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A Study of Some Methods of Waste Management of Rice Through its Impact on Soil Physical Properties, N, P and K Contents in Maize Yield and Water Use Efficiency under Different Tillage Systems

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Abstract: Rice straw is about 50% of the causes of the black cloud in Egypt which lead to environmental pollution and help increase global warming, also rice residues are important natural resources, and recycling of these residues improves the soil physical, chemical and biological properties. Water is an important factor effecting plant growth especially under arid and semi arid conditions and changes in concentration of greenhouse gases (GHGs) in the atmosphere. On the other hand, tillage is an ancient practice to alleviate soil related problems and mulch also have its definite role in conserving soil physical health, especially water soil. From this standpoint, an field experiments were conducted using maize (Zea mays L.) to determine the effect of rice straw as mulch or compost on soil physical properties, N, P and K contents in maize yield and water use efficiency (WUE) under different tillage systems in 2009 and 2010 cropping seasons. The experiment was a randomized complete block design (RCBD) with three replicated, in two sites: silty clay (Agriculture Research Station farm, Giza) and sandy soils (Agriculture Research Station farm, Ismailia). Combination of mulch rates (0, 0.5 and 1 kg m^2) and two tillage methods (no-tillage and conventional tillage) compared to rice straw compost at a 5 t fad^{-1}. The rice straw mulching was application with two methods, incorporated in the soil or surface soil applied. No-tillage methods significantly influenced physical properties and N,P and K contents in maize grains and shoots and yield production at sandy soil while the conventional tillage at silty clay soil was more favorite . The two tillage methods had significant effect on soil physical properties as increase in soil moisture constant, total porosity, organic matter and decrease in bulk density, however, improved of hydraulic conductivity and pore size distribution. Mulching was significantly effect on maize yield and improved soil physical properties through conversion water content and reduced of evaporation, temperature and increased of total organic carbon and consequently increased plant production, especially, rice straw mulched on surface soil application at a rate of 1 kg m^{-1}. On both the used soils, surface soil mulching combined tillage method had a significant effect on maize yield (plant height, number of grains cob^{-1}, number of cob plant $^{-1}$, 1000 grain weight (g), grain and stalks yield (kg fed^{-1})) as well as improved physical properties such as bulk density, total porosity, moisture constant (i.e., field capacity, wilting point and available water), hydraulic conductivity, organic content, and pore size distribution. The application of rice straw as compost was lowest effect on maize yield and soil physical properties compared to rice straw mulch in both soils. Straw mulched combined with tillage was more effective on increase of N, P and K in maize grins and shoots and water use efficiency in two soils.

Key words: Rice straw, Mulching, Compost, Tillage, Maize Yield quality, Silty clay soil, Sand soil, Water use efficiency.

INTRODUCTION

Rice (Oryza sativa L.) is considered one of the most economically cereal crops all over the world, serving as the daily basic source of nutrition for billions of people. The crop yields has a large amount of rice straw, which from the standpoint of health and environmental pollution are considered one of the most agricultural critical problems in rice producing countries (FAO, 1982). In Egypt, the problem has recently emerged with increasing the demand on rice grains to meet the rapidly growing population leaving behind a huge quantity of rice straw (4 billion tons/ annual), particularly in Delta regions where the crop is extensively grown (Afify *et al.*, 2002).

Use of rice straw as mulching increased soil moisture accumulation, increased soil nutrients, enhanced soil bioactivity, increased plant growth and consequently increased plant production (Davies *et al.*,1993). Rathore

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et al. (1998) reported that more water conserves in the soil profile during the early growth period with straw mulch than without it. Subsequent uptake of conserved soil moisture moderated plant water status, soil temperature and soil mechanical resistance, leading to better root growth and higher grain yields. Applications of crop residue mulches increase soil organic carbon contents (Saroa and Lal, 2003).

Compost has been used extensively in reclamation of marginal and low quality soils. It has the unique ability to improve soil properties and the growing media physically (structurally), chemically (nutritionally) and biologically. Addition of compost to soil improves soil structure and lowers bulk density, (Caravaca *et al.,* 2002).

Relationships between soil tillage methods and soil physical properties and consequently crop response in different soils have been reported by many authors (Sharratt, 1996). Lal (1974) mentioned that an important factor in continuous productivity of tropical soils is the maintenance of soil physical characteristics at optimum level. Once it is achieved production capacity of these soils can be substantially improved by the use of fertilizers. Total porosity and pore size distributions are also important parameters in the tilled soil. The water retention, hydraulic conductivity, and diffusivity of soils are the effect of the intensity of land preparation done by different tillage methods. Thus, types of tillage practices play an important role in rainfed or irrigated agriculture, and proper choice of implements, timely operations, and the methods of their use have to be specified for different agroclimatic zones, (Islam, *et al.,* 2005). Tillage practices that maintain crop residue on the soil surface have been shown to increase maize yields in numerous studies (Wicks *et al*., 1994). The yield increase was correlated with increase in water contents in the soil due to reduced evaporation. Among the crop production factors tillage contributes up to 20% (Ahmad *et al*., 1996). Subsoil compaction may reduce the availability and uptake of water and plant nutrients, thereby lowering crop yields. Tillage systems are site-specific and depend on crop, soil type and the climate (Rasmussen, 1999). Tillage also affects water contents, aeration and available C (Khurshid *et al*., 2006). No-tillage with standing stubble conserves soil organic matter and water, generally increases crop production (Phillips *et al*., 1980). Tillage practices that maintain crop residue on the soil surface have shown higher maize yield (Wicks *et al*., 1994). Conservation tillage (no till and reduced tillage) practices simultaneously conserve soil and water resources, reduce farm energy and increase or stabilise crop production. Conservation tillage leads to positive changes in the physical, chemical and biological properties of a soil (Bescanca *et al*., 2006). Soil physical properties that are influenced by conservation tillage include bulk density, infiltration and water retention (Osunbitan *et al*., 2004). Soil surface mulch can alter water distribution between soil evaporation and plant transpiration (Huang *et al*., 2005). In addition mulch can change the soil water distribution from deep layer to surface layer.

Tillage and mulch significantly affected the N and P concentrations in maize shoots, while its effect on K concentration was appreciable. Interactive effect of mulch and tillage was statistically significant in case of N (1.423 g kg -1) and P (0.156 g kg-1) concentrations but non-significant in case of K (1.767 g kg-1) concentration. It is concluded that wheat straw as mulch in conjunction with deep tillage improves soil physical health and crop quality, (Muhammad *et al*., 2009).

Keeping this in view, the present investigation was planned to determine the effect of different tillage systems in combination with rice straw as mulch or compost application on soil physical properties and N, P, K concentrations in maize plants.

MATERIALS AND METHODS

Two field experiments were carried out at the Agriculture Research Station farm, Giza (silty clay) and Ismailia (sandy soil) , during the summer seasons of 2009 and 2010. Soil samples from a two sites were taken for Physical and chemical analysis, which were done according to Black (1982) as Table I shows.

An evaluate was done to study the effect of rice straw as mulching and compost under different tillage systems in two sites on soil physical properties and quality of maize yield. Which included two levels of rice straw mulching application (control with no mulch, one dose (1kg m^2) and ½ dose) and two application methods (incorporated in the soil or surface applied) were combination with two tillages (no-tillage and conventional) compared with rice straw compost at a rate of 5 ton fad^{-1}. Deep placement, however, was done before seeding using hand tools but surface mulch was applied soon after seeding. It was laid out in Randomized Complete Block Design (RCBD) with plot sizes measuring 3m x 3.5m replicated three times.

