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The Effect of Different Tillage Systems on Some Soil Properties and Production of Radish (Raphanus Satives)

تأثير نظم الحراثه المختلفة علي بعض خصائص التربة وإنتاجية محصول الفجل

By

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Dedication

To my generous father

Fine Mother

Loved Brother

My Sincere Husband

To my daughter (Roba)

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I would like to express my sincere appreciation to my supervisor **Khalifa Ahmed Khalifa** for his useful guidance ,constructive direction patience and his sacrifice support throughout this study I am also grateful to Department of Horticulture for their participation during my study .

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The Effect of Different Tillage Systems on Some Soil Properties and Production of Radish (Raphan Sative)

Wissam Alamin Taha

Abstract: this study was conducted at the demonstration farm of the horticulture Department at the College of Agricultural Studies Sudan University of Science and Technology Shambat Khartoum North sudan four tillage systems were tested selector disc plough followed by disc harrow,scraper and ridger (dpdhsr) chisel plough followed by disc harrow, scraper and ridger (cpdhsr) rotovator only and zero tillage system with direct seeding. The purpose of the study was to determine the most appropriate system of land preparation for radish plant production (raphanus satvus) under Khartoum State Condition

The nutritive value of the plant was measured It was clear that different tillage system had effect on soil parameter and to lesser extent on plant parameters The highest crop production was obtained with the third system where Rotovator when used only The nutritive value analysis showed no significant defferens between different tillage system Randomized complete block(rcb)designe has been used to carry out the experiment the generated data collected from the field and the laborotary was subjected to statistical analysis fur the more of different tillage system upon as some soil physical properties have been studies in three different depths (10cm,20cm,30cm) the tillage system have similar effect on plant parameters particulevly the mean number plant per hectare , mean number of length of plant root(cm),mean plant weight (gm),mean number of leaves per plant and root diameter

تأثير نظم الحراثه المختلفة علي بعض خصائص التربة وإنتاجية محصول الفجل

وسام الأمين طه

الملخص: أجريت هذه التجربة بالمزرعة التوضيحية لقسم البساتين بكلية الدراسات الزراعية جامعة السودان للعلوم والتكنولوجيا بشمبات الخرطوم بحري لقد تم اختيار أربعة نظم للحراثة 1(محراث قرصي+مشط قرصي+قصابيه+طراد)2 (محراث أزميلي + مشط قرصي+ قصابيه+ طراد) 3(طراد)4(زراعة مباشرة) لقد كان الهدف من الدراسة هو تحديد المنظومة المثلى لتحضير الأرض لمحصول الفجل في ولاية الخرطوم لقد تم تحليل البيانات المتحصل عليها من التجربة إحصائيا باستخدام القطاعات العشوائية الكاملة ومن ثم إخضاع النتائج المتحصل عليها من الحقل للتحليل الإحصائي لقد تمت دراسة تأثير نظم الحراثة المختلفة على عوامل النبات متوسط عدد النباتات بالهكتار-متوسط عدد الأوراق بالنبات-متوسط طول النبات –متوسط وزن النبات-متوسط وزن الجزور –وإنتاج النبات لقد تمت دراسة القيمة الغذائية للنبات وطبقا للنتائج المتحصل عليها هناك تأثير على نظم الحراثة المختلفة على عوامل التربة وقد كان هذا التأثير بطريقة اقل على عوامل النبات .ان أعلى إنتاجية تم الحصول عليها عند استخدام النظام الثالث عند استعمال القصابيه فيما يتعلق بتحليل القيمة الغذائي لم تظهر أي فروقات معنوية

CHAPTER ONE

INTRODUCTION

1.1 General

The Sudan is considered as the one of the largest countries in Africa. It has strategic position in the middle of the continent. It lies in warm latitude between (4^{o} - 22^{o} c)

The Sudan can be divided gradually from the further north descending south wards into six regions .the desert & semi desert & semi dry & semi humid and humid dry Agriculture in the Sudan is conventionally divided according to the source of water supply into two main sectors irrigated and rain fed agriculture

The two main sectors are further sub divided according to the level of modernized into traditional and modernization sub -sectors

The traditional subsectors are characterized by cultivation of small areas (1-2) hectares, use of hand tools or animal drawn implement for low yield, this situation puts the farmer in a vicious circle. The modernized varieties subsector are characterized by use of motorized machines certified seeds and application of fertilizer .herbicides and insecticides.

The most of research work is oriented towards this subsectors

*I*n Khartoum province traditional agriculture has been practiced for decades . the state is specialized in the production of horticultural products and fodders .naturally the small farms are situated near the Nile banks. Hand tools and animal drawn implements are used for production this subsector is the main supplier of vegetables and fruits to the inhabitants of the capital and the adjacent rural areas .

In the last two decade the agriculture in Khartoum estate has received a lot of attention from the decision markers. the old traditional sector has been modernized and news large project has been established.

Now a days vegetable consumption is increasing specially in Khartoum province due to a number of reasons the urban development, the improvement of standard of living and the awareness of common people to the good nutritive value of vegetable and fruits. At a regional and international level horticultural products consumption and demand is increasing at an increasing rate which encourage export purposes production. The main problem facing the expansion of vegetable and fruits are production is that vegetable and fruits are still produced by traditional methods and in small areas.

Changing the production system to a large scale production necessitate the fully mechanization of this sector .any modernization of this sector should be preceded by an intensive research that should lead to an appropriate technology for production. Due to the fact that land preparation is the backbone of any mechanization system

1-2 Objectives:

The objective of this study are as follows :

1- To study the effect of different using the land preparation system used for horticultural crop production
2- To evaluate the existing system of land preparation in horticultural production area in Khartoum estate
3- To test a pre-designed tillage system of Raphanuss satires (Radish)plant.
4- To select the best system of land preparation for raphanus satives (Radish) plant.

CHAPTER TWO

THE LITERATURE REVIEW

2- 1DTillage

2-1 -1Tillage definitions

According to Smith and Wilks (1973) tillage is defined as the preparation of the soil for planting. It is a process for keeping it loose and free from weeds during the growth of crops. Deere and company in their fundamentals of machine operation (FMO- 1976) define tillage as those mechanical soil steering actions carried out for purposes of nurturing crops. Wilkenson Robert and Braun bek (1977) define tillage as a mean of improving soil tilth and bringing desirable physical changes in the soil that improve crop growing conditions. Love grove H.T.(1981) defined it as a much important process than the mere breaking down of soil , it is a process that leads to the production of the ideal soil environment for germination of seeds and development of crops. Tillage in a wide sense may be defined as the mechanical manipulation of soil for any purpose. In agriculture the main objective of tillage is to provide optimum environmental condition for plant growth (Kepner K.A. *et- al* 1978). Lal (1995) stated that tillage includes all operations leading to seed bed preparation that optimized both soil and environment condition for good seed germination, seeding establishment and crop growth.

Tillage operation changes the soil surface in a number of ways, the obvious change is roughisning or smoothing of the surface (Abdalla and Mohamed 1998). It was confirmed that undisturbed soil seems to be harder and more resistance to root penetration than tilled soil In fact high soil strength has been proved to reduce and even to stop root growth. (Comp .bell. and Hens .hall 1991).

One of the goals of tillage is to reduce soil bulk density (increase soil porosity) and the large pores in the soil generally favur high infiltration rates good tilth and adequate aeration for plant growth.

In contrast to temperate regions, tillage practices in arid and semi-arid climates should aims to increase water intake and conservation capacities of soil reduce evaporation and decomposition of organic matter as well as decreasing erosion and control weeds (Lal 1995).

2-1-2 Importance and objectives of tillage

Accumulated experience and better knowledge of crop husbandry by farmers make tillage a much and more important procedure than the mere breaking down of the soil as stated by Love grove H.T.(1981).

The ideal soil environment for the germination of seeds and crop development needs a collection of processes that includes (Mustafa A.t2008):

1- Production of good tilth, the term tilth means the fine soil texture necessary to ensure close contact between the soil and the seeds and subsequently plant roots.
2- The inversion of top soil severs weeds and their surface foliage is buried.
3- The breaking down of the soil facilitates the entry and free circulation of air and promotes the activities of microorganisms.
4- The exposure of fresh soil to the atmosphere and to the changes of temperature, humidity and wind facilitates further aeration and tilth production.
5- Burial of previous crop`s residues and their decomposition provides the soil with humus, which improves the crump structure of the soil.
6- The opening and loosening of the top soil enables excess surface water to infiltrate into the soil.

The goal of proper tillage is to provide a suitable environment for seed germination, root growth, weed control, soil erosion control and moisture control that avoid moisture excess and reduce stress of moisture shortage (Deer and Company (FMO -1976).

The objectives of tillage are summarized by Kepner K.A.*et al* (1978) as follow:

1- The development of desirable soil structure for a seedbed or root bed. The granular structure is desirable to allow rapid infiltration and good retention of rain fall.
2- To provide adequate air capacity and exchange within the soil.
3- To minimize resistance to root penetration.
4- The good seedbed is generally considered to imply finer particles and greater firmness in the vicinity of the seeds.
5- To control weeds and remove undesirable plants and to manage plant residues.
6- Through mixing of trash which is desirable from the tilth and decomposition stand points whereas retention of trash in the top layers reduces erosion. Complete coverage of trash is sometimes necessary to control insects or to prevent interference with precision operations such as planting and cultivating certain crops.
7- To minimize soil erosion by following such practices as contour tillage listing and proper placement of trash and to establish specific surface configuration for planting, irrigation, drainage, harvesting operations etc.
8- To incorporate and mix fertilizers pesticides or soil amendment into the soil and to accomplish segregation. This may be involve moving soil from one layer to another, removal of rocks and other foreign objects or root harvesting .

The objectives of tillage are also enumerated by(Wilkenson Robert .H. and Braun bek. A. Oscar (1977)) as follows:

1- Creation of deep seedbed physically, chemically and biologically fitted to the growth of crops,
2- To add humus and fertility to the soil by covering and burying crop residues and manure so that they are incorporated in the soil.
3- To destroy and prevent weeds or other undesirable vegetation from growth.
4- To leave the soil in such condition as to retain good quantity of moisture.
5- To facilitate freely circulation of air.
6- To destroy insects as well as their eggs larvae and breeding habitat.
7- To leave the surface in a condition that prevents erosion by wind and water.

The same authors summarized the primary objectives and fundamentals purpose of tillage in three phases:

1- To prepare a suitable seedbed
2- To destroy competitive weeds
3- To improve the physical conditions of the soil

2-1-3 Evaluation of tillage operations

From a realistic management stand point each tillage operation must be evaluated on the basis of its contribution to one or more of the following goals (Deere and Company (FMO-1976)

- Management of crop residues
- Improvement of soil tilth
- Weed control
- Insect control
- Erosion control
- Soil aeration
- Prepare surface for other operations
- Temperature control for seed germination

- Moisture management
- To provide good seed, soil contact
- Incorporation of fertilizer

2-1-4 Tillage systems

According to tillage intensity and mode, systems categorized into conventional and conservational tillage systems. A tillage system may comprises a single pass or more with one machine or machines in sequences depending on crop state, of previous residues or weeds, soil characteristics, water quality and socio-economic factor (Lal 1995). Conventional tillage term is used for the type of tillage that beginning with primary deep tillage followed by some secondary tillage operation (Beaumer and Bakemans 1973). In conventional tillage the top soil is usually loosened but at some depth just below the ploughed layer. Consequently a compacted layer commonly called plough sole develops and is characterized by abnormally high bulk density (Mauraya 1993).

