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Study of the Impact of Fertilization and Irrigation on Soil Chemical and Physical Properties under Different Cultivation Systems

By

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Abstract

This research reviews the human impact on land degradation through the integrated effect of fertilization and irrigation on soil chemical and physical properties at deferent cultivation systems. Agricultural operations in the semiarid is characterized somewhat by intensive irrigated cultivation system, open-field and protected field. Soil degradation has occurred because of the effect of mismanagement in fertilization and irrigation practices. Under arid Mediterranean climate, these practices increased the vulnerability of an already fragile ecosystem. The objective of the study was to investigate the effects of irrigation and fertilization on selected soil chemical and physical properties in deferent cultivation systems. Five sites of farmland that are located in Dura area of Hebron Governorate, southern Palestine were chosen. Three different adjacent cultivation systems, irrigated (open & protected) cultivation system and non-irrigated (rain fed) cultivation system at each site were sampled during three times (T1), through April/2006, (T2), through October/2006, and (T3), through April/2007. A composite soil sample that comprised 45 samples was collected from the layer (0–30 cm) for each irrigated and adjacent non-irrigated cultivation system. The study indicated that soil pH, CaCO3, and OM were higher in non-irrigated (rain fed) cultivation system than the irrigated (open and protected) cultivation system. This could be attributed to the continuous cultivation throughout the year. Moreover, relatively optimum soil moisture content throughout the year created favorable condition for OM oxidation. In addition, crop residues were immediately removed from irrigated (open and protected) cultivation system. This implies that little above ground crop residues remained on the Land for decomposition as

compared to the adjacent lands used for rain-fed agriculture. In contrast available phosphorus, Potassium, and nitrate were higher in irrigated, (open and protected) cultivation system. This could be due to the application of fertilizer, or could be due to the variations in the irrigation, soil type and the soil management practices adopted for the land management.

Introduction

With the steady rise of the world's population and the consequent expansion at the expense of the agricultural land, increasing the demand for agricultural products, in turn, led to an increased use of intensive agriculture and resulted in damage to the soil due to the widespread use of chemical fertilizers. Soil degradation has become an environmental problem which limits the sustainability of agriculture and decreases soil productivity throughout the world. This degradation is the result of negative changes in soil physical, chemical and/or biological properties (Barut, and Celik, 2009). Around the world, the fresh groundwater resources continue to deteriorate due to accelerated application of synthetic fertilizers. The excessive use of fertilizers in agriculture is recognized as a major contributor to this deterioration. Since, the agriculture sector uses over 70% of the available fresh water resources around the world. In the Occupied Palestinian Territories agriculture consumes about 70% of the water available, domestic and industrial users utilize 30% of the water supply (Abu-Madi, 2009). Irrigation can have adverse effect on soil properties thereby on sustainable productivity if not regularly monitored. (Henry and Hogg, 2003). This means Irrigation should be managed so that it could minimize adverse effects on soil quality. Moreover, the effects of irrigation on soil physicochemical properties in arid and semi-arid environments were well documented. The success of soil management to maintain soil quality depends on the understanding of how soils respond to agricultural use and practices over time. (Getaneh et al., 2007). Mismanagement of fertilizer and water application results in salt buildup in the soil-groundwater systems.

Fertilizer application and irrigation should be integrally managed according to the soil type, climatic factors and crop requirements. Soil degradation due to land mismanagement is a major global concern and threatens economic and rural development, especially in the third-world countries (El-Swaify, 1994). Arid and semiarid regions are particularly susceptible to soil degradation and often show low resilience (Seybold et al., 1998). Therefore, this study was carried out in five sites at Dura district, these sites represented different cultivation conditions. The objective of this research is to study the Impact of Fertilization and Irrigation on soil chemical and physical properties under Different Cultivation Systems in the West Bank.