The planting of maize plant was at 11 June and 18 June for 2009 and 2010 respectively. Recommended levels of N (150 kg fad^{-1}), P (100 kg fad^{-1}) and K (48 kg fad^{-1}) were used as ammonium sulfate, super phosphate and potassium sulfate respectively. Full doses of P were applied at the time of sowing, while N was applied in two doses. One third of recommended nitrogen was applied at seedbed preparation, after one month of germination and at tassling K Stage addition of remained nitrogen fertilizer. Maize (Zea mays) hybrid individual 10, was sown with the help of dibble, maintaining plant to plant 22 cm and row-to-row 70 cm distance. At maturity of maize (after 100 day from planting) plant height was taken using meter rule, fresh weight, number of cobs $plant^{1}$, number of grains cob^{-1}, 1000 grain weight, grains and stalks yield. Plant samples were dried at 70 C^{o}, ground and prepared for digestion and analysis. The digested were materials subjected to determine of N, P, and K using procedures described by Chapman and Pratt (1961).

Soil samples were taken (0-15 m depth) after harvest (after 120 days from planting) and air-dried, grounded, passed through 2 mm sieve and preparation for analysis. Samples were analyzed for soil bulk density which measured by core method (Blake and Hartge, 1986), total soil porosity was calculated as percentage from bulk and real densities from the relationship:

$$Tp= (1 - Bd/Pd) \times 100$$

Where TP is total porosity, Bd is bulk density and Pd is particle density (2.65 g/cm^3).
Soil moisture characteristics (field capacity (FC), wilting point (WP) and available water (AW)) were determined according to the methods of Jalota *et al.*, (1998). Pore size distribution was determined to the equation:

$$P=(2\ \sigma\ COS\theta)/r$$

Where, P pore radius, s is surface tension of water (s = 72 dyne/cm), q is the contact angle and P is the applied pressure. When contact angle equals Zero, the pore diameter corresponds to pressure 0.1, 0.33 and 10 bars is equal to 28.8, 8.62 and 0.288 micron, respectively.

Table 1: Some characteristics of original soil experiment.

Characteristics	location	
	Giza	Ismailia
	Physical properties	
Particle size distribution		
Sand%	12.04	83.12
Silt%	45.45	10.25
Clay%	42.51	6.63
Texture soil	Silty clay	sand
Bulk density gm cm-3	1.42	1.97
Total porosity%	46.41	25.66
Hydraulic conductivity cm h-1	0.8	5.63
Field capacity%	27.12	18.29
Wilting point%	13.04	7.82
Available water%	14.08	10.47
Organic matter content%	1.42	0.50
	Chemical properties	
pH (1:2.5)	7.85	7.86
EC dS/m	1.34	0.47
Available N mg kg-1	84.4	20.75
Available P mg kg-1	24.8	8.12
Available K mg kg-1	167	18.33

The plots were treated with treatments showed in Table 2 :

Table 2: Treatments of used in this investigation.

No	Treatments	Tillage	Mulched		Compost
			Incorporated with soi	lSurface applied	
1	Control +T1	No-tillage	-	-	-
2	Control +T2	Conventional	-	-	-
3	M1+T1	No-tillage	0.5 kg m^2	-	-
4	M1+T2	Conventional	0.5 kg m^2	-	-
5	M2+T1	No-tillage	1 kg m^2	-	-
6	M2+T2	Conventional	1 kg m^2	-	-
7	M3+T1	No-tillage	-	0.5 kg m^2	-
8	M3+T2	Conventional	-	0.5 kg m^2	-
9	M4+T1	No-tillage	-	1 kg m^2	-
10	M4+T2	Conventional	-	1 kg m^2	-
11	C+T1	No-tillage	-	-	5 ton fad^{-1}
12	C+T2	Conventional	-	-	5 ton fad^{-1}

De Leenher and De Boodt, 1965 classified the pore space to pore with a diameter> 28.8 μ as quick drainable pores, while those with diameters 28.8-8.62μ as slow drainable pores and total drainable pores as the pores with diameters > 8.62 micron. Soil pore size distribution was determined using the method by Nizeymana and Olson (1988). Soil clods were collected from each plot for treatments. Various pore size distribution volumes were calculated using the following equations:

Water storage porosity (WSP)= (θm -θπ)

Residual porosity (RP)= θπ

Air porosity (AP)= TP- (WSP+ RP)

Where;

θm= volumetric water contents at 33kPa

θπ= volumetric water contents at 1500kPa, and

TP= Total porosity

Estimation of Water Use Efficiency (WUE) was estimated according to (Kramer and Boyer, 1995)using the following equation:

WUE= total yield (ton. fad^{-1})/ amount of water consumption (cm^3)

The chemical properties were determined by standard methods: pH value in soil extract (1:2.5) and electrical conductivity (EC) of soil extract (1:5) by Black, (1982), available N by Bremner and Mulvancy (1982), available P by spectrophotometer (Olsen and Sommers, 1982), available K by flame photometer (Richards, 1954).

Obtained data were statistically analyzed using the average for the two seasons according to Snedecor and Cochran (1980), L.S.D. 0.05 test being used to compare the treatment means.

RESULTS AND DISCUSSION

Physical Properties:

• ***Bulk Density and Total Soil Porosity:***

One of the soil physical properties that are nearly always altered by tillage and mulch operations is bulk density (Cassel, 1982).

Data related to soil bulk density after harvesting of maize are given in Tables (3 and 4). The results indicated that both the tillage methods and rice straw as mulch or compost had a significant effect on bulk density of silty clay and sandy soil.

As regards tillage methods, mean values of bulk density 1.60 and 2.22 g cm^{-3} were observed in case of no-tillage, followed by 1.37 and 1.93 g cm^{-3} in case of conventional tillage in silty clay and sandy soils, respectively. Mean values of decreasing in bulk density 2.81 and 2.07 % were observed in case of no- tillage, while were 2.92 and 1.53 % in conventional in silty clay and sandy soils, respectively as compared to a control, indicating that no- tillage decreases the bulk density in sandy soil higher than silty clay one compared to conventional tillage. Application of compost led to decrease bulk density by percent 1.41 and 0.51 % in both silty clay and sandy soils in case of no-tillage and conventional respectively.

As regards mulch levels, the results indicated the application of rice straw mulched at a rate of 1 kg m^{-2} was more effective for decreasing bulk density as compared to other treatments, in two sites. Minimum mean value 1.33 g cm^3 was found in the treatment where mulch surface soil applied at a rate of 1kg m^{-2} under conventional tillage in case of silty clay soil, while in sandy soil minimum mean value 1.87 g cm^{-3} was found in the same treatment under no-tillage. The results of the present study are in agreement with the findings of Blanco-Canqui *et al.* (2006) and Ghuman and Sur (2001) who concluded that mulching decreases bulk density of the surface soil. The large decrease in bulk density with mulching in our study is attributed to the high concentration of soil organic carbon. The presence of straw mulch probably increased the soil organic matter content and protected the surface-connected earthworm channels or macropores by intercepting raindrops and improving surface soil structural stability (Kladivko, *et al.*, 1997). Osuji (1990) reported that bulk density of the tilled soil, especially on the unmulched tilled plots, approached that of the zero tilled plots with time. The decrease in bulk density in tilled treatment may be attributed to tillage that made the soil loose and more porous. However, bulk density tended to decrease with mulch non-significantly. Crop residues left on the soil surface protect the soil against crusting, surface sealing, and detachment by intercepting and buffering the kinetic energy of rainfall and runoff (Lentz and Bjorneberg, 2003).

Data in Tables (3 and 4) indicated the total soil porosity as affected of rice straw as mulched and compost under no-tillage or conservational tillage in two sites. Total soil porosity calculated from bulk and real density was taking reflect trend in bulk density. Generally, the application of rice straw mulched or compost were increased of total porosity values in silty clay and sandy soils, application of mulch surface soil at a rate of 1 kg m^{-2} was significant response to increases of total porosity in all sites. This result may be related to mulched surface soil application treatments produced 15%-21% more total carbon (TC) than the incorporated-only and no-amendment control treatments. Bulk density decreased the total soil porosity values which increased with increasing TC contents, (Gonzalez and Cooperband, 2003).

