Evaluation of Selected Soil Management Practices and Its Effect on Seed Yield of Soybeans in Gboko, Benue State.

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Abstract
This study was conducted at the teaching and research farm of the Akperan Orshi Polytechnic, Gboko. Benue state, During the 2024 cropping season. The aim was to evaluate the effect of management practices (using different tillage methods) on soil physical and chemical properties and yield of soybean. The experiment was laid out in Randomized Complete Block Design (RCBD) replicated three (3) times. The treatments consisted of four tillage methods viz: T_1-zero tillage (ZT), T_2 – surface hoeing (SH), T_3 – manual ridging (MR) and T_4 – conventional tillage (CT). Results obtained indicated that tillage significantly affected soil properties and yield of the test crop. Conventional tillage produced tallest plants, highest number of branches, highest dry matter yield and highest number of pods per plant as well as highest grain yield for both crops in the two years. It was closely followed by manual ridging, surface hoeing and the least was obtained from zero tillage. Conventional tillage, manual ridging and surface hoeing produced lower bulk density than zero tillage. Conventional tillage produced highest porosity, lower pH, lowest Organic Matter, N, P, Ca, Mg and CEC when compared with the other tillage methods. Manual ridging and surface hoeing therefore produced sustainable soil physical properties and soil nutrients that will enhance sustainable production of soybean on fragile guinea savanna soils.

INTRODUCTION

Background Information

Tillage is an integral part of crop production. This consists of series of operations that influence the physical, chemical and biological characteristics of the soil in such a way as to create the optimum conditions for good crop performance.

Culpin (1986) defined tillage as the practice of modifying the state of the soil in order to provide conditions favorable to crop growth and represents the most costly single item in the budget of an average farmer. Osuji et al. (1980); Lal. (1983) defined tillage as the physical, chemical and biological soil manipulation to optimize soil conditions for seed germination, emergence and seedling establishment.

Inappropriate tillage has been implicated in soil degradation particularly in tropical soils. White (1987) and Donahue et al, (1990) reported that tropical soils are highly weathered, Kaolinitic and low in CEC. The soil resource base of Africa is diverse and predominantly has low inherent fertility with serious constraints including poor structure, low water holding capacity, low organic mater and moisture stress, (Place et al, 2003). Higgins and Kassam (1984) suggested that the soil resources of the tropics it properly used could, at low levels of input produce enough food to feed our teeming population.

Objectives

The main aim of this research was to explore the effectiveness of some selected soil management practices for sustainable production of soybean in the sub humid Guinea savanna climate with the following specific objectives.

1. To determine the effect of some selected tillage methods on soil physical and chemical properties.
2. To determine the effect of some selected tillage methods on the growth and yield of soybean and
3. To establish appropriate tillage method for sustainable production of soybean in Gboko, agro ecological zone.

Justification

The serious problem of soil degradation in sub-Saharan Africa due to the physical and chemical fragility of the soils and the harsh tropical environment is well known. Odofin (2005) for example noted that rapid soil degradation under continuous cultivation based on mechanical and manual tillage practices had become a problem worldwide and this had led to the exploration of a variety of alternative tillage practices as possible means of conserving the soil, maintaining soil quality and achieving sustainable crop production. Experiments showing significant yield responses to tillage are usually site specific (Chang and Lindwall, 1990). The implication of this is that tillage experiments should be site and crop specific because of the diverse nature of tropical soils. Benue state can be said to be a leading producer of soybean in Nigeria, however the problem of soil degradation that limits yield per hectare resulting from continuous cropping and inappropriate tillage practices still persist. It is equally hopeful that given the optimum soil condition, the state can produce high amount of cowpea comparable to most of the northern states in Nigeria. It is on this basis that this work was carried out to establish optimum soil conditions by way of tillage for increased sustainable production of cowpea and soybeans in Gboko. For the State to sustain its potentials for large-scale production of legumes, especially soybean, there is need to establish the tillage methods that most suits this agro ecological zone.