Chapter One

1. Literature Review

1.1. Soil in Palestine.

The Palestinian territories (West Bank and Gaza, or Northern Palestinian Districts and Southern Palestinian Districts) are situated between the Mediterranean Sea and the Jordan River and Dead Sea at between 29° and 33° North Latitude and 35° and 39° Longitude. (PIALES, 1996). Mediterranean soil includes a wide variety of parent material, drainage conditions, and seasonal water regimes (Bech et al., 1997; Darwish and Zurayk, 1997). Despite the small area of Palestine, a variety of soil can be found (Qannam, 2003). This diversity is due to the differences in the original materials that compose the soil, and the diversity of the geographic and climatic systems. (Ghanem, 1999). However, the soils are widely diverse in morphological, chemical, and physical properties, (Zohary, 1947 and Retrenbreg et al., 1947). According to ARIJ (1997), depending on the soil map of Israel (1968) there are about 12 to 16 different types of soil associations in West Bank. Although, Zohary (1947) divided the soil of Palestine into six subdivision depending on the geobotanical view, these are; calcareous soils, basalt soils, sandy and sandy calcareous soils, loess soils, alluvial soils and saline soils. Terra Rosa soil series with all its varieties may be considered dominant on tops of mountain and slopes (PIALES, 1996). Figure (1) showed that Terra rossa is the most typical soil formation that dominant in the central mountains of Palestine and generally in all Mediterranean regions. Terra rossa is a product of Mediterranean climate as a result of alternation of rain in winter with dry period in summer; this soil is characterized by low amounts of organic matter, relatively high clay content (20-

50 %), soil reaction is generally neutral or moderately alkaline, and high content of soluble salts (Yaalon, 1997; Zohary, 1947; Retrenbreg et al., 1947). Soil characteristics represent important key issue in soil and water conservation managements. According to Mohammad (2005), the soil of the southern parts of the West Bank is generally characterized by heavy fine texture that ranges from clay to clay loam, and low soil fertility due to soil erosion and disappearance of vegetation cover. The topography of West Bank region is greatly variable; the semi-coastal zone in northwest part of the West Bank is characterized by the Mediterranean humid climate and mostly high amount of rainfall. The central high land is characterized by hilly and rocky features mainly with steep slopes. The Jordan valley is a narrow strip between the eastern slope and the Jordan River with 70 km long. Moreover, the landscape attributes (slope, aspects, and altitude) are significantly affecting the amount and the distribution of almost all chemical and physical soil properties (Rezaei et al., 2005). The effect of topography on soil characteristics become visible between the south and north facing slope in one hand and slope gradient on the other hand. Soil moisture, organic matter and plant characteristics are significantly high in North-facing hill slopes than south-facing hill slopes (Kutiel and Lavee, 1999; Zaady et al 2001). Other results indicate that most chemical soil properties, including electrical conductivity (EC), organic carbon (OC %), total N%, P, and K are significantly related to slope gradient ((Rezaei et al., 2005). The soils of Palestine have been the subject of many studies since the beginning of this century, when several attempts were made to classify, identify and even map the soils. Reifenberg and Whittles (1947) studied in details the chemical properties of most soil type’s that are occurring in Palestine, and compared their composition to that of adjacent rocks.