• ***Soil Moisture Constants:***

Results in Tables (3 and 4) showed the effect of rice straw mulched and compost under no-tillage or conventional tillage on soil moisture constants i.e., field capacity (FC), welting point (WP) and available water (AW). Generally, soil mulching significantly affected soil moisture contents at harvest, while tillage non-significantly affected (Tables 3 and 4). As regared to tillage methods mean values for FC (31.93 and 20.93 %), WP (14 and 8.72 %) and AW (17.5 and 12.2 %) in case of no-tillage, while were for FC (34.11 and 20.3 %), WP (14.3 and 8.47%) and AW (19.8 and 11.8%) in case of conventional tillage in both soils respectively.

Regardless for the mulch rates and methods of application, results indicated that moisture increase percentages were recorded 23.83 and 16.37 % for FC , 23.74 and 14.03% for WP and 23.17 and 18.07% for AW in case soil mulched combined with no-tillage as compared to control in silty clay and sandy soils respectively.

The moisture increase percentages were recorded 22.53 and 11.76 % for FC, 19.12 and 10.53 % for WP and 25.63 and 12.65 % for AW due to application of rice straw mulched combined with conventional tillage in both soils respectively. Succession the application of rice straw compost combined with no-tillage showed the moisture constants recorded 7.34 and 2.17% for FC, 7.61 and 5.44 % for WP, and 6.47 and 1.28 % for AW in two sites respectively, while the moisture constants increase percentages were 7.49 and 0.90 % for FC, 13.33 and 3.04% for WP and 3.19 and zero% for AW as compared to a control in case of conventional tillage, respectively.

The results showed that the reduced tillage system created more-friendly environment for soil physical properties-particularly soil stability than the conventional system. Management of crop residues in combination with no-tillage is a proven strategy for soil and water conservation and enhancement of soil biological processes (Blanco-Canqui *et al.*, 2006). As regard to the mulched rate and methods application, data indicated the application of rice straw as mulched at a rate of 1 kg m^{-3} on surface soil was more superior than soil incorporated mulch in the same rate, especially, in case of conventional tillage in silty clay soil which recorded 38.15, 1465 and 23.50 g cm^{-3} for FC, WP and AW ,respectively, The application of surface soil mulch at a rate of 1 kg m^{-2} companied with no-tillage was more effective on moisture constants in sandy soil, while in silty clay soil, they recorded 24.45, 10.11 an 14.34 g cm^{-3}, respectively. Diaz *et al.*, (2005) investigated the effects of mulching thickness and size of mulching granule on water evaporation. Results of their research showed that water evaporation decreased with mulching thickness. Mulch originated from organic materials with its generally large porous composition can reduce the water losses in mineral soils (Kimmins, 1997). Khurshid *et al.* (2006) stated the same results that mulching improves the ecological environment of the soil and increases soil water contents.

On the other hand, the added of mulch on silty clay soil surface was better than sandy soil; were the increase of moisture constants especially available water as compared to a control treatment. Water can easily drain inside the sandy soil due to large pores if the mulching material is absent. However, mulching increased the water absorption capacity of sandy soil up to four times even three days after watering, (Zeki e*t al*., 2009). This difference in soil water between the two soils can be attributed to the fact that sandy soils with higher ratio of macro pores drained the water more easily than the other soil type. Clay soil has higher soil surface and lower ratio of macro pores, so clay soil holds water more strongly than sandy soils (Kimmins, 1997).

• ***Saturated Hydraulic Conductivity (K_{sat}):***

Saturated hydraulic conductivity (K_{sat}) of the soil as affected by tillage method and rice straw as mulch or compost application is presented in Tables (3 and 4). As regad to tillage methods, data showed the tillage methods increased of K_{sat} were their values were recorded, 35.8 and 38.82 % in case of no-tillage and conventional tillage respectively, as compared to a control treatment in silty clay soil, while the tillage methods decrease of K_{sat} where their values were recorded, 5.63 and 4.58 % in case of no-tillage and conventional tillage respectively in sandy soil. Soil water content had been reported to be higher in no-till system, than in plowed soils (Karamanos *et al.*, 2004). This is a consequence of higher infiltration rates and lower evaporation under no-till (Franzluebbers, 2002) especially in light texture.

Regardless for the rate and method application of mulch, rice straw as mulch was better than compost on K_{sat} in both sites, the increase percentages in silty clay soil were recorded 48.14 and 17.28 % when applied of rice straw as mulch or compost combined with no-tillage, while were 50.58 and 30.58% in case of conventional tillage in both soils, respectively. However, the decrease percentages of K_{sat} in sandy soil were recorded, 7.57 and 3.52 % in case of no tillage, while were 6.16 and 2.46 % in case of conventional tillage respectively. The rice straw mulched surface soil application was more effective on K_{sat} in both soils, especially at a rate of 1 kg m^{-2} application combined with conventional tillage in silty soil and combined with no-tillage in sandy soil. The surface mulch was the only source of organic matter for faunal activity, as production of below ground plant biomass. Residue mulch strongly modifies the soil microclimate by reducing evaporation, increasing available water content, and reducing abrupt changes in soil temperature (Blanco-Canqui *et al.*, 2006). The surface soil having relatively higher organic matter content was less compact as compared to the subsurface soils that resulted easy passage of water through it. This result is in agreement with the findings of Ogunremi and Lal (1986) who found that soil compaction decreased the saturated hydraulic conductivity. Generally the higher the transmission porosity, the greater was the K_{sat}, but the magnitude and ratios would depend on the clay mineralogical make up soil texture etc.

• ***Soil Organic Matter Contents:***

The data pertaining to organic matter concentration (%) in soil at harvest of maize are listed in Tables (3 and 4). Different tillage systems (no-tillage and conventional tillage)affected significantly in organic matter content in two sites. The mean maximum soil organic matter contents were observed in no-tillage (1.54 and 0.64 %) while were in conventional tillage (1.62 and 0.59 %) in silty clay and sandy soils respectively. Similarly, the mean maximum soil organic matter contents in sandy soil were observed in case of no-tillage, while the mean maximum values were in silty clay soil in case of conventional tillage. Soils have a finite capacity to sequester organic carbon (OC) that is determined by soil texture and aggregation. SOC levels increase with silt + clay content and the maximum level is achieved when soils are most highly aggregated, i.e. when they are not tilled. Tillage breaks aggregates and exposes SOC to biological decomposition. Loss of SOC is proportional to the intensity of tillage, (Duxbury, 2005). This result may be due to differences in textural characteristics, conservation tillage protects the sub-soil against compaction and erosion by water, also increase organic matter content (Dexter and Czy, 2000), and increased biological activity (Urbanek and Horn, 2006). Also, conservation tillage leads to positive changes in the physical, chemical and biological properties of a soil (Bescanca *et al*., 2006). On the other hand, No-tillage with standing stubble conserves soil organic matter and water, generally increases crop production (Phillips *et al.,* 1980). Chaudhary *et al.* (2004) compared conventional tillage system to zero tillage and concluded that higher moisture retention and 13% more income was obtained in case of zero tillage. But minimum tillage could not compensate the adverse effects of fine texture, very low organic matter and an overall initial weak structure of soil. Khurshid *et al.* (2006) found maximum organic matter contents in minimum tillage as compared to conventional tillage in sand clay loam soil. Tillage systems are site-specific and depend on crop, soil type and the climate (Rasmussen, 1999).