LITERATURE REVIEW

Origin and Distribution of Soybean

Soybean, *Glycine max L. Merill*, is an important leguminous crop rich in protein and oil. The crop originates in China as it is recorded in 2800 BC (Hittle, 1974). From China the crop was introduced to Korea, Japan then to Europe. Singh and Rachie (1987) reported that soybean was introduced into Nigeria in 1908 but the first successful production was in 1937. Benue State is the leading producer of soybean in Nigeria.

Environmental Requirements and Economic Important of the Crops.

Soybean thrive under a wide range of environmental conditions. The crops can grow on a wide range of soils but ideally Singh et al (1997) stated that ideally a fertile well drained sandy-loam to clay-loam is most suitable. The optimum pH is 6 – 7. Because of their nitrogen fixing abilities, the crops can be cultivated on poor soils with low level of nitrogen Whingham (1975) reported that soybean is a short day plant.

Soybean is a highly promising crop in both human and livestock nutrition. The crop is a reputable legume for plant protein and soil. Singh and Rachie, (1987) reported that Soybean contains by proximate analysis, 40% protein, 32% carbohydrate and 20% edible oil and other minerals and vitamins. Giller and Wilson, (1991) reported that soybean is certainly the most important source of vegetable oil in the world.

Effect of Tillage on soil Physical Properties.

The effect of tillage on physical properties of soil has been a matter of serious concern on our fragile soils. Thompson and Troech (1979) stated that the breakdown of soil aggregates due to tillage of the soil and reduced sizes of many of the pores gives rise to better aeration. But Kohnke and Bertrand (1959) opined that the increase in pore space and the better aeration are temporary with tilled soil particularly with conventional tillage. Donahue et al., (1990) reported that tillage temporarily improves soil aeration but with time, it destroys desirable soil structure and eventually reduces the aeration. The reduction in soil aeration according to Ike and Aremu (1990) is due to the accelerated organic matter decomposition and the formation of a dense impermeable tillage (plow) player due to machine traffic. Ojeniyi (1986) noted that repetitive mechanized tillage degrades soil physically, chemically and biologically. Soil bulk density is influenced by tillage. Brophy and Heichel (1989) reported that soil density and porosity vary according to the type of and intensity of tillage and having more negative effects by conventional tillage.

The soil physical properties affected by tillage compaction include increase in bulk density, decrease in pore volume, shift in pore size distribution towards a higher proportion of small pores and consequently low infiltration rate. (Wingate-Hill 1978; Ike and Aremu, 1990). Guy and Oplinger (1989) reported that surface compaction created by conventional tillage due to heavy equipment offers strong resistance to root penetration and infiltration capacity restriction in the long run.

Lindwall and Erback (1983) in their findings on tillage and planting systems reported that tillage significantly affected soil bulk density, soil moisture content and the particle size distribution. However, Chang and Lindwall in another experiment found that tillage did not significantly affect soil physical properties at 0-30mm and 90-120mm among the tillage treatments from no-till to conventionally tilled treatments.

Awodun (2007) worked in South West Nigeria on tillage practices and reported that zero tillage and manual clearing compared with conventional tillage decreased soil bulk density. The significant and non significant responses to tillage by soil properties and crop yields are due to a number of factors including the many combinations of soil properties climate and crop involved (Tessier et al, 1990).

Effect of Tillage on Soil Chemical properties.

Tillage activities influence soil chemical properties. Kohnke and Betrand (1959) observed that the decrease in size of soil aggregates caused by most tillage methods encouraged oxidation which resulted in the loss soil microbial food, increase rate of soil nitrogen volatilization and a decrease in soil aggregate binding materials. Reduction in soil organic matter caused by continuous tillage practices was reported by Mbagwu and Bazzoffi (1989) leading to a reduction of organic carbon by 35% and total nitrogen by 26% when compared to the untilled plot. Obi et al, (2005) reported a decrease in organic carbon due to conventional tillage and this was attributable to the faster rate of mineralization of the organic carbon. They reported further that tillage did not affect other soil chemical properties. However, Ewulo (2004) reported a decrease in soil pH, organic carbon, soil N, available P, exchangeable K, Ca and Mg with increased frequency of tillage. Adeoye (1982) reported that the destruction of soil granular structure particularly at the surface by tillage operation increases rate of leaching which increases soil acidity. The acidity of the soil affects nutrients availability particularly phosphorus and this in turn reduces soil microorganisms population and decreases biological activities.