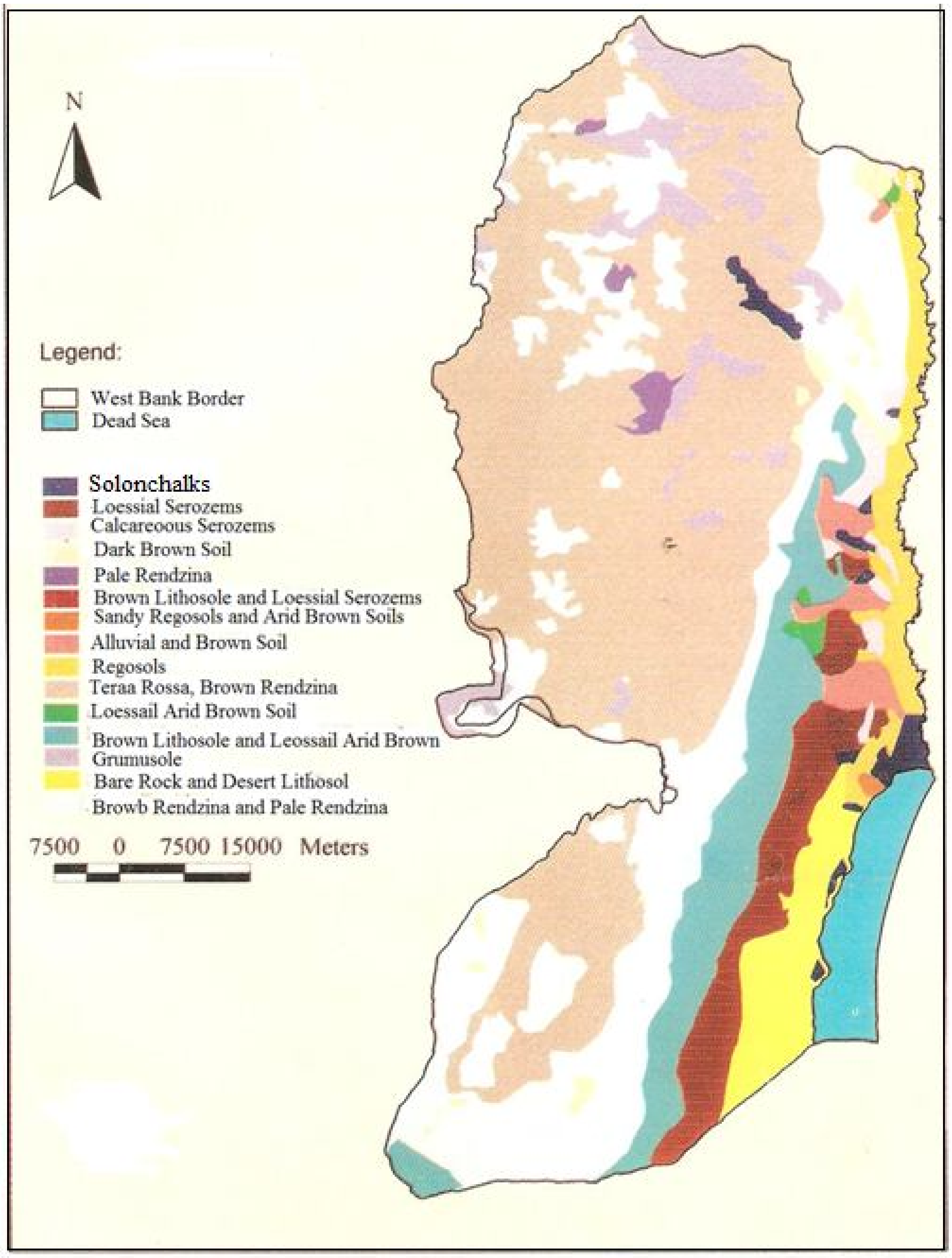


Figure (1): Soil type and their distribution in the West Bank.

Source: Land Research Center (2006).

1.2. Climate

In general, Palestine has a Mediterranean climate characterized by semi-arid and arid conditions, by long, hot dry summers and short, cool, rainy winters (Abu Zahra, 2000). Accordingly, (Qannan, 2003) the climate of the Palestinian Territories is classified as dry hot season from June to October, and cold wet season from November to May. The average annual rainfall, in the West Bank is 300-700mm, which concentrates in the winter season (60-70% of the annual average) and it distributes in the remaining months of the year except in the summer where there is no rain completely (ARIJ, 1997) .

1.3. Water in Palestine.

In the world, the fresh groundwater resources continue to deteriorate due to accelerated application of synthetic fertilizers, (Mirjat et al., 2007). The excessive use of fertilizers in agriculture is recognized as a major contributor to this deterioration. Since the agriculture sector uses over 70% of the available fresh water resources around the world; they always remain at the risk of contamination (Laegreid et al., 1999). In Palestine, the agriculture sector utilizes 60 to 70% of the available water resources. (Nofal, 1998). Agriculture in Palestine is divided into rain-fed and irrigated cultivation. Rain-fed cultivation forms the largest cultivated area, occupying 92.7-95.8% of the total cultivated land. Annual production is generally affected by the dominant climatic conditions, reflecting substantial variation between the various years. (Butterfield et al., 2000). The important of rain fed agriculture varies regionally but produce the larger portion of the food for poor communities in developing countries. Most countries in the world depend primarily on rain fed agriculture for their grain food. (Wani, Rocktrom and