The effects of mulch levels and method of application were also significant at both soil sites (Tables 3 and 4). The mean maximum values were observed in surface soil mulched (1.32 and 0.69 %) in case of no-tillage while were (1.70 and 0.64 %) in conventional tillage, followed by incorporated mulch (1.09 and 0.67%) in no-tillage and (1.20 and 0.58 %) in conventional tillage in silty clay and sandy soils respectively. The application of surface soil mulched at a rate of 1 kg m^{-2} was positive effect on increase of organic matter content regardless on tillage system in both soils. The SOM increased due to decomposition of applied mulch. Khurshid *et al.* (2006) concluded that organic matter was significantly higher when more mulch was applied. The interactive effect of tillage and mulch was also significant (Tables 4 and 5), the mean maximum value of organic matter contents was observed in soil mulched a rate of 1kg m^{-2} (M4) (1.36%) in combination with conventional tillage in silty clay soil. Gonzalez and Cooperband, (2003) showed that mulched treatments produced 15%-21% more TC than the incorporated-only and no-amendment control treatments. On the other hand, the application of compost slowly increased of organic matter content (1.52 and 0.59 %) in no-tillage and (1.60 and 0.61 %) in conventional tillage, respectively.

• ***Pore Size Distribution:***

Data in Table (5) indicated the values of water storage porosity (WSP), residual porosity (RP), air porosity (AP), total drainable porosity (TDP), quick drainable porosity (QDP) and slow drainable porosity (SDP) as related to the application of rice straw as mulch or compost under no-tillage and conventional tillage in silty clay and sandy soils. The interaction effect clearly indicated that, water storage porosity (WSP) which is important for soil moisture retention (storing available water) and the air porosity (AP) which is important for soil aeration. The data showed a decreased in case of no-tillage in silty clay soil, while it was increased under the same tillage method in sandy soil. Thus the lowest air porosity (AP) values were observed with application of rice straw as mulched at a rate of 1 kg m^{-2} on surface soil under conventional tillage in silty clay soil and under no-tillage in sandy soil as compared to other treatments. Lowest air porosity (AP) decreased percent record to 33.18 and 18.23% under no-tillage, but was 38.22 and 34.56 % under conventional tillage due to application of rice straw as mulched at a rate of 1 kg m^{-2} on surface soil in silty clay and sand soils respectively, compared to the control treatment. On the contrary, the results revealed increased in water storage porosity values with application of rice straw as mulched under different tillage systems in two sites. Regard to rice straw as compost was slow effective on air porosity and water storage porosity as compared to rice straw as mulch under two tillage systems in both soils. Data in Table (5) revealed that the conventional tillage treatments soil less total drainable pores and micropore volume (slow drainable pores) and had more macropore volume (quick drainable pores) in silty clay soil than the no-tillage. While, the no-tillage treated soil had less total drainable pores and macropore volume (quick drainable pores) and had more micropore volume (slow drainable pores) in sandy soil. The rice straw surface soil mulched at a rate of 1kg m^{-2} was positive effect on total drainable porosity (TDP), quick drainable porosity (QDP) and slow drainable porosity (SDP) more than other treatments in two tillage systems. Total drainable porosity was decreased to 8.28 and 28.76 % in case of no-tillage, while, was 11.18 and 25.58 % in case of conventional tillage due to application of surface soil mulched at a rate of 1 kgm^{-2} in silty clay and sandy soil respectively, compared to the control treatment. The quick drainable pores and slow drainable pores volumes were responded to treatments depended on the texture soil under studied. Blanco-Canqui and Lal (2006) reported that no-tillage management, in conjunction with application of large quantities of straw mulch on the soil surface, increased saturated and unsaturated hydraulic conductivities, earthworm population, soil water retention, bulk density, total soil porosity, and macroporosity. The greater saturated hydraulic conductivity in mulched treatments is partly due to an increase in effective soil porosity. Straw-management-induced large changes in these soil properties and generally highly significant within the 0- to 30cm soil depth. Surface-applied mulches provide several benefits to crop production through improving water, heat energy and nutrient status in soil, preventing soil and water loss, preventing soil salinity from flowing back to surface, and controlling weed (Bu *et al*., 2002).

Maize Yield:

Data on plant height at harvest influenced by rice straw as mulching or compost application and tillage in silty clay and sandy soils Tables (6 and 7) indicated that plant height was affected significantly by various levels of mulch. As regards to tillage methods, mean values of plant height (201 and 178 cm) were observed in no-tillage followed by 213 and 166 cm in case of conventional tillage in silty clay and sandy soils respectively.

Regarding to mulch method and level application, the mean height (207 and 178 cm) of plant were obtained, while the mean height of plant (216 and 166 cm) after mulched incorporated with soil combined with no-tillage and conventional tillage respectively in silty clay and sandy soil respectively. Also, the mean height of plant was obtained after soil surface mulch (213 and 190 cm) in case of no-tillage, and (231 and 174 cm) in case of conventional tillage applied in both soils respectively. The results indicated that the straw mulch application was increased plant height with the increase rate of application. The application of straw mulched at a rate of 1kg m^{-2} was superior in the increase of the maize plants height. Interaction between mulch and tillage treatments indicated that the results were indicated significant difference in plant height when mulch was incorporated with soil and surface one under two tillage methods as compared with control, but there was no significant difference between mulched at a rate of 0.5 and 1 kg m^{-2}in the same method application. Data in Tables (6 and 7) showed the plant height was (193 and 168cm) in no-tillage followed by (203 and 159cm) in case of conventional tillage, due to application of rice straw as compost for silty clay and sandy soils respectively, the application of rice straw as compost was more effective in conventional tillage than no-tillage in both sites.

Data regarding to number of grains cob^{-1} of maize Tables (6 and 7) showed the influence of rice straw as mulch or compost under two tillage methods on number of grains cob^{-1} of maize. As regards to tillage, the mean values of number of grains cob^{-1} were (389 and 155) observed in no-tillage followed by (549 and 105) in conventional tillage at all sites, respectively. The data regarding to number of cobs $plant^{-1}$ of maize Tables (6 and 7) indicated that tillage methods have non-significant in sandy soil but was superior effect in silty clay soil especially in case of no-tillage system. Conventional and no-tillage were statistically non-significant with each other.

As regards to mulch, the mean values for number of grains cob^{-1} were (578 and 514) observed in treatment where mulch applied on surface soil at rates of 1 and 0.5 kg m^{-2} respectively, followed by (510 and 500) in the treatment of mulch which was applied incorporated with soil at both rates respectively in silty clay soil, and mean values (173 and 154) in soil surface mulch in sandy soil, while were (153 and 107) in case of incorporated mulched with soil at rates of 1 and 0.5 kg m^{-2} respectively. There was no significant difference between the different mulch levels. Application of rice straw compost was slow effect on number of grains cob^{-1} as compared to mulch treatments, but higher than the control in both sites.

As regards to mulch, the mean maximum values of number of cobs $plant^{-1}$ 2.01 were observed in conventional tillage in silty clay soil, followed by 1.70 in case of mulched surface soil application at a rate of 1 kg m^{-2} combined with no-tillage in sandy soil. The application of rice straw mulched on surface soil was more effective on number of cobs plant $^{-1}$ especially at a rate of 1 kg m^{-2} in silty clay soil followed by a rate of 0.5 kg m^2 as compared to other treatments. There was no significant difference between the different mulch levels but were significantly different from as compared with control.

Data regarding to 1000-grain weight of maize are presented in Tables (6 and 7), which revealed that both tillage methods and rice straw as mulch and compost had been significant effect on 1000- grain weight of maize. As regards to tillage, the mean values of 1000-grain weight (346 and 246 g) were observed in no-tillage, followed by (376 and 208 g) in case of conventional tillage for silty clay and sand soils respectively.

