan G (2002) Depth distribution and bioavailability of pollutants in long-term differently tilled soils. Soil and Tillage Research 66(2): 183-195.
15. Flanagan DC, Foster GR (1989) Storm pattern effect on nitrogen and phosphorus losses in surface runoff. Trans ASAE 32(2): 535-544.
16. Ferreras LA, Costa JL, Garcia FO, Pecorari C (2000) Effect of no-tillage on some soil physical properties of structural degraded petrocalcic paleudoll of southern"pamapa" of Argentina. Soil Till Res 54(1-2): 31-39.
17. Ghuman BS, Lal R (1984) Water percolation in tropical Alfisol under conventional ploughing and no tillage systems of management. Soil and Tillage Res 4(3): 263-276.
18. Heenan DP, Chan KY, Knight PG (2004) Long-term impact of rotation, tillage and stubble management on the loss of soil organic carbon and nitrogen from a Chromic Luvisol. Soil & Tillage Research 76(1): 59-68.
19. Hemmat A, Taki D (2001) Grain yield of irrigated wheat as affected by stubble tillage management and seeding rates in central Iran. Soil and Tillage Res 63(1-2): 57-64.
20. Hill RL (1990) Long-term conventional and no-tillage effects on selected soil physical properties. Soil Sci Soc Amer J 54(1): 161-166.
21. Kargas G, Kerkides P, Poulovassilis A (2012) Infiltration of rainwater in semi-arid areas under three land surface treatments. Soil and Tillage Research 120: 15-24.
22. Logsdon SD, Cambardella CA (2000) Temporal changes in small depth-incremental soil bulk density. Soil Sci Soc Am J 64(2): 710-714.
23. Rose CW, Dalal RC (1988) Erosion and runoff of nitrogen. In: Wilson JR (Ed.), Advances in Nitrogen Cycling in Agricultural Ecosystems. CAB International, Wellington, pp. 212-235.
24. Schiettecatte W, Gabriels D, Cornelis WM, Hofman G (2008) Enrichment of organic carbon in sediment transport by inter rill and rill erosion processes. Soil Sci Soc Am J 72(1): 50-55.
25. Strudley MW, Green TR, Ascough JC (2008) Tillage effects on soil hydraulic properties in space and time: State of the science. Soil Till Res 99(1): 4-48

DOI: 10.19080/IJESNR.2019.19.556023

How to cite this article: Obsa Adugna. Effect of Different Tillage Practices on Production of Soya Bean - Maize (*Zea mays l. - Glycine max l.*) in Clay Loam of Assosa, Ethiopia. Int J Environ Sci Nat Res. 2019; 19(5): 556023. DOI: 10.19080/IJESNR.2019.19.556023