Conservation tillage system comprise varying degrees of soil disturbance describe as minimum reduced, low and finally zero tillage (lal 1995). These systems reduce pre planting tillage operations thus reducing soil erosion while saving labor and fuel. Conservation tillage may represent a broad spectrum of systems but is best described as tillage that leaves a minimum crop residue cover of 20-30% on the soil surface after planting (Melvin 2005- Alashri .S.R.2009).

Reduced tillage systems tested over several years and it has been proved that, it offers energy saving and reduced dust emission because they are less intensive than conventional tillage systems. Those types of tillage systems are associated with reduced soil compaction especially when they restricted wheel traffic to set path in the field a system known as controlled traffic farming. It also reduces field work time requirements because they require fewer passes over the field (Coates and Thacker 2001) but at the same time restoring or maintaining a good soil structure under minimal or no-till, on the other hand it can take place only if the organic matter in the soil increases considerably and the macrospores continuity is guaranteed, mostly due to (sustain mullah Lal1995).

(Melvin 2005) confirmed that no single tillage system is best for all situations at all times. Rotating tillage systems to coincide with crop rotations often provide a better alternative than a single system.

2-1-5 Tillage implements

Primary tillage is operated initially to break up or shatter compacted soil and then loosening the soil downwards to create pore volume for absorbing water and air to improve plant root and water penetration. At the same time it causes inversion of soil to bring up leached fine soil material and nutrients to the surface and decomposition of organic matter into deeper layers in addition to primary control of weeds. Four main types of implement are used as primary tillage implements; moldboard plow, disc plow, chisel plow and sub soiler. Each of them has its specific feature (Adam 2005).

1-Sub soilers: they are implements having a very specific and specialized function such as the deep ploughing for breaking hard pans of up to 100cm soil depth even in very compacted hard clay soil and loosens soil below the normal depth of tillage for maximum retention of water and root development (Hussein and Munir 1986). Some authors don't consider the sub soiler as a primary tillage implement and they put it in special category named specialized tillage implement.

2- Chisel plow: chisel plow is one of primary tillage implements which has a maximum loosening effect on soil, but with minimum pulverizing, mixing and inverting effects. It has a workable depth range of 46-76 cm (Doorenbos and Pruitt 1977). So that it used to break and shatter compacted soil to improve water penetration. It is operated more effectively at dry soil (Kepner*et al* 1982).

Chiseling at depths more than 16 inches is termed sub soiling (ASAE1979). Light chisel plow are available in different sizes they are used in cultivation and are called cultivators.

3-Moldboard plow: moldboard plow is the common implement of the temperate regions (Hussein and Munir 1986). It is adapted to the breaking of many types of soil and it is well suited for burying and covering crop residues (Smith and Wilkes 1986). Since soil plowing conditions vary widely many different shapes of moldboard have been developed. From functional stand point common types include general purpose bottom, black land bottom, digger, semi digger and slat moldboard (Kepner*et al* 1982). Despite the great success of this implement in temperate regions it finds difficulties to be accepted by the African farmer.

4-Disc plow: it partially or completely inverts and mixes soil horizons as well as buries weed at range of depth of 30-46 cm (Hussein and Munir 1986). It is more suitable for condition under which moldboard plows do not operate satisfactorily, such as hard dry soils, in sticky soil where moldboard plow are not able to score as in loose soil (Kepner*et al* 1982).

Shirin*et al* (1993) reported that disc plow consumes much energy in arid zone and it has greatest draft requirements which increase with increased speed and clay content. Degree of soil inversion tends to be reduced with increased tilt angle and the disc penetration was best at a low tilt angle. Reduced penetration has the advantage of reduced draft requirements.

2-1-6 Secondary tillage implements

Secondary tillage operations are optional complementary measured that mostly follow a primary tillage operation. Sometimes secondary tillage operations may be considered reduced or even completely omitted for economical or conservational justification, depending on prevailing farming conditions. They include implements that crush or pulverize clods resulting from primary tillage, land smoothing and leveling and establishing furrows or bed for crop planting (Adam 2005). Lal (1995) added that in this case lighter equipment was used to control weeds and smooth and firm the soil for good seed bed.

In spite of the availability of a large number of secondary tillage implements in the international market few of them are introduced in the Sudan and are used by the farmers and big schemes. These implements are:

1-Disc harrows: the disc harrows are used as secondary implements to crush the clodth cutting up and mixing stubble. Level the ground and controlling weeds (Smith and Wilkes 1986) they can be used also as a primary tillage implement for orchards (Adam 2005).

Smith and Wilkes(1986) enumerates factors within the harrow itself that influence the depth to which it penetrates the soil such as: the angle of the disc gang the weight of the harrow, the sharpness of the discs, the size of the discs, the concavity of the discs and the angle of hitch. Other factors include soil type and conditions prevaling in the area.

Disc harrows are divided into three types. Single acting which has two opposite gangs of discs bottom both throwing soil outwards from the center of the tilled strip. The second type is the tandem disc harrow in which two sets of single acting disc harrow are placed one behind the other. The rear set throws the soil back toward center as second operation. Thus tilling the soil twice and leaving the field more nearly leveled. The last one is the offset disc harrow in which one right hand gang operating in tandem (Kepner*et al* 1982).

2-Rotary tillers: rotary plows tillers are more complicated type of tillage equipment than most. In addition to the tractor power requirement power is needed to operate the rotor and pulverize the soil. As stated by Donel .R. Hunt and Lester W. Garver (1973) one consideration that is simpler on the rotary tiller than on most other types of tillage tools is the hitching forces. The rotary tiller has no side draft to consider and all the traction force is straight back behind the tractor. Rotary tillers can prepare a seedbed to a depth of (15 - 22.5 cm) if sufficient power is available.

Compare with the moldboard the rotary tiller needs three time greater power in the same soil. However the additional energy and cost for discing and harrowing after using the moldboard plow must be included to give a fair comparison and the rotary tiller should be credited with the increase in fuel efficiency obtained when a tractor transmit power through P.T.O rather than the drawbar. Rotary tiller normally need rotor speed between 100 – 300 rpm for good operation (Wolf .J.S.1985).

One of the criticisms of the rotary tiller is that it stirs the soil more than most other machines and can be expected to break down the soil structure more which is undesirable on loamy soils.

Conventional rotary tillers are good for cutting vegetation matter and mixing it through the tilled layer but coverage is not as complete as with the moldboard plow. They are also effective for mixing chemicals and manure into the soil.

Many types and shapes of blades have been developed but hoe type blades appear to be superior to other types in most aspects and are widely used. In trashy condition the L- shaped blades are better than the hook-shaped or the pointed blades. They are more effective in killing weeds and they do not pulverize the soil much. The rotor usually rotates in the same direction as the tractor wheels though reverse rotation has been investigated by various workers.

The high degree of pulverization although not desirable for root beds make conventional rotary tillers good for seedbed strips tilling and preparing precision-shaped raised beds for planting.

3- Scrapers: a large number of different models of land planes (scrapers) are available. The basic frame is constructed from steels that carry a rigid plane blade or bucket with a replaceable edge mounted perpendicular to the direction of travel.

Scrapers depth can be adjusted manually or hydraulically (Lorenz *et al* 1984). Pietola (2005) reported that reducing number of passes by substituting the combined machine instead of single operation has been a major concern of many studies. Minimum pass in the field particularly for tillage operation was goal to achieve sustainable farming. Especially of that increasing number of pass in tillage operation creates plow pan and would lead to hard pan after five years (Brikas *et al* 2005).

4- Ridger: Ridging is the operation by which soil is mounted to specific configuration to facilitate irrigation (ASAE 19979) it results in better soil and water management in surface irrigation than just establishing a seedbed. It determines the slope along which water can run off and may further decrease that slope to safer ranges when non-erosive seeds of water flow are required (Steven 1994).

A ridger consists of ridging bodies (3 - 5) with adjustable spacing. Ridges that of (70 – 80) cm spaced are commonly used. Ridger now a day are becoming reliable primary tillage tools in irrigated farming particularly in furrow irrigation (Yusuf Asota 1998).

2-1-7 Effect of tillage operation on some soil physical properties

The soil physical properties were commonly assessed and evaluated to detect the influence of different tillage practices on soil (Michael 1978). Lal (1995) also concluded that tillage requirements are generally soil and crop specific and hence climate is a tightly relevant variable. It is however difficult to predict the effects of tillage on soil as its physical biological and chemical characteristic will be affected by the manipulation process. The mode and intensity of tillage depends on the type of soil and related constants to crop production to avoid top soil degradation and subsequent erosion as well as fulfill soil conditions favorable for water infiltration and seedling and root development which ultimately results in economic yield (Michael 1978).

2-1-8 Effect of tillage on soil bulk density

The soil bulk density is defined as the ratio of the mass of dry solids to the bulk volume of the soil (Danielson and Sutherland 1986). The term bulk volume includes the volume of the solids and of the pore space. Bulk density is a widely used value for calculating porosity which gives an idea of the porous space left in soil for air and water movement (Cassel 1982). It varies with structure condition of the soil particularly that related to packing soil structure can be measured in various ways but perhaps it is most meaning fully evaluated through some knowledge of the amount size configuration or distribution of soil pores (Danielson and Sutherland 1986). The soil bulk density is the most widely used property to assess the changes in soil compactness resulting from the device load and other equipment. The soil bulk density is effected by so many soil characteristics such as texture, organic matter (Chan *et al* 1994), structure (Cassel 1982) and gravel content Frcenzen *et al* 1994). It also varies over year due to the action of climatic condition freezing and thawing (Unger 1991). Settling by desiccation and kinetic energy of rainfall. The biological factors are of great importance in bulk density value such as loosening by root action animal activity and finally crop operations specially tillage process may also alter bulk density (Cassel 1982).The soil porosity and pore size distribution are highly affected by bulk density and they have effects on some soil properties decreasing the bulk density increases the amount of water held at high soil water potentials and decreases the amount of water held at lower potentials however the optimal bulk density for plant growth is different for each soil high soil porosity lead to poor water retention and increases soil penetration resistance limiting root growth (Cassel 1982). From agronomical point of view root tips are unable to penetrate pores narrower than their diameter bulk density values that limit or alt growth depend on water content ranged between 1.46-1.9 g/cm^3 (Campwu and Henshall 1991).

The effect of minimum and no tillage had a subject of numerous experiments. The bulk density was studies under three different systems namely no-tillage conservation tillage and conventional tillage. The results obtained were different and in some cases contradicting in general those results could be grouped in three groups in most of the cases bulk density was greater in no-tillage in the first 5-10cm of soil (Unger and Jones 1998). In the second group no differences in bulk density were reported between different tillage systems (Cassel 1982; Iogsdon and Gamharadella 2000). In the third group the bulk density even decreased under no-tillage specially when an increase organic matter was observed in the first layer of soil (Edwards 1996; Crovetto 1998) this contradicting result were discuss by Kinselle (1995). Who stated that the first five years after the change from conventional tillage to no-tillage the two soils were in transition or repair period in which it builds humus and retains its structural stability and restores the pore space during this period there is first an increase in bulk density until a maximum and then a decrease due to destructing process until an equilibrium level is reached when the structure is fully restored.