As regards to mulch, the mean values of 1000- grain weight (395 and 239 g) were observed in treatment where rice straw mulched was applied at a rate of 1 kg m^{-2} soil surface application, followed by 380 and 336 g in treatment where mulch was applied at a rate of 0.5 kg m^{-2} in both soils respectively, while mean values (370 and 232g) and (378 and 350 g) were observed in mulched incorporated with soil application at rates of 1 and 0.5 kg m^2 respectively in silty clay and sandy soils respectively. There was no significant difference observed in the two mulch levels applied in case of mulched incorporation with soil, but they were significantly different in surface soil especially in silty clay soil. While minimum value was observed in case of rice straw compost (360 and 206 g) for conventional tillage, while was (312 and 212 g) for no-tillage in both sites respectively as compared to control treatments.

Data pertaining to grain yield of maize are listed in Tables (6 and 7), which showed the influence of tillage and mulch on grain yield of maize. As regards to tillage, the mean values of grain production were (2756 and 1954 kg fad^{-1}) observed in no-tillage, while were (2897 and 1467 kg fad^{-1}) in case of conventional tillage in all sites respectively. Conventional and no-tillage were statistically significant effect to grain yield in two sites under studied.

As regards to mulch, the mean grain yield (3417 and 2516 kg fad^{-1}) were observed in treatment where mulch was applied on the surface soil at a rate of 1 kg m^{-2} in silty clay and sandy soils, followed by (3339 and 2251 kg fad $^{-1}$) in treatment where mulch was applied at a rate of 0.5 kg m^{-2} in both sites respectively. There was significant difference in grain yield when mulch was applied at rates of 1 and 0.5 kg m^{-2} as compared with control. Also, data in Tables (3 and 4) showed the significant difference between mulch rates and methods applied. The application of rice straw compost in silty clay gave higher values of grain yield (2975 kg fad $^{-1}$) in conventional tillage than in case of no-tillage, but was more effective in sandy soil in no-tillage.

Stalks yield gave same the trend as in grains yield due to application of rice straw as mulched and compost under two tillage methods in both two sites. Compost treatment was superior in case of silty clay soil under conventional tillage as compared to control treatment.

From the previous results concluded that, the two tillage methods were affected the maize yield, generally, no-tillage method was more effective on height plant, number of grains cob $^{-1}$, number of cob plant $^{-1}$, 1000 grains weight, grains and stalks maize yields grown in sandy soil, but the conventional tillage was superior for maize yields grown in silty clay soil. As regard to rice straw, data showed that mulched was better on maize yields in both sites as compared to rice straw compost especially, for surface application at a rate of 1 kg m^{-2} in silty clay soil followed, by sandy soil, generally, this effect was increased by the increase of mulched rate application. Interaction between tillage methods and mulch levels were statistically significant for growth of maize in case of plant height, 1000-grain weight and grains and straw maize yields, while these results were non- significant for number of cobs per plant and number of grains per cob. agreement with those of (Khurshid *et al.*, 2006). Wicks *et al.* (1994) concluded that early maize growth was retarded by increasing mulch levels due to reduced soil temp., but after tasselling maize grew taller under greater mulch levels due to increased soil moisture. They also reported that stover dray matter (DM) and total DM (hence plant height) increased with increasing mulch levels. These results are also in accordance with Walter *et al.*, (2009) who showed that on both soil types, neither mulching nor tillage method had a significant effect on maize grain yield. Tillage methods significantly influenced stover production with planting basins giving the highest stover yield on sandy soil and conventional ploughing on clay soil. We conclude that minimum tillage, even in combination with mulching gives only small yield benefits in the short term. Mulching helps conserve soil water, but the benefits level at 4 t ha^{-1} of mulch application. On the other hand, a laboratory study showed that 1 kg m^{-2} of organic mulch was sufficient to cover the soil for rice, barley straw and maize harvest residue, (Anzalone *et al.*, 2009). Also, Surface-applied mulches provide several benefits to crop production through improving water, heat energy and nutrient status in soil, (Bu *et al.*, 2002).

On the other hand, Murari and Pandey (1984) mentioned similar reasons for obtaining higher yield of wheat from mulched treatment. The high root density directly beneath the straw mulch layer is attributed to favorable soil moisture and temperature regimes. The increased root density enhanced better uptake of water and nutrients and ultimately increased grain yield. The results of the present study are in agreement with the findings of (Rahman *et al.*, 1993). Surface mulch also increases soil microbial biomass (Jackson *et al.,* 2003), however, decomposing cover crop can lead to immobilization of nutrients by soil microbes (Hoyt, 1999).

N, P and K Contents in Maize Plants:

• Nitrogen Content in Maize Grains and Shoots:

The data regarding to the effect of tillage and mulch on nitrogen content (mg $plant^{-1}$) in grains and shoots at maturity indicated that tillage systems affected N significantly in grains and shoots (Table 8). The mean N content in grains maize was observed in no-tillage (258 and 151 mg $plant^{-1}$) while was in conventional tillage (287 and 128 mg $plant^{-1}$) in silty caly and sandy soils respectively. Similar trend in case, of maize shoots was observed (Table 8). Mean N content in maize shoots were found in no-tillage (212 and 146 mg $plant^{-1}$) while, in conventional tillage were (241 and 103 mg $plant^{-1}$) in both soils respectively. Tillage also affect nitrate-N concentration, water contents, aeration and available C (Khurshid *et al.*, 2006), which in turn, can impact N loss through denitrification and N_2O emissions. Conservation tillage methods are considered most effective under low rainfall conditions. No-tillage with standing stubble conserves soil organic matter and water, generally increases crop production (Phillips *et al.*, 1980).

As regard to rice straw as mulched, mean N content in maize grains was observed in no-tillage (290 and 166 mg $plant^{-1}$), while in case of conventional tillage was (323 and 142 mg $plant^{-1}$) followed by rice straw compost in no-tillage (223 and 123 mg $plant^{-1}$) but was in conventional tillage (235 and 103 mg plant $^{-1}$) in both soils respectively, minimum in control treatment. But mean N content in maize shoots was observed in rice straw as mulched (239 and 160 mg $plant^{-1}$) in case of no-tillage, while was in conventional tillage (277 and 110 mg $plant^{-1}$) followed by compost in no-tillage (167 and 120 mg $plant^{-1}$) but was (187 and 95.9 mg $plant^{-1}$) in case of conventional tillage in all sites respectively.

Generally, the results indicated the application of straw mulched was more effective on increasing the N content in maize grains and shoots, especially surface soil mulched application at a rate of 1kg m^2, as compared to rice straw compost, it could be due to the straw mulching reduced the maximum soil temperature and helped in conserving soil moisture thus improving the edaphic environment and favoured the various growth parameters, also, increased nutrients in soil solution through recycling nutrients mainly nitrogen and calcium (Aguiar, 2006). The results in Table (8) indicated the N content in maize grains and shoots were lower in sandy soil than silty clay soil, this may be due to the light texture, poor fertility and low water retentively of sandy soils which restrict the crop productivity.

Concerning the interaction of mulched and tillage, data in Table (8) showed the surface soil mulched application rate of 1kg m^{-2} incorporated with conventional tillage was superior for N content in maize grown in silty clay soil, while the same treatment incorporated with no-tillage was better in sandy soil. Minimum tillage coupled with straw mulch application to the whole plot was found to be highly effective in promoting the various plant growth and yield parameters by providing maximum surface cover and improving the physical conditions of the soil. The interactive effect of tillage and mulch was significant at all treatments. There are a number of factors which may affect the availability of nutrients where this tillage method is used. It is believed that the lower N status under mulch was due chiefly to changes in the soil microflora brought about by this tillage, (Moody *et al.*, 2010).