Organic carbon plays an important role in nutrients availability and soil aggregate stability, (Bauer and Black, 1994; Karlen et al., (1991) reported an increase in soil pH of surface soil with no-till treatment when compared to moldboard plough and chisel plough. This increase in pH was attributed to organic matter accumulation at the surface soils of no till treatments.

The accumulation and distribution of organic carbon in soil is affected by different tillage practices and time. The findings of Karlen et al., (1994) indicated that under no-till treatment organic carbon increased significantly compared to mould board plough and chisel plough at the top 05cm of soil depth. In the same vein, Aldarby and Lowery (1984) reported a no-till plot in the 0-15cm depth of a sandy clay-loam layer compared with mould-board plough and conventional tillage.

Effect of Tillage on Growth and yield of Soybean

Tillage effect on crop performance is crop specific and thus exerts varying influence on crop growth and yield. Crop response to tillage depends on the soil type and the amount of rainfall. Soil manipulation can change fertility status markedly and the changes may be manifested in good or poor performance or crops (Ohiri and Ezuma 1991). Ojeniyi et al., (1999) reported that manual heaping and ridging were found to conserve soil fertility and raised the yield of cowpea. Simpson and Gums (1985) observed no yield difference in cowpea under reduced and conventional tillage practices. In Guyana, Maurya and Lal (1981) reported better growth and higher yield in the conventionally tilled plots than the zero tillage treatments. Ewulo (2004) reported that reduced frequency of tillage conserved soil fertility leading to significant increase in maize yield. Obi et al., (2005) reported an increase in dry matter yield of Okra in Waka, South Western Nigeria. Wijewandene and Waidyanatha (1984) reported that the poor aeration and the high moisture levels observed in no-till systems resulted in crops poor performance in terms of growth and yield, Vazaquez *et al.,* (1989) reporting on soil compaction associated with tillage for soybean, reported a higher yield of the crop for conventionally tilled plots than the no-till treatments. They noted further that soybean yields decreased after the second and third years of continuous no-till plots. Unger and Mccalla (1980) reported that in the United States of America, a shift from conventional tillage to conservation tillage system has increased the yield of soyaben and corn. However, Erbach (1982) reported that soybean nodulation, nitrogen fixation and seed yields decreased with conservation tillage systems compared to conventional tillage. Elmore (1990) reported that on well drained soil, soybean yields are often similar regardless of the tillage system. He also reported that on poorly drained soils especially under poor weed management, pests and diseases attack, yield of soybean grown without pre-plant tillage are low.

In their findings, Webber et al (1987) reported that soybean grown under no-till treatments on silty clay-loan soils produces less grain yield than soybean produced under conventional tillage method. They reported in another experiment that, the yield of soybean was less in no-till plots in the first year, but greater in the following year and the next following year, but this yield was still lower than yield from conventionally tilled plots. Conventionally tilled soybean has greater grain yield potential due to the greater vegetative growth but with less than adequate rainfall, soybean in no-till systems had less plant-water stress, resulting in greater yield. Awodun (2000) in Western Nigeria, reported that zero tillage practice decreased soil bulk density and lowered the grain yield of cowpea when compared to ridge planting and that the increase in grain yield of the crops increased with the frequency of ridging.