Oweis, 2009). Israel has restricted Palestinian water usage and exploited Palestinian water resources after occupation. Presently, more than 85% of the Palestinian water from the West Bank aquifers is taken by Israel, (Butterfield et al., 2000). In Palestine, there is a severe water shortage for domestic use and for agricultural use. However, About 95% of agriculture in Palestine is rain fed, (Al-Seikh, 2006). Water is always considered as an essential factor of life and development in arid and semi-arid countries. In Palestine the total per capita water consumption is 139m^3. (Sbeih. 2007). Water resources in the West Bank and Gaza Strip of Palestine are scarce and under the threat of depletion and degradation by different land-use activities, the lack of infrastructure that would protect and/or reduce their deterioration, and a lack of resource management plans, (Thawaba, 2006). there isn't any water harvesting structures i.e. dams, most of this rainwater flowing towards the Dead Sea or the Mediterranean Sea as runoff (Sbeih. 2007).

1.4. Effect of Fertilization on Soil Properties:

Fertilizers may be divided into two broad categories, natural and synthetic. Natural fertilizers generally originate from unprocessed organism sources such as plants or animals. Synthetic fertilizers are man-made or processed. Synthetic fertilizers can be organic (for example, urea) or inorganic (for example, superphosphate), (Powell, 1996). Long-term fertilizer applications have been reported, in a number of cases, to cause increasing in water stable aggregation, porosity, infiltration capacity and hydraulic conductivity and decreases in bulk density. Fertilizer additions can also have physiochemical effects which influence soil aggregation (Haynes and Naidu, 2004).

Dry land soils are usually low in organic matter (OM), which, in turn, limits soil structure and chemical fertility. Arid soils usually contain from 0.1% to 1% OM, while semiarid soils range from 1% to 3%. OM serves as a nutrient reserve, particularly for N, and P to a lesser extent, and is critical to maintaining soil aggregate stability (Masri and Ryan, 2006). Soils high in organic matter tend to form under wet or cold conditions where decomposer activity is impeded by low temperature (Wagai et al, 2008) or excess moisture (Minayevs et al, 2008). Sarah (2004), Kutiel, et al, (1999), and Al- Seikh, (2006) found that the organic matter increases from arid zone to Mediterranean zone. With cultivation and intensification of agriculture, declines in OM invariably occur. As a consequence, P behavior in dry land soils is dominated by inorganic soil compounds. As most dry land soils are calcareous, solubility relationships dictated by high pH and $CaCO_3$ combine to reduce available P in soils. As a result, most dry land soils that have not been fertilized are P-deficient (Matar et al., 1992). Thus, inherent soil properties dictate nutrient behavior and fertilizer use; as a consequence, N is invariably deficient (Ryan and Matar, 1992; Ryan, 1997). Prior to the advent of commercial fertilization, P deficiency was also widespread (Matar et al., 1992). These deficiencies reflected many centuries of exhaustive cropping, with little or no return of nutrients, since crop residues were usually grazed bare. While K is rarely deficient in the soils of Mediterranean region—a result of the parent materials and the low weathering intensity— increasingly there is evidence of other nutrient stresses being locally important, e.g., zinc deficiency (Materon and Ryan, 1995), and boron (B) toxicity (Yau et al., 1995). The type of fertilizer and method of application significantly influence soil chemical properties.(Treder, 2005). Organic matter is regarded as a very important parameter of soil productivity. It has number of important roles to play in soils, both in their physical structure and as a medium for biological activity. Organic matter makes its greatest contribution to soil productivity. It provides nutrients to the soil, improves its water holding capacity, and helps the soil to maintain good tilth and thereby better aeration for germinating seeds and plant root development (Zia et al., 1993). Soil organic matter encourages granulation, increases cation exchange capacity (CEC) and is responsible for adsorbing power of the soils up to 90 %. Cations such as $Ca^{+2,}$ Mg^{+2} and K^{+} are produced during decomposition (Brady, 2005). Cultivation of high yielding crop varieties and multiple cropping is depleting the fertility of soils at a rapid pace. The soils, which were, once well supplied with available nutrients, are now gradually becoming deficient (Zia et al., 1994). Use of compost can be beneficial to improve organic matter status. Compost is rich source of nutrients with high organic matter content. Physical and chemical properties of soil can be improved by using compost, which may ultimately increase crop yields (Hussain et al. 2001). According to(Sarwar, Schmisky et al. 2008), the soil pH was lowered and SAR decreased due to the acidic effect of compost, formation of acids, release of Ca and leaching of Na. There was a slight increase in ECe of the soil. The available amount of all the major plant nutrients (N, P, K, Ca and Mg) and organic matter content increased in the soil. Agricultural use of soil affected its chemical properties. The changes in these properties were associated with the fertilizer management practices at each site (Shen et al. 2007). Fertilizers are applied to soils in order to maintain or improve crop yields. In the long-term, increased crop yields and organic matter returns with regular fertilizer applications and result in a higher soil organic matter content and biological activity being attained more than in areas where no fertilizers are applied. As a result, long-term fertilizer applications have been reported, in a number of cases, to cause increases in water stable aggregation, porosity, infiltration capacity and hydraulic conductivity and decreases in bulk density. Fertilizer additions can also have physico-chemical effects which influence soil aggregation(Haynes and Naidu., 2004).