Phosphorous Content in Maize Grains and Shoots:

The data regarding the effect of tillage and mulch on phosphorous content (mg $plant^{-1}$) in grains and shoots revealed that tillage and mulch had statistically significant effect on phosphorous content in maize grains and shoots (Table 8). The maximum phosphorous content in grains and shoots of maize was observed in conventional tillage in case of silty clay soil while the maximum values were observed in sandy soil in case of no-tillage. Mean phosphorous content in maize grain was observed in no-tillage (91 and 56 mg plant $^{-1}$) and (100 and 44 mg plant $^{-1}$) in case of conventional tillage. Maximum P content in shoot of maize was observed in no-tillage (78 and 47 mg plant $^{-1}$) while in conventional tillage was (88 and 44 mg plant $^{-1}$) in both soils respectively. Similar results were found for application of rice straw compost. Straw mulched at a rate of 1kg m^{-2} was superior for increasing P content in maize grains and shoots especially surface soil application. Acharya and Sharma (1994) reported that mulched treatments showed significantly greater total uptake of nitrogen, phosphorus and potassium than corresponding unmulched ones. The interactive effect of tillage and mulch affected significantly in maize grains and shoots (Table 8). Maximum P content in maize grains and shoots was observed in conventional tillage in case of silty caly soil while was in no-tillage in case of sandy soil. Similarly, minimum P content was found in rice straw compost as compared to straw mulched in all sites.

Potassium Content in Maize Grains and Shoots:

The data regarding the effect of tillage and mulch on potassium content (mg plant^{-1}) in maize grains and shoots are presented in Table (8). Tillage systems affected non-significantly K content in all treatments. Maximum K content in maize grains and shoots was observed in no-tillage in sandy soil while maximum K content in silty clay soil observed in case of conventional tillage. But at harvest, mean maximum K content in maize grains was (297 and 213 mg plant^{-1}) in case of no-tillage, while in conventional tillage was (331 and 153 mg plant^{-1}), on the other hand, mean K content in maize shoots was recorded for no- tillage (287 and 241 mg plant^{-1}) and (275 and 173 mg plant^{-1}) in conventional tillage in silty clay and sandy soils respectively. Iqbal *et al.* (2005) reported that tillage methods significantly increased K content in shoots only, while their effect on N and P content in shoot was non-significant.

Mulch levels affected non-significantly K content in maize grains and shoots Table (8), generally, straw mulched at a rate of 1kg m^{-2} was better for K content in all parts of maize plant especially, soil surface application compared to the other level and method application. Interaction effect between straw mulch and tillage on K content showed that the mean K content was (338 and 230 mg plant^{-1}) and (311 and 256 mg plant^{-1}) in case of no-tillage, while was (382 and 168 mg plant^{-1}) and (305 and 192 mg plant^{-1}) in case of conventional tillage respectively, in silty caly and sandy soils respectively. But minimum values were obtained after rice straw compost application under two tillage systems followed by control treatments. The interactive effect of mulch and tillage on K content was found non-significant in maize grains and shoots (Table 8).

Acharya and Sharma (1994) also reported that mulched showed significantly greater total uptake of nitrogen, phosphorus and potassium than un-mulched ones.

We can concluded from the previous results that all form straw mulched and tillage system had the biggest impact on maize yields and N, P and K contents in grains and shoots, especially surface soil mulched application with at a rate of 1kg m^{-2} followed by surface soil mulched with at a rate of 0.5 kg m^{-2}, then incorporated mulched with soil at rates of 1 and 0.5 kg m^{-2} under no tillage or conventional tillage on bases of texture soil. Rice straw compost was slower effect on nutrient content in two parts of maize compared to straw mulched, it could be due to the organic manure is low in the C/N ratio and therefore be faster in the decomposition and the release of elements in the early stages of plant growth than row materials (straw mulched). Liu *et al.* (2002) concluded that mulch increases soil moisture and nutrients availability to plant roots, in turn, leading to higher grain yield.

Water Use Efficiency (WUE) and Economic Evaluation:

Water used efficiency and economic evaluation under rice straw as mulched or compost and two tillage system treatments are shown in Table (9). A comparison between different tillage on water use efficiency in all sites the obtained results indicated that WUE value was recorded 0.27 and 0.19 ton fed^{-1} cm^{-3} under no-tillage due to application of rice straw mulch in silty clay and sandy soil respectively, while was recorded 0.25 and 0.16 ton fed^{-1} cm^{-3} under conventional tillage respectively. No-tillage with preserved plant remains in soil surface, soil temperature, soil radiation reflected with reduced moisture and store, it reduces evaporation and increases water infiltration into the soil to further and require less water during irrigation and consequently shows higher efficiency, (Cresswell *et al*., 1993). Karamanous *et al.*, (2004) showed that conservation tillage system generally causes more stored moisture in the soil that reduces water consumption. This system compared with conventional tillage system due to residue on soil surface reduces evaporation of soil moisture and increase water infiltration and reduce slavery.

The application of rice straw compost was recorded 0.26 and 0.18 ton fed^{-1} cm^{-3} under no-tillage while was 0.26 and 0.10 ton fed^{-1} cm^{-3} under conventional tillage in all sites respectively. Organic matter retains more water and slowly nutrients releases than the chemical fertilizers do.

As regard to levels and methods application of mulched, this result indicated the application of surface mulched at a rate of 1kg m^{-2} was more superior for increasing water use efficiency due to surface organic mulch (straw) which can result storing more precipitation water in soil by reducing storm runoff, increasing infiltration, and decreasing evaporation (Schertz and Kemper, 1998) while, no-mulch treatment significantly lower water use efficiency due to more evaporation from the bare soil surface without mulch. It was also reported that straw mulch increased soil water storage, decreased soil evaporation and increased plant transpiration (Raeini- Sarjaz and Barthakur, 1997). The mulch layer on the field surface reduces the intensity of turbulent exchange between the atmosphere and soil water, which causes soil moisture to be prevented from evaporating, and thus reduces ineffective water consumption (Dong and Qian, 2002). Ahmad *et al.* (2007) indicated that increasing rate of wheat straw mulch from 1 to 4 t ha^{-1} enhanced the soil water contents progressively at various stages of crop growth. Data in Table (9) also presents an interaction effect between mulch and tillage treatments which was no clear in silty clay and sandy soils, while, response was obtained comparatively higher under treatment M4+T1 and M3+T2 followed by M4+t2 and M3+T2 (Table 9). Mulching gave statistically superior results over no mulch with respect to grain and stover yields, and water use efficiency (WUE), and it also reduced total water used. It was concluded that when mulch water was used more efficiently, it produces higher crop yield as compared to no-mulch, (Shaheen, *et al.,* 2010).

Total cost of production, gross returns, net returns and investment of maize as affected by different treatments are presented in Table (9). Conventional tillage system with and without straw mulch was registered higher gross return and net return as compared to no-tillage in silty clay soil, while no-tillage was more effective in sandy soil. Generally, all treatments fulfilled reasonable profitability where their investment factor (IF) values were more than 0.2. Net return (NR) and investment factor (IF) values of surface soil mulched at rates of 1 and 0.5 kg m^{-2} were superior for those of incorporated with soil. It is clear that the effect of mulched on NR was as follows: mulched > compost > control.

As for the effect of different levels of straw mulched on NR and IF, the Table (9) show that the values of net return (NR) increased with increasing the applied rate, on contrary, the investment factor (IF) was decreased. This means that the highest yield does not necessarily mean the highest profitability. Table (9) it is noticed that rice straw compost gave minimum values for each of NR and IF. Therefore, it could be recommended with surface soil mulched at a rate of 0.5 kg m^{-2} application because it is cheaper. Howeve, highest net returns (10311 L.E. fed^{-1}) due to application of M3+T2 (rice straw as mulched at a rate 0.5 kg m^{-2} surface soil application combined with conventional tillage) in silty clay soil, while, the lowest value was (1481 L.E. fed^{-}1) due to application of C+T2 (compost rice straw combined with conventional tillage) in sandy soil. Interaction effect between tillage and straw mulched resulted in optimum plant growth and development with improvement in water use efficiency.

Table 3: Effect of mulch and compost on soil physical properties under tillage condition in silty clay soil.