MATERIALS AND METHODS

This study was conducted at the teaching and research farm of the Akperan Orshi Politecnic, Yandev. Gboko local Government Area, Benue state in the Southern Guinea Savanna of Nigeria. Gboko, lies within latitude 70.45'N and Longitude 80.35'E. The experiment was conducted during the 2024 cropping season. The plot of land was fallowed for three years, with a slope of less than 2%. The pre-dominant weeds were spear grass (*Imperata Cylindrica)* and Guinea grass *(Panicum maximum).*

Experimental Layout and Design

The design of this experiment was the Randomized Complete Block Design (RCBD). A gross plot size of 12m x 40m with the treatments and replicates was used.
Each plot measuring 4m x 10m consisted of five ridges constructed at 0.75m apart.
The tillage treatments used were; zero tillage (**T_1**), Surface hoeing (**T_2**), manual ridging (**T_3**) and conventional Tillage (**T_4**).

Planting and Planting Materials

The test crops were TGX 1448-E, (Soybeans) which was obtained from IITA Kano Sub-section. The crops were planted simultaneously on July 21 2024.
Soybeans were drilled on ridges and flats depending on the tillage treatment at a spacing of 5cm as recommended by Benue Agricultural and Rural Development Authority (BNARDA).

Weed Control and Fertilizer Application

Weed control was done manually, and two hoe weeding were done at 4 weeks after planting (WAP) and at 8 weeks after planting (WAP).
200kg of SSP fertilizer/ha was applied at 4 WAP after the first weeding.

Harvesting

Harvesting was done when the pods were sufficiently dried in the field. Soybean was harvested and manually threshed and winnowed to remove plant debris. The pods were manually threshed and the seeds weighed.

Crop Data

The following data were collected on the plants.

- Germination count at one week after planting (1WAP)
- Weed count at two weeks after planting (2WAP).
- Plant height/number of branches/number of leaves. These data were collected at two weeks interval beginning from two weeks after planting (2WAP) to maturity.
- Dry matter content (weight) at full maturity.
- Pod weight at harvest

The data collected were subjected to Analysis of variance (ANOVA). Treatments that showed significant difference were separated using least significant difference (LSD).

Dry matter: Oven dried plants were weighted using a chemical scale determine their dry matter accumulation.

Air dried and crushed plant samples were collected according to treatments and subjected to the method of digestion using nitric perchloric acid mixture (Greweling, 1976) to produce extracts which were used to determine the following:

a) **Total nitrogen in plant:** This was determined by the micro kjedhal method.
b) **Plant Phosphorus:** This was determined by the VanoMolybdate colorimetric method.
c) **Plant exchangeable bases:** Ca, Mg, Na, and K were determined by atomic Absorption Spectrophotometer (AAS).

Soil Data

Soil samples were collected at the beginning of the experiment (composited) at 0-20cm dept and at the end of the experiment based on the treatments all of which were analyzed at the NICANSOL laboratory to determine the effect of the different tillage practices on the soil chemical and physical properties which were monitored throughout the period of the experiment.

The soil data at the beginning and end of the experiment were analyzed at the NICANSOL laboratory for the following parameters: bulk density, soil particle size distribution, total nitrogen pH, organic matter content, total N, available P, Base Saturation and CEC and total porosity.

Soil physical properties

Bulk density (Db): This was determined from oven dried soil samples and core dimensions using the equation, Db=Ms/Vb g/cm^3 where:

Ms = Mass of oven dried soil.

Vb = Bulk volume of the soil or core volume.

Particle size distribution (PSD): This was determined by the hydrometer method (Gee and Baudar, 1986). This involves the suspension of soil samples with sodiumhexamethaphosphate (calgon). The reading on the hydrometer was taken at 40seconds. The second reading was taken three hours later. The particle size was then calculated using the following formulae;

Sand = $100 – (H_1 + 0.2(T_1 – 68) – 2.0) 2$;

Clay = $H_2 + 0.2(T_2 – 68) – 2.0) 2$

Silt = 100 – (%sand – Clay)

Where:

H_1 = Hydrometer 1st reading at 40 seconds.

T_1 – Temperature 1st reading at 40 seconds

H_2 – Hydrometer 2nd reading after 3 hours.

T_2 = temperature 2nd reading after 3 hours.

Soil Chemical Properties

Soil pH: This was determined in both water and 0.1 NKCL in a ratio of 1:1soil: water and 1:2;5 soil: Kcl, respectively after stirring the soil suspension for 30 minutes, the pH values were read using glass electrode pH meter (McLean, 1982).