Long-term application of fertilizers containing P, especially organic fertilizers, usually increases the water soluble and available P of soil and at the same time may result in P accumulation in soil. Organic fertilizers may also increase movement of P in the soil profile that could result in surface and ground water pollution, (Mohammad, Kalbas, and Shariatmadari, 2009). Braimoh and Vlek, (2003), found that permanently cultivated soils showed significantly lower physical and chemical soil properties. (Smaling et al., 1997) said that continuous cropping with little or no inorganic fertilizer input leads to low nutrient balances.

1.5. Effect of Irrigation on Soil Properties:

Soil degradation has become an environmental problem which limits the sustainability of agriculture and decreases soil productivity throughout the world. This degradation is the result of negative changes in soil physical, chemical and/or biological properties (Barut et al, 2009). Monitoring the impacts of irrigation on soil chemical properties is crucial as far as the issue of sustainable crop production and productivity is concerned. The success of soil management to maintain soil quality depends on the understanding of how soils respond to agricultural use and practices over time (Negassa et al, 2004). Irrigation can have adverse effect on soil properties thereby on sustainable productivity if not regularly monitored. Timely monitoring helps to avoid negative effects of irrigation on soil properties (Henry and Hogg, 2003). This means Irrigation should be managed so that it could minimize adverse effects on soil quality (Itanna et al. 2003; Qian, and Mecham, 2005). Excessive application of irrigation water and nutrients result in some serious problems (Türkmen et al., 2004). However, Loch and Foley (1994) suggested that the quality of the irrigation water is essential in the soil structural stability. Parameters such as the water electrical conductivity (EC), sodium adsorption ratio (SAR), and pH influence the physicochemical dispersion of clay. To make optimal use of water resources, contribute to sustainable agriculture and to decrease or to eliminate the negative effects of irrigation to the environment, it is necessary to apply irrigation water only as a plant needs for optimal use and to apply it on time to the active root zone depth with minimal water loss (Thompson and Doerge, 1996). The presence of salts in irrigation water influences most of the chemical soil characteristics such as soil pH, soil EC, soluble ions and SAR as well as actual evapotranspiration and water use efficiency. (Alawi et al., 1980 and Mostafa et al., 1992). El-Boraie (1997) found that soluble Ca^{++}, Mg^{++} and Na^{+} increased with increasing salinity level of irrigation water, while soluble K^{+} decreased with increasing salinity levels, soluble Ca^{++} and Na^{+} increased with decreasing irrigation frequency, while increasing salinity levels and irrigation frequency decreased the hazardous effects. Ragab (2001) studied the use of irrigation water qualities on chemical properties of soil. He observed that there was a progressive and significant increase in soil salinity values as the salinity of irrigation water increases. The increase in irrigation water salinity had no effect on the soil acidity, but it decreased the water holding capacity. The increase in irrigation water salinity decreased the leaching efficiency of soils. (Zadeh–Fard et al., 2007).