The tillage system used has great effects in some soil physical properties. It significantly affect bulk density mainly by compaction or decomposition. (Alhashem 2004) reported that when a compaction force is applied by wheels traffic the bulk density and by consequence soil compaction will increase to values based on factors such as soil moisture content and wheels load. In an experimental conducted in a sandy soil Meek *et al* (1992) found that a wheels mass of 2.7 tons working on a tilled sandy soil resulted in a bulk density of 1.92 g/cm^3 compare to 1.67 g/cm^3 for un-trafficked soil (Abdalla and Mohamed 1998). In studing the interactions between plow types and plowing depth indicated that chisel plow at (0-15 cm) depth gave significantly less bulk density among the other treatments (ridging, no-till). The effect of tillage on the soil bulk density is temporary and after tillage the soil rapidly settled and recovers it is former bulk density (Franzluebbers *et al* 1995). In some soils porosity under no-tillage decreases in the first few years until the soil recovers it is natural structure so that owing to progressive increase in bulk density after tillage and differences between tillage and no-tillage become smaller as time between tillage practices increase (Kinsella 1995).

2-2 Vegetables

2-2-1 Definition

Vegetables are defined as herbaceous plants that need great and special care during their cultivation and handling. The majority are annual plants even though biennial and perennial species are recorded.They are characterized by a remarkable variation in their edible parts which may be the root, the stem, leaves, immature flowers buds or fruits. Edible parts are selected according to their nutritive value (Khalafala, Abdel azeez 1993).

Origin of vegetables:

The development of cultural practice suitable for growing vegetables need thorough knowledge of their origin. The origin is defined as place in which the plant grows and where it has been seen for the first time it is the place with suitability for reproduction. A place where a great number of wild species of the plant are found (Khalafala, Abdelazeez 1994). Wild species are used in hybridization of commercial plants a cause to their suitability to environmental conditions and resistance to infection.

2-2-2 World centers of origin of vegetables

There are eight important centers of origin of vegetables (Yamaguchiinas1983). These are :

1. Chinese center: mountain of central and western china and adjacent low lands.
2. Indian-Malaysian center which include:
a) Assam and Burma.
b) Indo-Malay center.
3. Central Asiatic center.
4. Near-East center.
5. Mediterranean center.
6. Ethiopian (Abyssinian) center.
7. South Mexico and Central American center.
8. South American center:
    a) Peru, Ecuador, Bolivia.
    b) Chiloe center.
    c) Brazilian Paraguayan center.

2-2-3 Important of vegetables

The exact amount of nutrients required by an individual vary widely with sex, age, body and the individual activity other causes in this difference are genetic and biochemical makeup of the individual.

Vegetables contains main nutrients necessary for human well being vegetables are constituted of carbohydrates and related substance cellulose, fibers, fats protien and amino acid vitamin and essential minerals elements (Aldujwi-Ali 1986).

The main plant carbohydrates are starches and sugar largely sucrose glucose and fructose. These elements supply the human body with it is need in energy. The cellulose in human diet affects the texture of plant foods they are considerably important roughages in regulation of bowel movement.

Vegetables oils are less saturated than animal fats. Highly unsaturated fats from plant origin are cause of lower blood cholesterol level. In recent years the blood cholesterol level has been of much concern in human health. High

blood pressure and heart disease have been attributed to excess intake of dietary fats. Animal protein is better in protein quality than plant protein but in some areas the plant protein is the only source of protein for humainbeing.
The main function of proteins is to serve as a building block of the body cells. They are also parts of enzymes necessary to carry out the body functions plants are the most important source of vitamins which are very potent organic substances necessary for normal body function. Vitamins are of great importance in some of its function such as carbohydrates metabolism cells energy production, prevention of anemia and poor wound healing.
Vegetables as a source of nutrients :- vegetarians can live and grow just as well as those who eat meat by eating food from plant sources containing high amount of proteins. A proper balance of all nutrients can be obtained from nutritive point of view vegetables can be grouped as follow:

1. High carbohydrates (potato, sweat potato, cassava).
2. High oils (legumes, mature vegetable seed).
3. High proteins and amino acids (legumes sweet corn, most leafy vegetables crucifers).
4. High in vitamin (A) carrot sweet potato green leafy vegetable, green beans and green peas, peppers.
5. High in vitamin (C) (crucifers pepper, tomatoes, melons and most leafy vegetables).
6. Minerals (most leafy vegetables, roots crops, crucifiers).

2-2-4 Classification of vegetables

Vegetables classification is a method of grouping vegetables plants according to a definite characteristic such as salt tolerance, tolerance to soil acidity or to deficiency to a special element in the soil. It may also be classified according to adaptation to a certain environment conditions or similarity in cultural practices. But the most practical method of vegetable classification is the one that depend on their usefulness consequently vegetables may be classified according to

- The edible part of the plant (root-stem-leaves-flowers-or fruits).
- The cultural practices (land preparation cultivation and harvesting).
- Optimum growing temperature (cools season crops and worm season crops).
- Relative resistance of plant to frost or low temperature.
- Salt tolerance.
- Number of season plant may live (annual, biannual or perennial).
- Botanical classification according to inheritance between plants morphology .
- Botanical and physiological relationship of flower.

Botanical classification is based on botanical relationship between plants according to common morphological and physiological characteristics type and structure of flower (Hassan Ahmed Abdelmoneim 1989).

Botanical classification is useful for biologist to establish relationships origin and serve as positive identification for horticulturist the climate requirements of a particular family or genus are usually similar use of crop for economical purpose is similar and diseases and inset controls are quite often similar for related genera (Yamaguchi mas 1983).

Botanical classification normally starts with the kingdom and it ends with the species as follow:

- Kingdom.
- Subkingdom.
- Division.
- Class.
- Order.
- Family.

- Genus.
- Species.

2-2-5 Vegetables production in Sudan:

Traditionally vegetables are produce all over the Sudan either under irrigation around the river Nile and .. it is tributries or by rain in rain fed area . Traditional productions limited to small number of vegetables dominated by okra which is consumed fresh or dry

In recent last year's vegetable production is increasing at increasing rate in big states . the local consumption in some parts of the country is still very low in comparison of world consumption individual average consumption of vegetable per year is about (136kg/year)

In Sudan while the average for neighboring Arab countries is about (136kg/year). (Adam, Abbas et al 2003)

Create variation can be noticed in vegetable consumption in different part of the country .in Khartoum province the vegetable consumption for the individual is about (65kg/year) ,in Algezira in middle Sudan is about (60kg/year) ,in Northern Sudan is about (55kg/year) , in Eastern Sudan (50kg/year) ,in kurdafan (20kg/year), and only (10kg/year) in Darfur . (Sayed Ahmed AbdallAwad et al 2003)

Difference in consumption is affected by number of factors such as personal income local nutritional habits and to some extend are affected by the quantity of local production (ministry of agricultural frist 1999).

Historically the world trading of horticultural crops was low compare to field crops an this was attributed to the highs perish ably of these crops. Recently the proper handling and improving transport rapid this commodity internally and externally worldwide thank to refrigeration and controlled at mosphemic storage. the in creased st demand for fresh vegetables by European countries especially during winter months encourage tropical and subtropical, middle east and north Africa countries to increase export of fresh vegetables and fruits to European countries.

The improvement of infrastructure level of living in Sudan, and thee high demand of vegetable from Arab countries in last two decadas has encourage Sudanese farmers to produce good quality of vegetable as fruits for local and international market especially Arab world market.

2-3 Radish plant

Radish (Raphanus sativus) is belonged to the family cruciferous . It is considered as a one of popular vegetables crops in most countries around the world specially in Arabs world. But it is of less economic importance in comparison with other vegetable crops.

The origin of this plant is China where wild species are still found in this region of the world. It is believed that central Asia constitute the secondary center for different species of Radish after it is transfer from china. Radish as a food had been discovered by the old Egyptian old creak and old Roman (A grow seed.co) it is also mentioned that Radish was originated in the eastern part of the Mediterranean Sea and then it had been transferred to china (Bangas 1976). The radish plant is grown for it is leaves and roots which are consumed fresh as a salad or cooked as in some species. In some countries Radish is treated with the acetic acid to prolong. It is consumption period during the year. A chemical analysis of the plant showed that 100mg of Radish root consist of 94.5mg water, 1.7 calorie ,1.0g of protein, 0.1g of fats, 3.6g carbohydrates, 0.7g of fibers, 0.8g ash, 30mg calcium, 31mg phosphor, 0.1mg iron, 18mg sodium, 323mg potassium, 15mg magnesium, 10 I.U of vitamin A, 0.03mg thiamer, 0.03mg Niacieen, 26mg ascorbic acid (Wattand Merrill) 1963.

Botanically Radish is a perennial or biannual herbaceous plant. The primary root develops rapidly and it penetrate deep in the soil. When the plant is ready to be consumed the root reaches 60-90 cm. the roots spread laterally and it their length may reach 30-40cm but the most active absorptive root surface found at adept of 5-20cm from the soil surface. In mature plant the main root may reach 180-210cm and lateral root may reach 90-120cm in depth is to be notice that only roots originated from the first foot of the root will reach this depth. The lateral spreading of the mature plant may reach 90cm. the most absorptive root surface is found within the upper foot of the soil in a circle of 180cm diameter (Weaver and Bruner 1937).

In the beginning of the first season the plant have small stem in which the leaves start to prolong at the beginning of the flowers period that prolongation constitute abroad. Peduncle that reach a height of 60-90cm. the leaves reaches 5-15cm in the first season in perennial species where as in biannual species it may reach 45cm. the leave may be smooth or covered with rough hairs depending on the variety. The plant flowers are either white or reddish in color and are carried in a Preferral vertical bloom. The pollination is mixed due to the self in compatibility (Frayxall 1957). The pollination is accomplish with the aid unlike other curipic the plant fruit is true pod with length that may reach 2.5-7.5cm and it has a peaked fruit that bear no compartment which is in dehescence normally it contain from 6-12cm seeds(Hawthani and Pollard 1954).

Radish is classified according to the length of the growing season and the color and type of roots.

The seed germinate within 3-4 days from planting in a range of temperature of 18-29c̊.

The germination percentage decrease with decreasing temperature and this decrease is become noticeable when the temperature reaches 13c̊.

For the production of high yield of good quality the plant required a moderate climate condition the plant propagation is done by seeds which are sown in permanent field by direct seeding. The seed rate is ranging from 4-10 kg/Feddan according to planting method and variety used. For the imported varieties the seed rate is only 4kg/Fadden where as 10 kg/Feddan is used for the local varieties.