Organic carbon: This was determined using the Walkley and Black method. (Nelson and Sommers, 1982) which involves the oxidation with dichromate and tetra oxosulphat VI acid (H2SO4). The excess was titrated against Ferrous Sulphate. The organic carbon was calculated using the following formula.

%organic carbon in soil = $meK_2Cr_2O_7$-$meFeSO_4$ x 0.003 x 100 x F of air-dry soil.

Organic matter: This was determined by calculation using the formula: %organic carbon x 1.729, (Nelson and Summers 1982).

Total nitrogen: This was determined using Macro-Kjedahl method, (Bremmer and Mulvancy, 1982) in which the soil samples were digested with tetraoxosulphate VI acid. H_2SO_4 after the addition of excess caustic soda. This was distilled into 2% Boric acid (H_2BO_4) and then titrated with 0.01NHCL.

Available Phosphorus: This was determined using Bray-1 method. This involves the mechanical shaking in an extracting solution then centrifuging the suspension at 200 revolutions per minute for 10 minutes. Using the ascorbic acid method, the % transmittance on the spectrophotometer at 660m wavelength was measured. The optical density of the standard solution was then plotted against the phosphorus ppm and then the extractable phosphorus of the soil was then calculated.

Cation Exchange Capacity (CEC): Was determined by the Kjedahl distillation and titration method using ammonium acetate solution, the soils were leached and washed with methyl alcohol and allowed to dry. The soil was then distilled in a Kjedahl apparatus into a 4% boric acid solution. The distillate was then titrated with standard solution of 0.1NHCl, (Black, 1965).

Exchange Bases: Were determined by the method of the Association of Analytical Chemist (AOAC1970) using ammonium acetate. The soil samples were shaken 2 hours then centrifuged at 2000 rpm for 5-10 minutes after decanting into a volumetric flask, ammonium acetate (30ml) was added again the shaken for 30 minutes, centrifuged and the suspension transferred into the same volumetric flask. Atomic Absorption Spectrophotometer (AAS) was used to read the cations.

RESULTS

Soil Properties

Physico-Chemical Properties of the Soil Before Planting

Result of soil physical and chemical properties of the experimental site before tillage treatment is presented on Table 1.
The result of the soil properties shows that the soils is sandy-loam and slightly acidic. The soil is low in total nitrogen, available phosphorus, and soil organic matter. The exchangeable calcium, magnesium and potassium as well as the cation exchange capacity CEC are low.

Soil Physical Properties as Influence by Tillage Method Under Soybean

Result of soil physical properties as influenced by tillage method is presented on Tables 2 and 3.

The particle size distribution (PSD) in Tables 2 and 3 for 2024 sows the tillage methods investigated did not affect the sandy-loam textural class of the experimental site although there were slight variations among the tillage methods on the percentage sand, clay and silt, Soil bulk density and porosity (tables 3 and 4) were significantly influenced by tillage.

The zero tillage treatment produced the highest bulk density and least porosity. Surface hoeing, manual ridging and conventional tillage produced highest porosity followed by surface hoeing and the least porosity in zero tillage for soybean plot.

Soil Chemical Properties as Influenced by Tillage Methods

Result of soil chemical properties as influenced by four tillage methods in 2024 on soybean plots is presented on Tables 4. Tillage methods applied on soybean in Gboko affected soil chemical properties.

The pH was slightly lowered the initial soil pH before tillage treatment of 6.45 was lowered to 6.40 in the soybean plot in zero tilled plots, 6.21 in the surface hoeing, 6.22 in the manual ridge plot and 6.01 in the conventionally tilled plots.

DISCUSSION

The pH value of the soil is characteristic of guinea savanna whose rain fall intensity is moderate. The low CEC, exchangeable bases OM, N and P are characteristics features of the Nigeria guinea savanna. Harpstead (1973) has earlier stated that savanna soils are less leached hence moderately acid to near neutral as shown on Table 1. Lombin (1987) reported that it has long been established that the guinea savanna soils are characteristically low in organic matter (OM) CEC and also deficient in N and P.