1.6. Soil physical Properties:

1.6.1. Soil Texture:

Particle size distribution describes the relative amounts of gravel, sand, silt and clay within the soil. These are the building blocks for the soil and can have a large effect on the soil properties. Clays have a high surface area of 5–750 m^2/g depending on clay type and can have a high amount of chemical and physical activity. Sands have a smaller surface area (0.01-0.1m^2/g) and tend to be less chemically and physically active (McKenzie et al. 2004). A change in the soil texture from course to fine is associated with a decrease in coarse particles and increase in the fine ones, fine particles play an important role by its character and through its effect on other soil properties such as OM, CEC, $CaCO_3$ content and aggregate formation and consequently on pore size distribution and surface area (Atinut et al.. 2004).

1.6.2. Bulk Density

Bulk density (Db) is the oven dry weight of soil per unit volume. It may be expressed in g/cm^3 or t/m^3 ($1\ g/cm^3 = 1000\ kg/m^3 = 1\ t/m^3$). It affects porosity and soil strength. (Cresswell and Hamilton, 2002). Limiting values of bulk density for plant growth depend on soil texture (Cass 1999).

Table 1: Critical values of bulk density for plant growth at which root penetration is likely to be severely restricted.

Texture	Critical bulk density (g/cm3)
Sandy loam	1.8
Fine sandy loam	1.7
Loam and clay loam	1.6
Clay	1.4

Source: Jones (1983).

Table 2: A general scale of bulk density.

Bulk density (g/cm3)	Rating
<1.0	very low
1.0–1.3	low
1.3–1.6	moderate
1.6–1.9	high
>1.9	very high

Source: Jones (1983)

1.6.3. Porosity

Porosity (or volumetric air content) is the proportion of soil volume occupied by air, and this varies with moisture content. Most plants cease to grow when air porosity falls below 10% (Murphy 2000).

Table 3: Bulk density required to give 10% air porosity at different Gravimetric moisture contents (Assuming soil solid density = 2.65 g/cm3).

Gravimetric moisture content (%)	Bulk density to give 10% air porosity (g/cm3)
5%	2.1
10%	1.9
20%	1.55
30%	1.3
40%	1.15

Source: Geeves et al. (2007).

1.7. Soil Chemical Properties

1.7.1. Soil pH

The pH is a measure of soil acidity or alkalinity that gives an indication of the activity of the hydrogen ion (H+) and hydroxyl ion (OH–) in a water solution. Both these ions have a high chemical activity. Their chemical activity is lowest when the solution or soil is close to a neutral pH of 7.0. The pH characterizes the chemical environment of the soil and may be used as a guide to suitability of soils for various crop species. Soil pH is also an indicator of the chemical processes that occur in the soil, and is a guide to likely deficiencies and/or toxicities (Slattery et al. 1999). The beneficial effect of organic materials incorporation followed by leaching is preferred to the decomposition of organic matter resulting in the evolution of carbon dioxide and organic acids, lowering soil pH and release Ca by solubilization of $CaCO_3$ and other soil minerals, thereby increasing the electrical conductivity and replacement of exchangeable sodium by cations like calcium and magnesium and thus lowering the ESP (Alam and Khan, 2006). Soil pH may be one of the most important parameters which pinpoint the over all changes in soil chemical properties (Mostafa, Elsharawy, and Elboraei, 2004). During growth stages, soil pH values decrease. This may be due to that H+ ions are released from the exchange complex by the influence of other soluble cations in the applied saline waters (Mahrous et al., 1983) or due to increasing the solubility of CaSO4 and sulfate transformation which led to decrease in the soil pH values (El Sawaby, 1965). The soil pH affects the availability of various nutrients, toxic elements and chemical species to plant roots. The pH is therefore a very good guide to some expected nutrient deficiencies and toxic effects (Brady 1984; McKenzie et al. 2004:).