The small seed of the plant required a fine seed bed preparation that should be thoroughly done. The land preparation in conventional tillage starts with plowing with a moldboard or with disk plow that followed by harrowing with a disk harrow or rotary plow then leveled with tractor mounted scraper. The ridging operation is only done in case of planting in ridges. The farm yard manure is distributed before planting. The field is then divided in to small plots 2×2 m or 2×3 m in heavy clay soils seeds are drills in ridges 60cm apart. In light soil Radish is sown on flat in small plots. The sowing depth of the seed must not exceed 1-1.6 cm (Mursyand Morabe 1960). In small farms seeds are sown by manual broadcasting in big farm seed are sown mechanically by a seed drill which is available in different size. A 200 cm width seed drill can plant a 26 rows 25 cm apart each linear meter receive from40 – 50 seed. The daily productivity of the machine is about 40 feddan (1977 Murray).

2-3-1 Sowing date

The local varieties are growing all over the year and the best sowing dates range from September to February during the good climatic conditions with short day. The plant sown after February tend to produce flowers before the establishment of economic roots so these plant are stripped in early stages and the leaves only are ready to be consumed.

The imported varieties are grow only during the winter season September to February which is the best period for the plant development and formation of roots before plant flowering for continuous supply of Radish to the market the plant is either sown every 10 days with the same demanded variety or to saw different varieties differ in periods of maturity.

To alleviate competition between plant Radish is normally thin to plant every 2-3 cm in early maturing varieties and 5-10 cm in late maturing varieties.

Weed is an important operation in plant production. Manual weeding is done for plant sown by broadcasting whereas plant sown with seed drill cultivated mechanically with one available cultivators.

The plant requires an abundant amount of water during its whole life. There for it need to be supply with adequate quantity of water in irrigated area. Because of shortage of water supply may leads to drastic results in production.

Traditionally farmers add $10m^3$ of farm yard manure to the soil per Fadden at the same time 100 kg of Ammonia sulphate and 100 kg super phosphate and 50 kg of potassium sulphate two weeks after sowing poor soil receive about 100 kg of Ammonia sulphate at sowing.

2-3-2 The harvesting handling and storage

The harvesting date of the plant depends on the variety sown and the sowing date. The local variety spend from 25-30 day on the soil in summer where as in winter it spend 45 days. The imported variety require from 25-80 days to reach a good size root. Harvesting is done by pulling the plant from the leaves either manually or mechanically. The mechanical harvester are available in different size which pull the plant and cut the vegetative partts and discharge the crop in a trailer or a truck moving side by side with harvester. After harvesting the plant washed and sorted out to eliminate the crack and affected roots grading is done after that. The Radish is normally sell in bundles of 3-4 roots. First cooling of the root to a degree of 4c is important. This operation is done either by spraying the root with water or by hydro cooling. The roots of the Radish are stored in aplastic sac at zero degree centigrade with relative humidity between 90%-95%. The whole plant is store with crushed ice. The storage period which vary from 2 week to 4 month depend on variety, storage method.(Luts and Hardenburg 1968).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Materials

3.1.1. Experimental Site

This study was conducted at the demonstration farm of the college of the Agricultural studies. Sudan University of Sciences and Technology at Shambat Khartoum North. The soil is vertisols with clay ranging from 45-60% dominated by montmorillonite (LAT:150 40 N Long: 320 32 E Alt:380m),on 2014 – 2015. The mean daily temperature is 29.3C˚, average maximum temperature is 47.3C˚in may the minimum temperature is 5.5C˚in February. The mean relative humidity is 28% and shows some variation range from 16%in April to 45% in August. The average annual rainfall is about 147.5/mms. The average wind speeds is about 11m/s and increase to maximum in the hot dry (April – May).(Shambat Meteorological Observatory Station-2015).

. The climate is semi- arid and the average annual rainfall is between 50-250 mm. The temperature ranges from 15 – 42 Co (Blockhuis) 1962. The experiment site physical and chemical properties of the soil are exposed in the table below.

Table 3.1 Shambat Soil Characteristic

Depth(cm)	BD(g/cm3)	Sand (%)	Silt(%)	Clay(%)	PH	SAR	EC(ds/m)
0 – 20	1.7	10.5	20.02	69.52	7.8	2.1	0.83
20 – 40	1.7	10.5	16.27	73.27	8.8	3.16	0.94
40 – 60	1.7	7.98	17.5	74.52	8.7	1.5	0.96
60 – 80	1.7	7.98	17,52	74.52	8.8	2.6	0.98
80 – 100	1.7	7.98	15.0	77.02	8.7	2.8	1.04

Source SUST.agu- Soil and Water research lab

3.1.2 Agricultural Tractor

A440 Massey Ferguson tractor in a very good working condition was used in this experiment. For hitching a predetermine implements. The tractor specification are gaiven in the table(3-2) :

Table 3.2 Tractor Specifications

Mark	Massey 440
Make	Massey Fargesson
Engine	Diesel engine
Number of Cylinder	4- cylinders
Stroke Cycle	4- stroke
Cooling System	Wet cooled
Rear Tires Size	13.61.12.38
Power	75 hp

3-1-3 Implements

Table 3.3 Implement Specification

Implement/Specification	Disc Plough	Off-set disc harrow	Ridger plough	Screper	Chisel plough
Width	150 cm	200cm	200cm	200cm	200cm
Working width	100cm	180cm	150cm	200cm	150cm
Depth	30cm	30cm	25cm	-	30cm
No of bottom or shanks	3	20	3	-	5

Locally made hande hoe was used for minimum or zero tillage parchce

3-2 Other malenias

i. Different length measuring tapes.
ii. Steel pegs.
iii. Stop watch.
iv. For making .
v. Measuring- cylinders.
vi. Fuel container.
vii. Balances.
viii. Staff rod

ix. Vernier caliber.

3-4 Tillage Machine

Dsic Plough

Table 3.4 Mounted disc plough with the following specification

Make	Model	Type integral	No. of dsics	Size of discs	Type of discs	Bearing type	Frame	Type of furrow whee
KOsNEXS	KNX-70	Fully mounted – one way	3-Bottom.	70 cm (28 inch) diameter	Plain discs.	Ball bearings.	Rigid frame with adjustable disc angle	Adjustable, spring loaded. Hitching cal II,III.

Disc Harrow

Table 3.5 The disc harrow used in this experiment having the following specification

Make	Type integral	No. of dsics	Size of discs	Type of discs	Bearing type	Frame	Type of scrapers
Cherardi.	Off- set . Fully mounted. Width of cal 240 cm (96 inch).	10 discs (5 discs per gang).	70 cm (28 inch) diameter	Front gang with corrugated disc. Rear gang with plain disc..	scaled anti –friction type angle adjustable ,accessories disc	Rigid frame	Hitching cut II and III.

Ridger:

Table 3.6 The Ridger used in this experiment the following specification

Make	Model	Type integral	Number of units	Power requirement	Frame	Unit adjustment
Italy.	Nardi	Fully mounted. Width of cut 280 cm	4 units	70 – 80 hp.	Rigid frame with adjustable disc angle	adjustable

Wasoog: Atwo – man shovel (wasoog) was used to make earth embankment around plots to demark the experimental field.

Spade: locally made spade was used to raise up earth embankment to for the irrigation channels .

Hand hoe: a locally made hand hoe was used for stretchen the plot and channels and to perform cultivation.

3-5 Measuring tapes

A fifly meter long measuring tape had been used to measure various distances during field layout.

Ruler: a plastic ruler was used to measure the plant parameter measurement.

Balance: Two types of balance had been used to carry out the necessary weights .A sensitive balance for weighting the seeds and fertilizer and another one for weighting the fresh plant material.

Seed material: The raddish seed used in this experiment were bought from the local marked.

Bulk density measurement equipment steel ring with the following specification had been used to measure the bulk density.

Table 3.7 Specification had been used to measure the bulk density

Ring diameter(D)	Ring height(H)	Ring volume(V)
9.5cm.	10cm.	709cm3

Moisture content measurement equipment the same ring used for the bulk density determination was used for the determination of the moisture content.

Proportional dimension:

Bulk density g /cm^3 = total soil mass/total soil volume ………..(3-1)

Soil Moisture Content cm^3 g/ (W_c)=(W_w - W_S) / W_w ……………(3-2)

Where are:

Wc : Soil Moisture Content

Ww: wet Soil.

WS: dry soil.

Infiltration Rate m^3 /sec (I) = akt^{a-1} …………………………….(3-3)

Where are:

a: conctent.

k: factor.

t: end time of the experiment.

Yield- plant/ =m^2AV-NO. Of plant per blocks/ At ………………..(3-4)

Where :

At : Total Area.

CHAPTER FOUR

RESULTS AND DISCUSSION

4-1 Soil Properties

Table 4.1 Effect of different tillage systems on soil bulk density g/cm3

Treatment	Infield bulk density	Outfield bulk density
1	1.3	0.6
2	1.4	0.7
3	1.1	0.6
4	1.1	0.8

The above tables showed that the bulk density results obtained were not so big either within the same treatment and with different depths or between different treatment and as we previously said . this result also revealed that in all treatment the bulk density values obtained were less them that found in the literature .

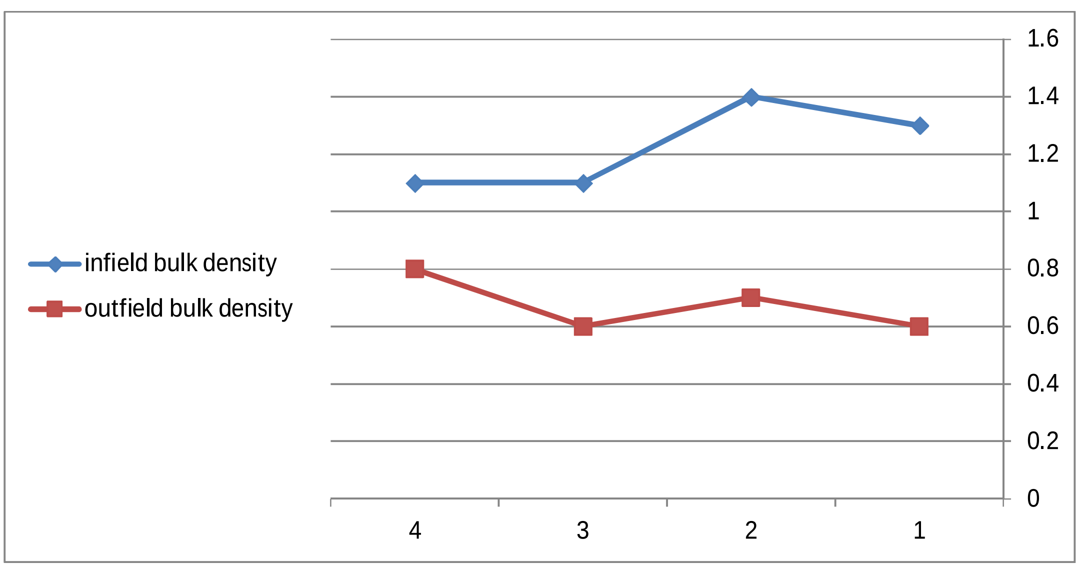

Fig. 4.1 Effect of different tillage systems on soil bulk density g/cm3

Table 4.2 the effect of different tillage system on the moisture content percentage.