Treatments	Bulk density gm cm^{-3}	Total soil porosity%	Field capacity%	Welting point %	Available water %	Hydraulic conductivity $cm.h^{-1}$	Soil organic matter content %
				No-tillage			
Control +T1	*1.42	46.41	27.23	12.34	14.98	0.81	1.42
M1+T1	1.39	47.56	30.45	14.23	16.22	0.97	1.55
M2+T1	1.38	47.92	33.01	15.67	17.34	1.20	1.53
Mean	1.39	47.74	31.73	14.95	16.78	1.09	1.54
M3+T1	1.36	48.67	34.21	14.35	19.86	1.30	1.58
M4+T1	1.35	49.05	37.20	16.83	20.37	1.34	1.64
Mean	1.36	48.86	35.71	15.59	20.12	1.32	1.61
C+T1	1.40	47.17	29.23	13.28	15.95	0.95	1.52
Mean	1.38	47.80	31.89	14.45	17.45	1.10	1.54
			Conventional tillage				
Control +T2	1.41	46.79	29.34	12.45	16.89	0.85	1.48
M1+T2	1.37	48.30	33.23	13.75	19.48	1.15	1.62
M2+T2	1.36	48.67	35.75	14.35	21.40	1.25	1.64
Mean	1.37	48.49	34.49	14.05	20.44	1.20	1.63
M3+T2	1.34	49.43	36.67	14.57	22.10	1.34	1.68
M4+T2	1.33	49.81	38.15	14.65	23.50	1.37	1.72
Mean	1.34	49.62	37.41	14.61	22.80	1.36	1.70
C+T2	1.39	47.56	31.54	14.11	17.43	1.11	1.60
Mean	1.37	48.43	34.11	14.31	19.80	1.18	1.62
L.S.D. 0.05	0.02	4.02	1.23	0.43	0.04	0.11	0.12

Table 4. Effect of mulch and compost on soil physical properties under tillage condition in sandy soil

Treatments	Bulk density gm cm^{-3}	Total soil porosity%	Field capacity%	Welting point %	Available water %	Hydraulic conductivity $cm.h^{-1}$	Soil organic matter content %
				No-tillage			
Control +T1	*1.95	26.42	18.81	7.91	10.90	5.68	0.54
M1+T1	1.93	27.17	19.64	8.56	11.08	5.52	0.65
M2+T1	1.90	28.30	23.01	9.01	14.00	5.48	0.67
Mean	1.92	27.74	21.33	8.79	12.54	5.50	0.66
M3+T1	1.89	28.68	20.45	8.41	12.04	5.42	0.69
M4+T1	1.87	29.43	24.45	10.11	14.34	4.98	0.71
Mean	1.88	29.06	22.45	9.26	13.19	5.20	0.70
C+T1	1.94	26.79	19.22	8.34	11.04	5.48	0.59
Mean	1.91	27.80	20.93	8.72	12.21	5.36	0.64
			Conventional tillage				
Control +T2	1.96	26.03	18.79	7.88	10.91	5.68	0.51
M1+T2	1.94	26.79	19.33	8.42	10.91	5.62	0.56
M2+T2	1.93	27.17	21.57	8.47	13.10	5.57	0.59
Mean	1.94	26.98	20.45	8.45	12.01	5.60	0.58
M3+T2	1.90	28.30	20.34	8.93	11.41	5.45	0.62
M4+T2	1.89	28.68	22.76	9.02	13.74	5.38	0.65
Mean	1.90	28.49	21.55	8.98	12.58	5.42	0.64
C+T2	1.95	26.42	18.96	8.12	10.84	5.54	0.54
Mean	1.93	27.23	20.29	8.47	11.82	5.42	0.59
L.S.D. 0.05	0.01	3.12	1.24	0.10	0.33	0.24	0.03

*Means two Consecutive seasons.

Table 5: Effect of rice straw mulch and compost under different tillage systems on water storage porosity (WSP),residual porosity (RP), air porosity (AP), total drainable porosity (TDP), quick drainable porosity (QDP) and slow drainable porosity (SDP) in silty clay and sandy soils.

Treatments	WSP%	RP%	AP%	TDP%	QDP%	SDP%
			Silty clay soil			
			No-tillage			
Control +T1	14.89	12.34	19.18	27.15	5.01	22.14
M1+T1	16.22	14.23	17.11	25.73	6.23	19.50
M2+T1	17.34	15.67	14.91	26.87	6.12	20.75
M3+T1	19.86	14.35	14.46	25.21	7.54	17.67
Mean	16.78	14.95	16.01	26.30	6.18	20.13
M4+T1	20.37	16.83	11.85	24.90	6.84	18.06
Mean	20.12	15.59	13.16	25.06	7.19	17.87
C+T1	15.95	13.28	17.94	25.87	5.42	20.45
Mean	17.44	14.45	15.91	25.96	6.19	19.76
			Conventional tillage			
Control +T1	16.89	12.45	17.45	20.03	5.19	14.84
M1+T1	19.48	13.75	15.07	16.65	6.23	10.42
M2+T1	21.40	14.35	12.92	17.95	6.72	11.23
Mean	20.44	14.05	14.00	17.30	6.48	10.83
M3+T1	22.10	14.57	12.76	16.57	7.12	9.45
M4+T1	23.50	14.65	11.66	17.79	7.54	10.25
Mean	22.8	14.61	12.21	17.18	7.33	9.85
C+T1	17.43	14.11	16.02	19.43	5.95	13.48
Mean	20.32	14.16	14.39	18.48	6.50	11.69
L.S.D. 0.05%	1.12	1.06	0.45	2.45	0.23	0.45
			Sandy soil			
			No-tillage			
Control +T1	10.90	7.91	7.61	31.57	28.70	2.87
M1+T1	11.08	8.56	7.53	26.57	22.90	3.67
M2+T1	14.00	9.01	5.29	24.51	21.23	3.28
Mean	12.54	8.79	6.41	25.54	22.07	3.48
M3+T1	12.04	8.41	8.23	23.17	19.54	3.63
M4+T1	14.34	10.11	4.98	22.49	17.63	4.86
Mean	13.19	9.26	6.61	22.83	18.59	4.25
C+T1	10.88	8.34	7.57	28.43	25.42	3.01
Mean	12.21	8.72	6.87	26.12	22.57	3.55

Table 5: Continue.

			Conventional tillage			
Control +T1	10.91	7.88	7.24	32.01	29.56	2.45
M1+T1	10.91	8.42	7.46	28.22	25.46	2.76
M2+T1	13.10	8.47	5.60	26.70	23.75	2.95
Mean	12.01	8.45	6.53	27.46	24.61	2.86
M3+T1	11.41	8.93	7.96	24.91	21.90	3.01
M4+T1	13.74	9.02	5.92	23.82	20.38	3.44
Mean	12.58	8.98	6.94	24.37	21.14	3.23
C+T1	10.84	8.12	7.46	30.25	27.56	2.69
Mean	11.82	8.47	6.94	27.65	24.77	2.88
L.S.D. 0.05%	0.03	0.12	0.23	1.04	2.11	0.34

Table 6: Yield and yield contributing characters of maize as affect by rice straw as mulched or compost and tillage condition grown in silt clay soil.