Chude, (1998) reported that Nigeria savanna soils are low in exchangeable bases. In Nigeria, the bulk of the potential arable lands have low activity clay and low inherent fertility among others (Opara-Nadi 1990).

Tillage methods slightly increased percentage sand, particularly the conventional tillage method this did not change the textural class. This is so because Fitzpatric (1986) reported that the determination of a soil textural class is a function of weathering of the parent material as influenced by climate over a given period of time.

The reduction in the soil bulk density and increased porosity were caused by conventional tillage in this study. Tillage loosens the soil and increases porosity in the order of conventional tillage manual ridging surface hoeing relative to least porosity and highest bulk density in the zero tillage is consistent with the observation by Ewulo (2005) who noted that tillage is used in different intensities to reduce soil compaction. Ojeniyi (1990) reported higher bulk density and greater soil mechanical strength for zero tillage. Agbede and Ojeniyi (2003) reported that heaping and ridging raised total porosity and reduced soil bulk density when compared with zero tillage increased porosity caused by tillage in this experiment can be attributed to fragmentation and loosening of the soil.

As presented on Table 4 all the tillage methods decreased the soil pH when compared to the initial pH before tillage and cropping. This lowering in soil pH in the order of conventional tillage, manual ridging, surface hoeing and least in zero tillage is attributable to cultivation practices and cropping activities on the soil. This result trend was also reported by Udo (1987) who noted that cultivation accelerates acidifying processes in the soil which leads to soil acidity. This is attributable to increased porosity and associated leaching of bases by infiltrating rain water Ewulo (2005) also reported a reduction in soil pH among all tillage methods used in a rainforest zone of Nigeria.

The N enrichment by legumes as observed here has been highlighted by many researchers. People et al; (1995) attributed building soil nitrogen after legumes to the sparing of soil N by the legumes due to their reliance on atmospheric N2 fixation and the release of N from the mineralization of their residues left on the field after harvest and Brophy and Heichel (1989) reported the release of N2 from the break down of roots and nodules after the legume harvest.

The soil organic matter (SOM) and CEC were reduced by tillage practices when compared with the initial value. Although this was observed, zero tillage method produced higher organic matter and CEC than the surface hoeing, manual ridging and conventional tillage that produced the least OM and CEC. This was as a result of the breakdown of the OM rapidly in plots that were tilled and more rapidly in conventionally tilled plots. This result has earlier been reported by Mbagwu and Bazzoffi (1989) that continuous cultivation in tilled plot led to reduction of organic carbon when compared to untilled plots. Also in their findings, Karlen et al, (1994) reported an increase in soil organic carbon in the no-till (zero tillage) plot than the manually tilled and convention tilled plots. Due to the higher organic carbon in the zero tillage method there was a resultant significant increase in CEC and exchangeable bases relative to the conventional tilled plots and other tillage treatments.

The increase in plant height, number of pods, per plant and increased yield of soybean due to conventional tillage, manual ridging and surface hoeing would have facilitated good root penetration that resulted in creased nutrients uptake in those treatments than the zero tillage. The higher dry matter, number of branches and number of pods of soybean in the conventional tillage, manual ridging and surface hoeing transformed into higher yield of those crops than the yield in the zero tillage. The result obtained in this experiment is similar to the finding of Awodun (2007) who reported that zero tillage in soybean production resulted in increased soil nutrients but gave lower values of grain yield when compared to ridging and conventional tillage.

Guy and Oplinger (1989) and Philbrook and Oplinger (1989) reported a lower yield of soybean in untilled plots than tilled plots particularly conventionally tilled plots which produced highest yield within the first few years of that experiment.