%Soil Moisture			
Treatment	**10 cm**	**20 cm**	**30cm**
1	13.8	15.8	16.4
2	16.8	15.4	37.7
3	15.8	23.1	19.4
4	16.8	17.5	19.4

In the first 10cm the high moisture content value obtained were with the second system which comprise a chisel plow followed by a disc harrow , scraper and ridger while the lower moisture content was obtained with disc plow ,disc harrow ,scraper and ridger the other treatment gave approximately same result . the good soil manipulation was expected to be the reason .
The result concerning the moisture content value in the second layer (20cm) of the soil revealed high moisture content obtained in plots treated with the rotovator .
Approximately the same results were obtained in the third zone (30cm) the highest moisture content value was obtained with treatment three re presented by the ridger in depth (30cm) .
There far the technique used in many agricultural scheme in Sudan which is the ridging up of old field need to be studied .

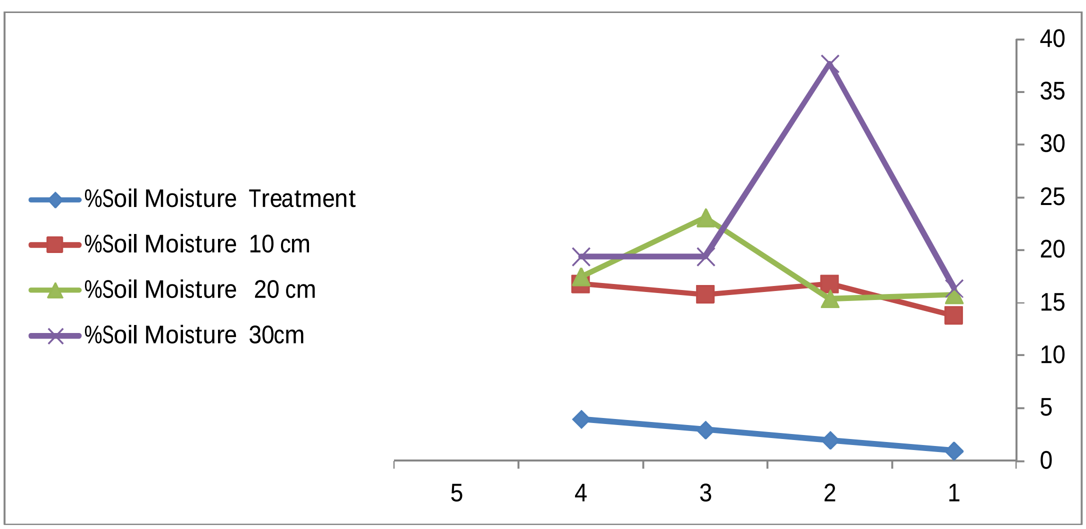

Fig. 4.2 the effect of different tillage system on the moisture content percentage .

Table 4.3 The effect of different tillage system on Infiltration rate

Infiltration rate	Before	After
Tillage(1)	5.4	7.4
Tillage(2)	4.8	3.2
Tillage(3)	5.0	3.0
Tillage(4)	6.0	3.5

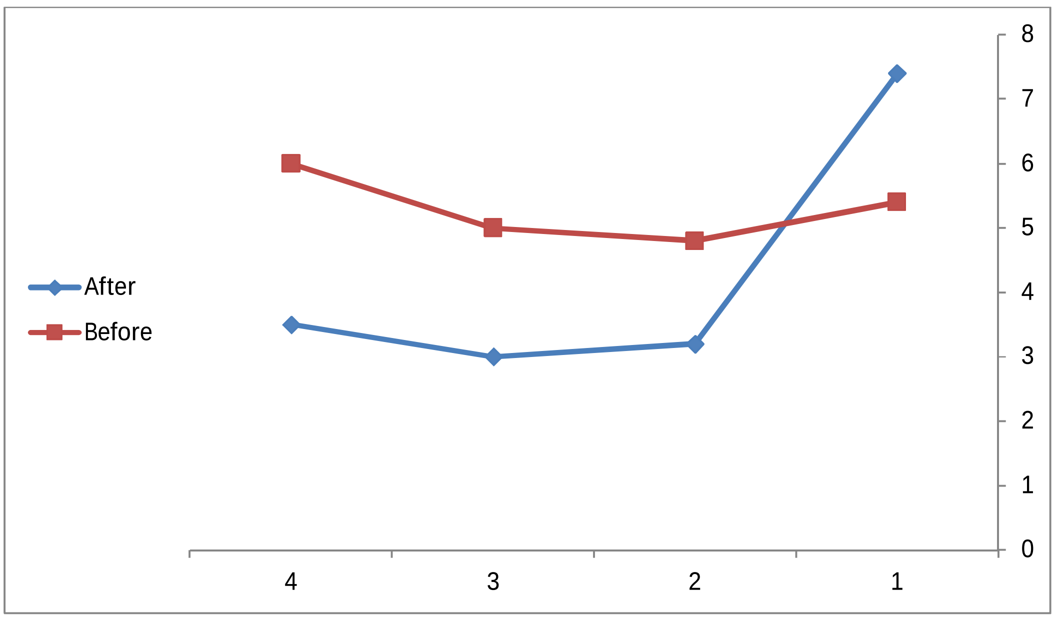

Fig. 4.3 The effect of different tillage system on Infiltration rate

4-2 Plant parameters

The effect of different tillage systems on plant population radish (Ravanus sativa) (plant /m^2)

Table 4.4 Mean number of radish plant/m2

Treatment	**Mean number of radish plant m^2**
D P DH S R	80.21
C P DH S R	86.04
R	70.62
O T	46.67
C.V	11.92
LSD	13.51
SE	4.223

From the above table its clear that the highest number plant per m^2

was recorded with the use of chisel plow followed by disc harrow scraper and ridger .

The second higher number of plant m^2 was recorded for disc plow followed by disc harrow , scraper and ridger (DHSR) .

The ridger only ranked third where as the last number of plant was obtain where as no tillage or zero tillage or direct seeding was practice .this result could be explained by the fact that the chisel plow and disc plow penetrate the soil to deep layer they break down the upper layer shatter the soil so they reduce the soil resistance to penetration the minimum the disc harrow followed by scrapper and retake the soil and breakdown the big cloth so the land preparation end up with deep tilth soil and fine seed bed preparation favorable for small seed germination . the ridger was use as a land configuration ration as common root crops are grow on ridges a cause to salinity of the soil .

The ridging up of the soil which is a common practice in many agricultural schemer could be use as a land configuration for big seeds grown on ridges without preliminary soil tillage .

The simple ridging up of the land gave mediocre result .the direct seeding in a heavy clay soil like those of Shambat soil was expected to give the last number of plant this expectation was confirmed by the obtain result the statistic analyses show significant difference between difference treatments .

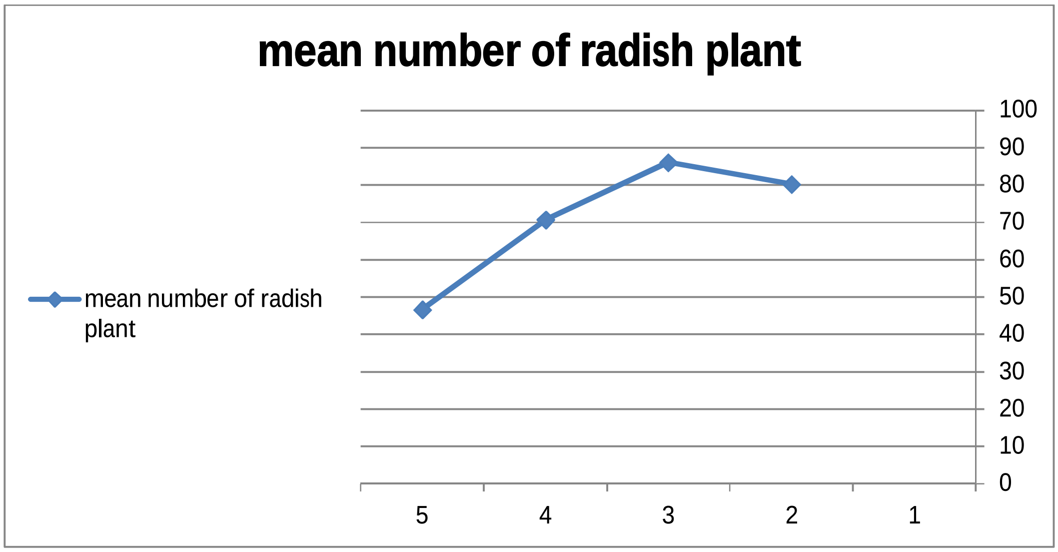

Fig. 4.4 Mean Number Of Radish Plant/m^2

The effect of different tillage systems on number of leaves of radish plant

Table 4.5 Mean number of leaves per plant

Treatment	**Mean number of leaves per plant**
D P DH S R	9.3
C P DH S R	10.7
R	10.3
O T	9.6
C.V	21.4
LSD	2.4
SE	1.0

The results obtained showed that the highest number of leaves per plant were obtained where the second system was used which comprise a chisel plow ,disc harrow, scraper and ridger .the second in ranking was the system which comprised s only one implement which was a ridger for ridging up the land the first system (DPDHSR)is the last one (0 T) gave approximate the same result.

All the difference between treatments were not so big ,this result could be all related to the fact that the number of leaves per plant is a genetic characteristic and it is less affected by tillage treatment .

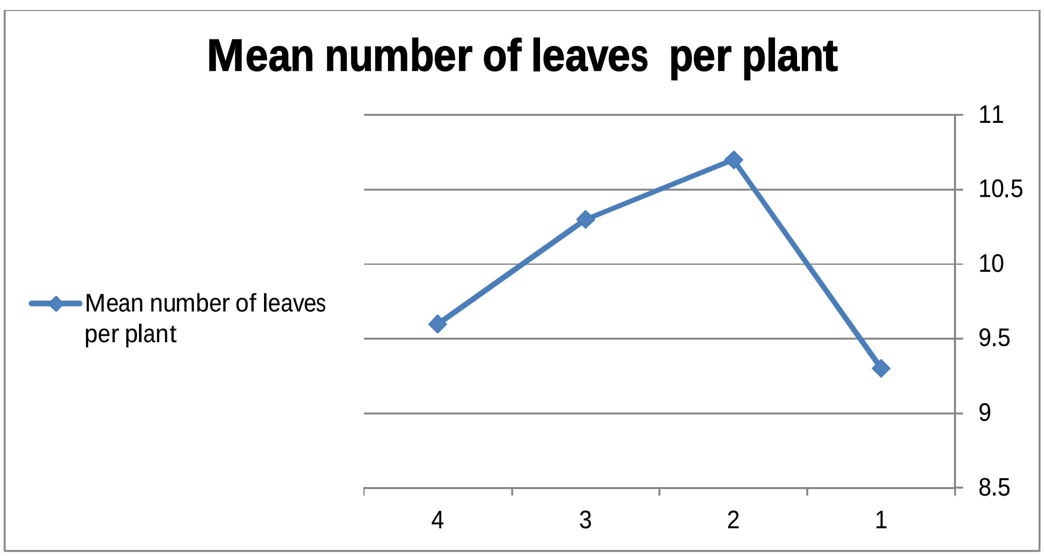

Fig. 4.5 Mean number of leaves per plant

The effect of different tillage system on root length

Table 4.6 Mean length of plant root (cm)

Treatment	Root length (cm)
D P DH S R	16.32
C P DH S R	16.37
R	19.27
O T	18.72
C.V	21.11
LSD	3.55
SE	1.11

The result obtained showed that the best result for the root length between different tillage system was obtained with the minimum and zero tillage where ridging up no tillage wee used this result followed by the first system second system where a conventional tillage system of tillage with disc plow and chisel plow were used.