Treatments	Plant height (cm)	No of grains cob-1	No of cob plant-1 weight g	1000 grain	Grain Yield Kg fad-1	Shoot yield Kg fad-1
			No-tillage (T1)			
Control +T1	*175	294	1.0	305	1485	2540
M1+T1	205	397	1.0	354	2745	3075
M2+T1	209	411	1.2	365	2875	3125
Mean	207	404	1.1	360	2810	3100
M3+T1	211	418	1.6	362	3261	4332
M4+T1	214	498	1.7	379	3345	4875
Mean	213	458	1.7	371	3303	4604
C+T1	193	315	1.0	312	2825	3098
Mean	202	389	1.3	347	2756	3508
			Conventional tillage (T2)			
Control +T2	*183	385	1.23	309	1684	2845
M1+T2	214	603	1.33	386	2874	3426
M2+T2	219	609	1.45	390	2945	3582
Mean	217	606	1.4	388	2910	3504
M3+T2	225	611	1.98	398	3418	4975
M4+T2	237	659	2.01	410	3489	5112
Mean	231	635	2.0	405	3454	5044
C+T2	203	425	1.30	360	2975	3248
Mean	214	549	1.6	376	2898	3865
L.S.D. 0.05%	15.23	31.20	0.02	4.51	23.25	21.05

* Means two Consecutive seasons

Table 7: Yield and yield contributing characters of maize as affect by rice straw as mulch or compost and tillage condition grown in sandy soil.

Treatments	Plant height (cm)	No of grains cob-1	No of cob plant-1 weight g	1000 grain	Grain Yield Kg fad-1	Shoot yield Kg fad-1
			No-tillage (T1)			
Control +T1	*162	102	1.0	205	985	1540
M1+T1	172	111	1.2	254	1805	2075
M2+T1	185	197	1.0	265	2145	2135
Mean	179	154	1.1	260	1975	2105
M3+T1	187	198	1.7	262	2353	2485
M4+T1	194	218	1.6	279	2614	2432
Mean	190	208	1.7	270	2483	2458
C+T1	168	105	1.0	212	1825	2098
Mean	178	155	1.3	247	1955	2128
			Conventional tillage (T2)			
Control +T2	155	85.94	0.93	190	684	845
M1+T2	163	103	1.05	209	1294	1582
M2+T2	169	109	1.13	236	1284	1346
Mean	166	106	1.1	223	1289	1464
M3+T2	170	111	1.21	210	2149	2512
M4+T2	178	129	1.28	198	2418	2575
Mean	174	120	1.2	204	2284	2544
C+T2	159	95.3	1.0	206	975	1148
Mean	166	106	1.1	209	1467	1668
L.S.D. 0.05%	21.03	29.02	0.04	10.21	18.90	17.05

*Means two Consecutive seasons

Table 8: Effect of rice straw as mulch or compost on concentration N, P and K in grains and shoots of maize plants under tillage system in silty clay and sand soils.

Treatments	Concentration of nutrient mg plant-1					
	Grains			Shoots		
	N	P	K	N	P	K
			Silty clay soil			
			No-tillage			
Control +T1	165	71.3	195	148	59.7	187
M1+T1	217	85.4	257	187	75.7	217
M2+T1	287	90.3	314	213	84.2	294
Mean	252	87.8	285	200	79.9	255
M3+T1	310	101	378	257	89.6	342
M4+T1	345	110	401	298	94.1	389
Mean	328	106	390	278	92	366
C+T1	223	89.2	234	167	65.4	294
Mean	306	107	353	251	92	339
			Conventional tillage			
Control +T1	198	74.3	212	151	62.5	197
M1+T1	224	95.4	310	197	82.1	234
M2+T1	305	103	396	275	92.6	275
Mean	265	99	353	236	87	255
M3+T1	367	110	403	290	98.4	314
M4+T1	395	125	417	345	103	398
Mean	381	118	410	318	101	356
C+T1	235	94.0	245	187	89.9	237
Mean	395	136	458	333	119	275
			Sandy soil			
			No-tillage			
Control +T1	118	42.5	176	114	31.6	197
M1+T1	135	50.1	204	128	42.6	231
M2+T1	142	54.6	210	145	47.8	245
Mean	139	52	207	137	45	238
M3+T1	175	67.8	234	169	57.9	257
M4+T1	210	70.1	271	198	63.2	289
Mean	193	69	253	184	61	273
C+T1	123	47.9	182	120	37.8	227
Mean	206	76	289	199	64	241
			Conventional tillage			
Control +T1	96.7	32.7	114	83.6	27.3	119
M1+T1	114	42.5	146	97.6	44.3	167
M2+T1	135	44.1	153	102	47.9	187
Mean	173	60	207	142	60	237
M3+T1	141	49.4	175	119	52.9	203
M4+T1	176	56.4	196	121	60.7	212
Mean	208	208	208	208	208	208
C+T1	103	38.4	132	95.4	32.6	149
Mean	183	63	218	147	64	173
L.S.D. 0.05%	14.5	5.26	40.5	20.1	3.76	43.2

Table 9: Effect of rice straw as mulch or compost under two systems tillage on water use efficiency, total cost, gross return, net return and investment factor

Treatments	Total yield ton fed-1	WUEton fed-1 cm-3	Economic evaluation			
			Total cost L.E	*Gross return L.E	Net return (NR) L.E	Investment Factor (IF)
			Silty clay soil			
			No-tillage			
Control +T1	4.03	0.19	205	5367	5162	26.18
M1+T1	5.92	0.26	680	7760	7080	11.41
M2+T1	6.00	0.25	1310	8000	6690	6.11
M3+T1	7.59	0.28	680	10124	9444	14.89
M4+T1	8.22	0.30	1310	10960	9650	8.37

Table 9: Continue.

C+T1	5.82	0.26	1150	7897	6747	6.87
			Conventional tillage			
Control +T2	4.53	0.19	405	6039	5634	14.91
M1+T2	6.30	0.24	880	8400	7520	9.55
M2+T2	6.53	0.22	1510	8703	7193	5.76
M3+T2	8.39	0.28	880	11191	10311	12.72
M4+T2	8.60	0.28	1510	11468	9958	7.59
C+T2	6.22	0.26	1350	8297	6947	6.15
			Silty clay soil			
			No-tillage			
Control +T1	2.53	0.12	205	3367	3162	16.42
M1+T1	3.88	0.18	680	5173	4493	7.61
M2+T1	4.28	0.16	1310	5707	4397	4.36
M3+T1	4.84	0.21	680	6451	5771	9.49
M4+T1	5.05	0.19	1310	6728	5418	5.14
C+T1	3.92	0.18	1150	5231	4081	4.55
			Conventional tillage			
Control +T2	1.53	0.07	405	2039	1634	5.03
M1+T2	2.88	0.14	880	3835	2955	4.36
M2+T2	2.63	0.10	1510	3507	1997	2.32
M3+T2	4.66	0.22	880	6215	5335	7.06
M4+T2	4.99	0.19	1510	6657	5147	4.41
C+T2	2.12	0.10	1350	2831	1481	2.10
L.S.D. 0.05%						

Where: Gross total =yield x sale price
Net return = gross return - total cost
Investment factor= gross return/ total cost

Conclusion:

Rice straw as mulched or compost was more effective on maize yield and soil physical properties in silty clay and sandy soils, especially mulched combined with no tillage and conventional tillage. It could be due to the application of mulched led to increase of moisture content and total carbon in soil and decreased of evaporation and temperature especially soil surface application. The effect of rice straw mulch was increased with increasing the rate of application; therefore, the application of rice straw mulched on surface soil at a rate of 1 kg m^{-2} was more effective on maize yield and physical properties than other treatments. Mulch combined with any tillage method was significantly affected the soil growth of maize and physical properties as it increased plant height, grain, stalks yield soil moisture contents, organic matter contents, and improved of bulk density, total porosity, hydraulic conductivity, pore size distribution. Effect of tillage method was depended on texture soil, however, maize yield and physical properties under studied were more response to no-tillage in case of sandy soil , while the conventional tillage was better in silty clay soil. Also, the application of straw mulched combined with tillage was more effective on water use efficiency in two soils compared to other treatments. Tillage significantly affected the N and P concentrations in maize shoots, while effect on K concentration was non-significant. Mulch significantly increased N and P concentration in maize shoots and its effect on K concentration was non-significant. Interactive effect of mulch and tillage was statistically significant in case of N and P concentrations but non-significant in case of K concentration.

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