CONCLUSION AND RECOMMENDATION

CONCLUSION

This study has shown that at the end of the cropping season, tillage affected soil properties and yield of soybean. Relative to no tillage, Conventional tillage increased soil porosity and reduced bulk density had led to enhanced crop growth and yield per hectare. Manual ridging gave optimum yields with improved soil physical properties and higher soil nutrients status. Manual ridging therefore is a more sustainable and environmentally compatible tillage method for optimum production of soybean in humid savanna zone.

RECOMMENDATIONS

1. On the basis of nutrients availability and good physical properties of the soil after the cropping seasons manual ridging is hereby recommended.
2. To reduce drudgery associated with manual ridging, it is recommended that light weight mechanical implements be developed such that will be comparable to manual ridging while drudgery is reduced.
3. Due to high bulk density and low yield associated with Zero tillage, It is no recommended for the study area.
4. Because of high porosity generated by conventional tillage followed by possible nutrient loss through runoff and leaching and high rate of organic matter decomposition, it is not recommended for sustainable crop production in this zone as it may lead to high nutrient depletion over time.

TABLES

Table 1: Soil Physico-Chemical Status Before Treatmen Application

Parameters	
Bullk density (g/cm^3)	1.18
Sand (%)	88.7
Silt (%)	7.7
Clay (%)	3.6
pH in H_2O	6.45
Organic carbon (%)	0.68
Organic matter (%)	0.18
Total N %	0.12
Available P (ppm)	3.53
Exchangeable K cmol/kg	0.20
Exchangeable Ca cmol/kg	2.71
Exchangeable Mg cmol/kg	0.82
Exchangeable Na cmol/kg	0.16
CEC (Cmol/kg)	2.3

Table 2: Soil Physical Properties as Affect by Tillage Treatments
(soybean)

Treatment	Bulk density g/cm3	sand (%)	Silt (%)	Clay (%)	Porosity (%)
Zero tillage	1.15	88.4	7.8	3.8	58.4
Surface hoeing	1.10	88.7	7.8	3.5	59.5
Manual ridging	1.12	88.6	7.5	3.9	61.2
Conventional tillage	1.09	89.2	7.6	3.2	61.6
LSD (0.05)	**0.4**	**NS**	**NS**	**NS**	**0.81**

**Tale 3: Soil Chemical Properties as Affected by Tillage Methods.
Soybean**

Treatments	pH	OM %	N %	P ppm	K Cmol/kg	Ca Cmol/kg	Mg Cmol/kg	CEC Cmol/kg
Zero tillage	6.40	1.05	0.10	3.20	0.21	2.71	0.84	2.41
Surface hoeing	6.21	1.02	0.10	3.41	0.20	2.69	0.81	2.01
Manual ridging	6.22	1.01	0.10	3.42	0.19	2.68	0.80	2.02
Conventional tillage	6.01	0.95	0.09	3.45	0.20	2.70	0.81	2.00

Plant Data

Plant Growth as Affected by Tillage Methods

Table 6 Plant Height of Soybean an Affected by Tillage Methods.

Treatments	4WAP (cm)	6WAP (cm)	8WAP (cm)
Zero tillage	21.5	31.2	49.5
Surface hoeing	22.6	43.3	59.6
Manual Ridging	23.3	42.4	60.2
Conventional tillage	23.5	46.5	65.4
LSD (0.05)	**NS**	**5.1**	**4.2**

Table 7: Number of Branches of Soybean per Plant as Affected by Tillage Methods.

Treatments	4WAP (cm)	6WAP (cm)	8WAP (cm)
Zero tillage	0.0	4.1	6.2
Surface hoeing	0.5	5.4	7.1
Manual Ridging	0.2	6.5	7.4
Conventional tillage	0.0	7.3	8.5
LSD (0.05)	**NS**	**1.8**	**1.7**

Yield and Yield Components of Soybean as Affected by Tillage Methods.

Treatments	Dry matter (g)/Kg	No of pods per plant	Grain yield t/ha
Zero tillage	46.0	48.8	0.9
Surface hoeing	58.2	54.6	1.3
Manual Ridging	58.8	56.1	1.4
Conventional tillage	6.11	62.1	1.8
LSD (0.05)	**1.6**	**5.3**	**0.2**

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