The results could be explain at the light of the soil autostructuring theory. the soil during consecutive period of the wetting and drying work itself by itself without any mechanical intervention which facilitate the root penetration into deep layer also the irrigation frequency affect much the rate at which the plant root are pent rate the soil

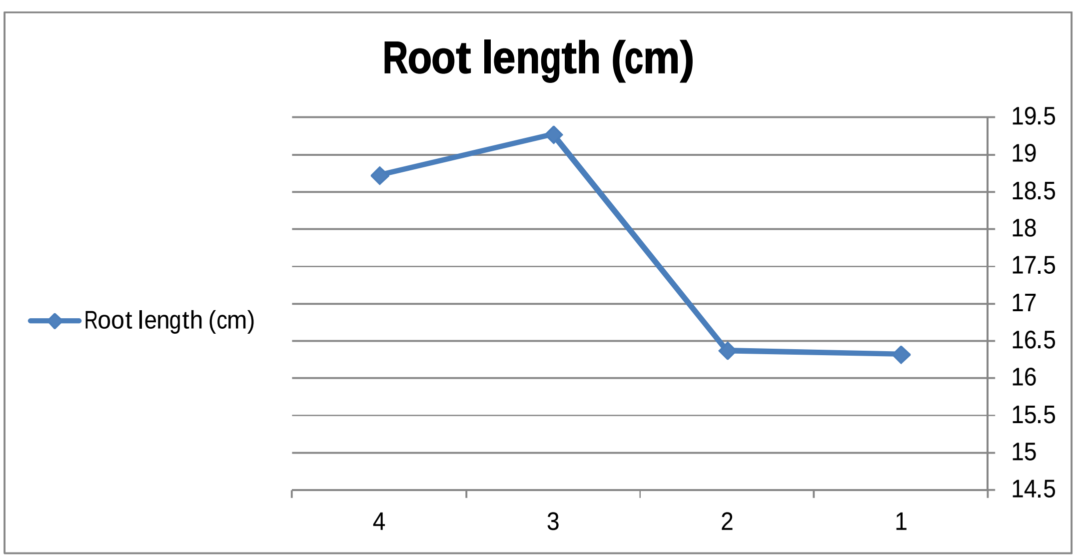

Fig. 4.6 Mean length of plant root (cm)

The effect of different tillage system on plant weight

Table 4.7 Mean of plant weight (gm)

Treatment	Mean plant weight (gm)
D P DH S R	122.5
C P DH S R	117.8
R	125.5
O T	114.0
C.V	33.2
LSD	64.0
SE	20.0

From the above table it's clear that the highest weight of plant obtain was with the minimum tillage system where a ridger only was used followed by the first system where a disc plow ,disc harrow ,scraper and a ridger were used the conventional tillage with achisel plow and the zero tillage or direct seeding gave a proximally the same result ,this result could be explain by the fact that in clay soil the plant weight is affected by the good seed bed preparation and the volume of the soil that provide a good environment for root crop the disc plow and the disc harrow followed by scraper prepare a good seed bed ad root bed for root crop .

The ridging up of the land and without any preliminary manipulation of soil gave a good soil condition for plant germination and development now a day the ridging up of the previous ft cropped land become a common tradition in land preparation in most agricultural scheme where condition are favourable

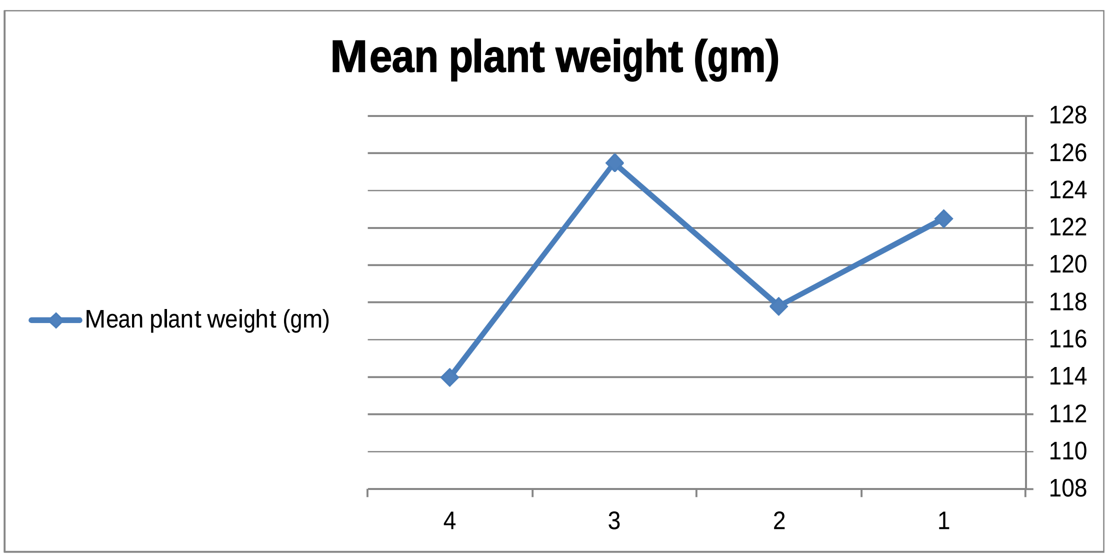

Fig. 4.7 Mean of plant weight (gm)

The affect of different tillage systems on the weight of the root

Table 4.8 Mean root weight (gm/root)

Treatment	Roots weight (gm)
D P DH S R	60.3
C P DH S R	53.2
R	61.5
O T	63.1
C.V	38.7
LSD	36.8
SE	11.0

From the above table it clear that the best result for the root weight obtain with the no tillage system followed by first system (DPDHSR). The ridging up of the soil come in the third rank . the lowers value was obtained with the second system (CPDHSK) .

the differences between different treatments were not big so the different treatment gave the same result .the statistical analysis com to confirm that this result could be explained by the fact that the auto structuring of the soil gave similar result to that of mechanical manipulation .

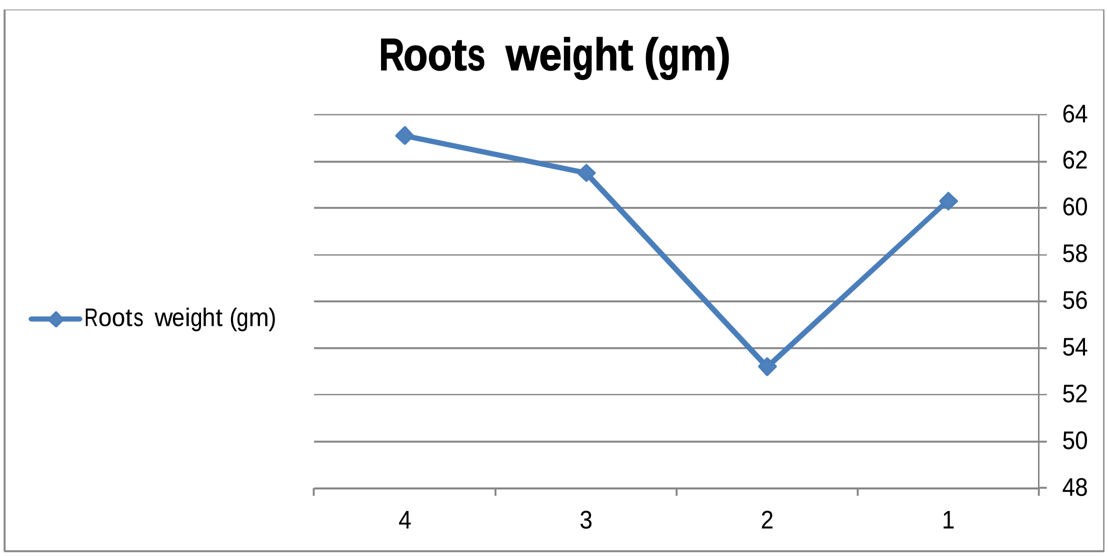

Fig. 4.8 Mean root weight (gm/root)

Table 4.9 Effect of different tillage systems on the root diameter

Treatment	Root diameter (cm)
D P DH S R	28.655
C P DH S R	28.9
R	30.845
O T	31.61
C.V	13.89
LSD	6.644451
SE	2.0829

The highest value for the root diameter was obtained with the fourth system(OT) .

The second best result was obtained with the third system (CPDHSR) and the second system (CPDHSR) which gave approximately the same result .

The same trend was followed for the plant diameter the statistical analysis showed no significant difference.

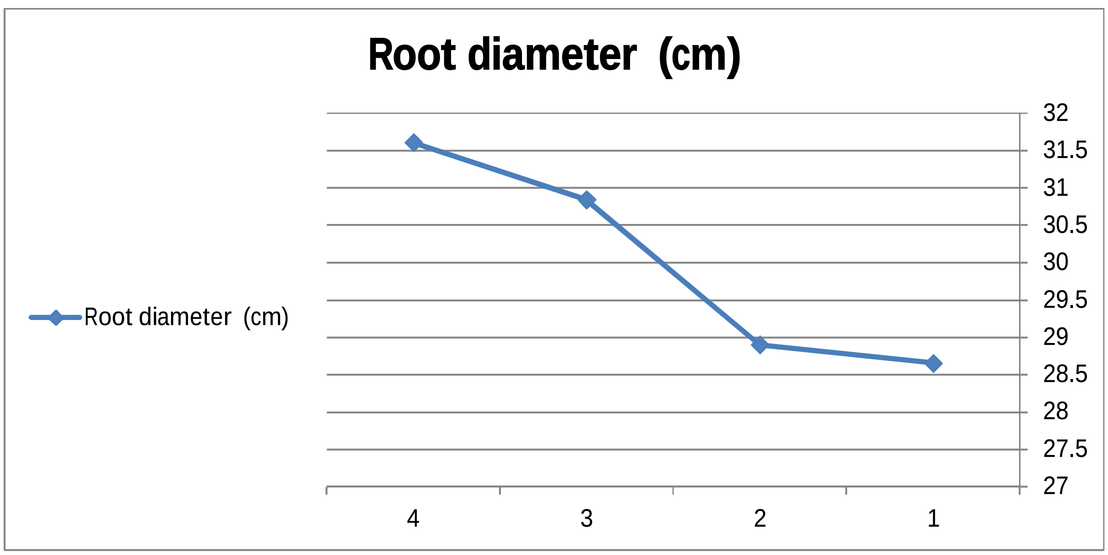

Fig. 4.9 Effect of different tillage systems on the root diameter

Table 4.10 Effect of different tillage systems on nutritive value of the crop

Treatments	Moisture content	Fats	Protein	Fiber
D P DH S R	88.7	0.766	3.66	0.706
C P DH S R	89.6	0.667	3.46	0.667
R	89.33	0866	3.6	8.66
O T	88.7	0.833	2.86	9.00
LSD	0.115	0.78	0.099	0.0758
SE	0.322	0.047	0.0408	0.1854

The result obtained during this study concerning the nutritive value of the crop
showed no significant different with different tillage systems.
This result could be explained by the fact that the different tillage system including zero tillage realised the same amount of nutrient from the soil to the plant the minimum tillage and zero tillage gave relatively higher value for plant nutrient.

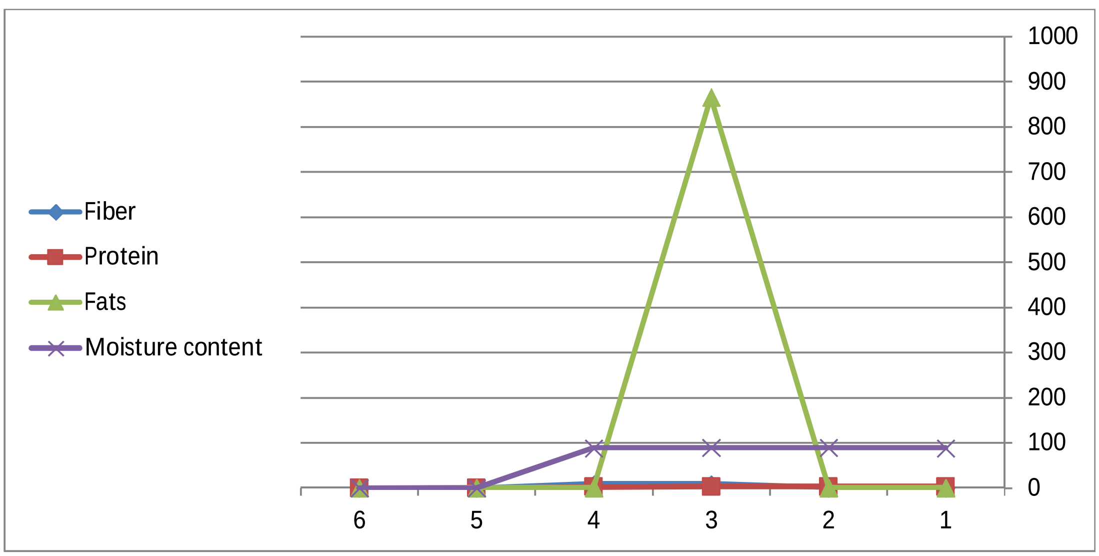

Fig. 4.10 Effect of different tillage systems on nutritive value of the crop

Table 4.11 The effect of different tillage systems on crop yield plant/m3 .

Production								
Treatment	**R1**	**R2**	**R3**	**R4**	**AV/M2**	**AV/Fd**	**Av/hect**	**Av/Ton**
1	92	39	49	95	68.75	288750	687500	68750
2	78	56	77	105	79	331800	790000	79000
3	73	88	106	72	84.75	355950	84700	8470
4	56	60	53	72	60.25	253050	602500	60250

The above table show that the best yield obtained where the third system (k) was used followed by the second system (CPDHSK), and first system where as the lowest yield obtained with the fourth system (0 T) this result can be explained by the fact that the root system of plant need a good land preparation with firm ridges. The ridging up of the soil without preliminary preparation gave the best result that confirm the fact that auto structuring of soil effective than land preparation.

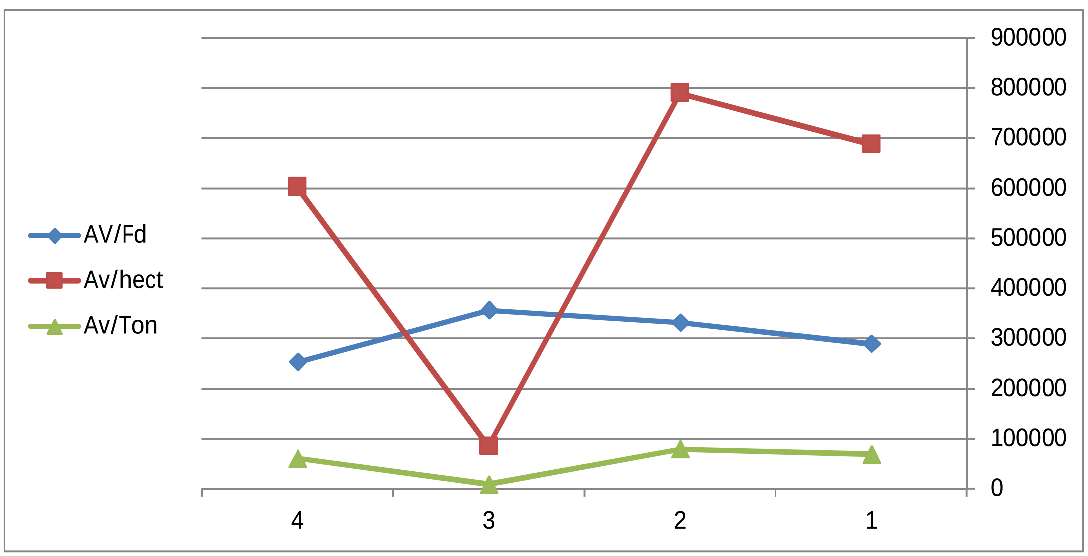

Fig. 4.11 the effect of different tillage systems on crop yield plant/m3

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5-1 Conclusions

The following conclusions are drawn frosm the study :

- Al tillage operation affect positively the physical property of the soil namely bulk density, moisture content and infiltration rate.
- The plant parameters are also affected positively by the different tillage systems however.
- The nulntive value of the plant is not affected by the tillage operation .
- The conventional tillage using a disc plow breakdown deep layer which facilitate the penetration of the irrigation water and root system and lead to pulverization of the soil that enable the p lant to hare good development.
- The conservation tillage with a chisel plow break down the soil in deep layer which facilitate the penetration of roots and water in deep layer without pulverizing the top layer or to less extend.
- The minimum tillage manipulate the soil only in the upper layer of the soil surface that leave the rest of the soil intact without any manipulation.
- The minimum tillage gave the best results concerning the productivity of the plant.

5-2 Recommendation

From the above result and conclusions the following recommendation are stated alones similar line are* Recommendation under different soil condition

1- This experiment and study need to be repeated in other areas of the state having different soil to get a solid and ceperbensive conclusion for all the project in the state
2- The effectiveness of minimum tillage on day soil was confirmed by this study the repetition of this experiment will confirm its perennially
3- Tillage system should be coupled with different water rate to investigate the effect of different tillage system used on soil plant and water used.
4- During this study only the direct benefit of minimum tillage had been evaluated further studies need to be carried out to investigate the indirect benefit of this technique

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Appendices

Treatments	R1	R2	R3	R4	R1%	R2%	R3%	R4%	Total Ratio	Average
1.	95.00	92.00	89.00	109.00	79.17	76.67	74.17	90.83	320.83	80.21
2.	107.00	99.00	105.00	102.00	89.17	82.50	87.50	85.00	344.17	86.04
3.	73.00	88.00	106.00	72.00	60.83	73.33	88.33	60.00	282.50	70.63
4.	55.00	56.00	60.00	53.00	45.83	46.67	50.00	44.17	186.67	46.67

Plant percent

Bulk Density in Field						
Treatment	10 cm	20 cm	30 cm	Dencity10cm	Density 20cm	Density 30cm
1	825	949	943	1.16	1.35	1.34
2	912	893	1097	1.29	1.27	1.56
3	872	775	711	1.23	1.10	1.01
4	860	857	832	1.21	1.22	1.18

Bulk Density out Field						
Treatment	10 cm	20 cm	30 cm	Dencity10cm	Density 20cm	Density 30cm
1	343	399	385	0.55	0.64	0.61
2	385	489	487	0.61	0.78	0.78
3	351	355	393	0.56	0.57	0.63
4	352	468	396	0.56	0.75	0.63

Yield

Treatment	R1	R2	R3	R4	Av / m2	Av / fed
1	92	39	49	95	68.75	288750
2	78	56	77	105	79	331800
3	73	88	106	72	84.75	355950
4	56	60	53	72	60.25	253050

Tillage one
Number of
Leave

Treatment	R1	R2	R3	R4	R5	Total	Av
1	10	9	9	10	10	48	9.6
2	10	7	13	7	10	47	9.4
3	21	12	15	9	5	62	12.4
4	15	11	10	10	11	57	11.4

Length of Root

Treatment	R1	R2	R3	R4	R5	Total	Av
1	11.5	19.5	15	17	11.5	74.5	14.9
2	16	20	16	15.5	13.5	81	16.2
3	12.5	14.5	16	16.5	15	74.5	14.9
4	19.5	26	15	17.5	19.5	97.5	19.5

Weight of Plant

Treatment	R1	R2	R3	R4	R5	Total	Av
1	57	185	67	96	45	450	90
2	83	65	154	99	52	453	90.6
3	109	221	73	79	90	572	114.4
4	171	165	98	277	170	881	176.2

weight of Roots

Treatment	R1	R2	R3	R4	R5	Total	Av
1	18	56	34	48	13	169	33.8
2	44	34	50	41	15	184	36.8
3	38	88	45	31	20	222	44.4
4	69	95	51	160	113	488	97.6

Diameter of Roots

Treatment	R1	R2	R3	R4	R5	Total	Av
1	20.5	31.4	25	33.7	15	125.6	25.12
2	29	26.5	26.5	26.5	19.5	128	25.6
3	31.5	32.9	25.7	29	20.3	139.4	27.88
4	33	32.7	33.5	42.5	43.3	185	37

Tillage

tow Number of Leaves

Treatment	R1	R2	R3	R4	R5	Total	Av
1	14	13	10	10	11	58	11.6
2	10	6	10	6	6	38	7.6
3	7	12	10	5	5	39	7.8
4	12	9	11	7	13	52	10.4

Length of Root

Treatment	R1	R2	R3	R4	R5	Total	Av
1	18	15	15.5	19.5	18	86	17.2
2	20.5	16	21	22	15	94.5	18.9
3	8	22	15.5	10	9	64.5	12.9
4	10	18	17	15.5	21	81.5	16.3

Weight of Plant

Treatment	R1	R2	R3	R4	R5	Total	Av
1	257	94	163	198	292	1004	200.8
2	49	116	118	55	64	402	80.4
3	61	69	137	106	64	437	87.4
4	90	128	107	64	219	608	121.6

weight of Roots

Treatment	R1	R2	R3	R4	R5	Total	Av
1	141	58	54	79	146	478	95.6
2	42	59	54	35	38	228	45.6
3	37	23	42	58	46	206	41.2
4	23	81	44	20	127	295	59

Diameter of Roots

Treatment	R1	R2	R3	R4	R5	Total	Av
1	44.8	21.5	27	22.3	32.3	147.9	29.58
2	16.5	19	20	30.4	36	121.9	24.38
3	16.7	33	18	22.7	31	121.4	24.28
4	39.5	31	29.8	38.7	42.9	181.9	36.38

Tillage three

Number of Leaves

Treatment	R1	R2	R3	R4	R5	Total	Av
1	10	9	14	6	12	52	10.4
2	14	13	20	9	10	68	13.6
3	12	8	9	8	4	44	8.8
4	4	9	9	10	6	42	8.4

Length of Roots

Treatment	R1	R2	R3	R4	R5	Total	Av
1	18	20	9	14	19	81	16.2
2	22.5	24	16	14.5	21	100	20
3	19	24	19	20	19	104	20.8
4	16	19	24	19.5	18	100.5	20.1

Weight of Plant

Treatment	R1	R2	R3	R4	R5	Total	Av
1	48	198	94	88	106	1	0.2
2	140	206	102	116	86	2	0.4
3	95	180	201	63	90	3	0.6
4	65	74	288	168	152	4	0.8

					weight of Roots		
Treatment	R1	R2	R3	R4	R5	Total	Av
1	24	65	12	16	56	174	34.8
2	68	133	51	63	50	367	73.4
3	34	108	85	38	56	324	64.8
4	34	51	145	79	52	365	73

Diameter of Roots

Treatment	R1	R2	R3	R4	R5	Total	Av
1	21.5	28.6	19.5	19.6	26.6	1	0.2
2	32	44.3	30	34.7	26.8	2	0.4
3	30.5	35	32.5	25.5	32.2	3	0.6
4	29.3	24.9	28.4	45	40	4	0.8

Tillage Four

Weight of Plant

Treatment	R1	R2	R3	R4	R5	Total	Av
1	75	144	88	88	108	4	0.8
2	83	94	105	34	315	6	1.2
3	250	144	86	81	117	3	0.6
4	36	43	160	122	101	4	0.8

Weight of Roots

Treatment	R1	R2	R3	R4	R5	Total	Av
1	47	138	52	65	75	3	0.6
2	22	51	61	18	155	5	1
3	70	88	48	39	48	7	1.4
4	15	18	104	73	75	4	0.8

Number of leaves

Treatment	R1	R2	R3	R4	R5	Total	Av
1	8	12	6	10	10	3	0.6
2	9	13	14	8	13	4	0.8
3	4	9	7	7	5	3	0.6
4	8	8	16	7	8	4	0.8

Length of Root

Treatment	R1	R2	R3	R4	R5	Total	Av
1	18	21	19	16	20	4	0.8
2	13	15	17.5	14	20	6	1.2
3	21	20	19	20	17	3	0.6
4	19.5	11.5	22	20	21	4	0.8

Diameter of Root

Treatment	R1	R2	R3	R4	R5	Total	Av
1	28	40	32	28.2	33.2	1	0.2
2	20.5	31.5	35.2	20.5	47.4	2	0.4
3	35.4	40.2	27.4	27.6	26.7	3	0.6
4	17	22.5	38.4	33.5	37	4	0.8

Weight of wet soil

Treatment	10 cm	20 cm	30 cm
1	957	1127	1141
2	1096	1056	1312
3	1036	1008	1142
4	1033	1039	1032

Weight of wet soil dry soil

Treatment	10	20	30
1	825	949	943
2	912	893	1097
3	872	775	711
4	860	857	832

	Moisture content		
Treatment	10 cm	20 cm	30 cm
1	13.793	15.79414	17.3532
2	16.788	15.43561	16.3872
3	15.83	23.11508	37.74081
4	16.747	17.51684	19.37984

Prametr	sample	moisture content	fat%	protein%	ash%	fiber%	CHO%
1	1	88.5	0.8	3.7	1.4	0.6	5
1	2	88.9	0.7	3.7	1.5	0.8	4.4
1	3	88.7	0.8	3.6	1.5	0.7	4.7
2	1	89.6	0.6	3.4	1.3	0.7	4.4
2	2	89.7	0.7	3.5	1.4	0.6	4.1
2	3	89.7	0.7	3.5	1.4	0.7	4
3	1	90.1	0.9	3.6	1.1	0.8	3.5
3	2	89.2	0.8	3.6	1.2	0.9	4.3
3	3	88.7	0.9	3.6	1.2	0.9	4.7
4	1	88.8	0.9	2.8	1.6	1	4.9
4	2	88.6	0.8	2.9	1.6	0.8	5.3
4	3	88.7	0.8	2.9	1.7	0.9	5

In**filtration Rate befor tillage type1**								
Time(min)	depth(cm)	cm/h	Accu-infilt	$\mathbf{t_1}$	80	16	1.20412	
0	21	#DIV/0!	0	$\mathbf{t_2}$	420	84		
5	20.5	246	21	$\mathbf{t_1/t_2}$		0.19047619	-0.72016	
10	20	120	41.5	$\mathbf{z_1}$	97.7	19.54	1.290925	
15	19.5	78	61.5	$\mathbf{z_2}$	85			
20	19.1	57.3	81	$\mathbf{z_1/z_2}$		1.149411765	0.060476	
30	18.6	37.2	100.1	**a**	log(z1/z2)/log(	log(t1/t2)	-0.08398	0.916025
40	18.3	27.45	118.7		Loga	#NUM!		
50	17.6	21.12	137	**k**	logz1+loga+logt1		1.90309	#NUM!
80	16.5	12.375	154.6	**Z**	kt^{a-1}	175.9403622		
110	16.3	8.890909	171.1					
140	16.3	6.985714	187.4		0.69897			

Infiltration Rate befor tillage type2							
Time (min)	depth(cm)	cm/h	Accu-infilt	**t_1**	16	1.20412	
0	20	#DIV/0!	0	**t_2**	84		
5	19	228	20	**t_1/t_2**	0.190477	-0.720157936	
10	18.5	111	39	**z_1**	91.6	1.961895474	
15	18.3	73.2	57.5	**z_2**	84.3		
20	18	54	75.8	**z_1/z_2**	1.086595	0.036067899	
30	17.8	35.6	93.8	**a**	0.018384	-1.73555502	-2.73556
40	17.4	26.1	111.6				
50	17.1	20.52	129	**k**	3.166015	1.430460454	
80	16.6	12.45	146.1	**Z**	kt^{a-1}	1.92586E-06	
110	16.6	9.054545	162.7				
140	16.6	7.114286	179.3				

Infiltration Rate befor tillage type3				t1	16	1.204119983
Time (min)	depth(cm)	cm/h	Accu-infilt	t2	84	
0	17.6	#DIV/0!	0	t1/t2	0.190476	-0.7201593
5	17	204	17.6	z1	81.5	1.911157609
10	16.8	100.8	34.6	z2	71.1	
15	16.2	64.8	51.4	z1/z2	1.146273	0.059288008
20	16.1	48.3	67.6	A	-0.08233	-1.08232624
30	15.4	30.8	83.7		#NUM!	
40	14.8	22.2	99.1	K	3.115278	#NUM!
50	14.3	17.16	113.9	Z	kt^{a-1}	0.014814468
80	14	10.5	128.2			
110	14	7.636364	142.2			
140	14	6	156.2			

Infiltration Rate befor tillage type4				t_1	16	1.204119983
Time (min)	depth(cm)	cm/h	Accu-infilt	t_2	84	
0	17.8	#DIV/0!	0	t_1/t_2	0.190476	-0.720159304
5	17.5	210	17.8	z_1	83.1	1.919601024
10	17.1	102.6	35.3	z_2	71	
15	16.8	67.2	52.4	z_1/z_2	1.170423	0.068342675
20	16.2	48.6	69.2	a	-0.0949	-1.094899385
30	15.5	31	85.4		#NUM!	
40	15.1	22.65	100.9	k	3.123721	#NUM!
50	14.8	17.76	116	Z	kt^{a-1}	698.9828247
80	14.1	10.575	130.8			
110	13.5	7.363636	144.9			
140	13.5	5.785714	158.4			

Infiltration Rate after tillage type1									
Time (min)	depth(cm)	cm/h	Accu-infilt	t1	80	16	1.20412		
0	22	#DIV/0!	0	t2	420	84			
5	21.5	258	22	t1/t2		0.19047619	-0.7202		
10	21.1	126.6	43.5	z1	100.9	20.18	1.30492		
15	20.4	81.6	64.6	z2	90.4	18.08			
20	19.3	57.9	85	z1/z2		1.116150442	0.04772		
30	18.6	37.2	104.3	a		Log(Z1/Z2)/Log(T1/T2)			
40	18.3	27.45	122.9			-0.066266916	-1.0663		
50	18.1	21.72	141.2	k		Logz1+Loga+Logt1	2.44277		
80	18	13.5	159.3	**Z**		**k*t^{a-1}**	**0.01258**		
110	18	9.81818	177.3						
140	18	7.71429	195.3	t2	420	84	z2	88.4	17.68
				t1	80	16			
				z1	94.8	18.96			
					t1/t2	0.19047619		-0.72016	
					z1/z2	1.07239819			

	Infiltration Rate after tillage type2								
	Time (min)	depth(cm)	cm/h	Accu-infilt					
	0	20	#DIV/0!	0		t1	80	16	1.20412
	5	19	228	20		t2	420	84	
	10	18.5	111	39		t1/t2	0.19047619	-0.72016	
	15	17	68	57.5		z1	87.5	17.5	1.243038
	20	16.7	50.1	74.5		z2	78	15.6	
	30	16.3	32.6	91.2		z1/z2	1.121794872	0.049913	
	40	16	24	107.5		a	log(z1/z2)/log(t1/t2)		
	50	15.8	18.96	123.5			-0.069308902	-1.06931	
	80	15.4	11.55	139.3		k	logz1+loga+logt1	1.377849	
	110	15.4	8.4	154.7		**Z**	**kt^{a-1}**	**0.006988**	
	140	15.4	6.6	170.1					

Infiltration Rate after tillage type4							
Time (min)	depth(cm)	cm/h	Accu-infilt		**t_1**	80	16
0	21	#DIV/0!	0		**t_2**	420	84
5	20.4	244.8	21				
10	20.1	120.6	41.4		**t_1/t_2**	0.19047619	
15	19.4	77.6	61.5		**z_1/z_2**	1.221526909	
20	19.1	57.3	80.9		**a**	Log(z1/z2)/Log(t1/t2)	
30	18.6	37.2	100			-0.120671965	-1.1207
40	18.1	27.15	118.6		**k**	Logz1+Loga+Logt1	
50	16.5	19.8	136.			2.021189299	#NU

			7				M!
80	15.1	11.325	153.2		**Logz1**	1.322219295	
110	15.1	8.23636	168.3		**Loga**	#NUM!	
140	15.1	6.47143	183.4		**Logt1**	0.698970004	
				Z	**kt^{a-1}**		
					0.00795		

Infiltration Rate after tillage type3							
Time (min)	depth(cm)	cm/h	Accu-infilt				
0	20	#DIV/0!	0		A	Log(Z1/Z2)/Log(T1/T2)	
5	19.8	237.6	20			-0.042151885	-1.04215
10	19.2	115.2	39.8		K	Logz1+Loga+Logt1	
15	19	76	59			2.481958316	1.439806
20	18.6	55.8	78		**Z**	**k*t^{a-1}**	
30	18.2	36.4	96.6			**0.008350505**	
40	18.1	27.15	114.8				
50	17.8	21.36	132.9				
80	17.5	13.125	150.7	Logz1	1.277838		
110	17.5	9.545455	168.2	Logt1	1.20412		
140	17.5	7.5	185.7	Loga	#NUM!		