1.7.2. Exchangeable Cations

The five most abundant cations in soils are calcium (Ca^{+2}), magnesium (Mg^{+2}), potassium (K^{+}), sodium (Na^{+}) and, in strongly acid soils, aluminium (Al^{+3}). The cations manganese (Mn^{+2}), iron (Fe^{+2}), copper (Cu^{+2}) and zinc (Zn^{+2}) are usually present in amounts that do not contribute significantly to the cation complement (Abbott, 1989). Because sodium and magnesium more hydration than calcium, soils that are high in sodium and magnesium show more dispersion than soils that are high in sodium and calcium (Abbott 1989; Emerson and Bakker 1973).

1.7.3. Nitrogen (N) in Soil

Nitrogen occurs in the soil in several forms, only some of which are available to plants. Generally nitrogen has to be in a mineralised form (nitrate or ammonium) to be readily available to plants (Strong and Mason 1999). The nitrogen that is readily available to plants is generally measured as nitrate. Nitrate levels can be highly variable in soils (Holford and Doyle 1992). High levels of nitrate in groundwater can become toxic. Excessive use of fertilizers and applications of effluent can cause nitrate levels to become high (NHMRC 2004)

1.7.4. Phosphorus (P) in Soil

Phosphorus levels in soil can be used as a guide to indicate whether phosphate fertilizer is required for plant growth. Phosphorus is in various forms in the soil, only some of which are actually available (i.e., orthophosphate, $H2PO4^-$ and $HPO4^{2-}$) to plants. (Moody and Bolland, 1999).

1.7.5. Potassium (K) in Soil

Plant requirements for potassium (K) are supplied from two soil sources: exchangeable K that is immediately available, and non-exchangeable available potassium (NEAP), which is more slowly available. NEAP is not a useful source of K where the rate of K absorption by plants is high and sustained Critical values for K that begin to limit plant growth which is around 0.2–0.5 cmol(+)/kg or 80–200 mg/kg (Gourley, 1999).

1.7.6. Soil Electrical Conductivity (ECe)

Soil salinity is a major environmental factor limiting the productivity of agricultural lands. Soil salinity causes land degradation and affects food production (Sharma & Rao, 1998). Conventionally, saline soils are defined as those having an ECe value >4 dS/m, see (Table 4).

Table 4: Salinity ratings for soil based on ECe.

Rating	ECe dS/m	Effect on plants
Non-saline	<2	Salinity effects are mostly negligible
Slightly saline	2 - 4	Yelds of sensitive crops are affected
Moderately saline	4 - 8	Yields of many crops are affected
Highly saline	8 - 16	Only tolerant crops yield satisfactorily
Extremely saline	>16	Only very tolerant crops yield satisfactorily

Source: Richards (1954).

Due to the diversity of water type used for irrigation, it was necessary to set up particular criteria for evaluating the quality of irrigation water. In this respect, the most important characteristics that may be considered here in determining water quality are salinity (expressed as electrical conductivity values ECw, and sodium adsorption ratio (SAR). Based on salinity of irrigation water, it could be mentioned that water with EC <0.7 dS/m has no restriction for use in agriculture, such water is similar in characteristics lik tap water (Mostafa et al.,1992).

1.7.7. Sodium and Sodicity

Concerning the ECe values of soil extract, changing Sodium adsorption ratio (SAR) reflect the ratio between Na^+ and Ca^{+2} + Mg^{+2} in the soil solution, so it describe precisely soil quality (relative to salinity). In other words, the increase in SAR values led to increase in the activity of the monovalent ions particularly (Na^+) with a relative decrease in the activities of both Ca^{++} and Mg^{++}, this may be due to the nature of SAR equation. The numerator (Na^+) is reduced as a result of dilution at a greater rate than the dominator (Ca^{+2} + Mg^{+2}) because the denominator is reduced by square root of the dilution as discussed by Ayers and Westcott (1985). Therefore, high concentrations of Na. and Cl^- in the soil solution may depress nutrient-ion activities and produce extreme ratios of Na./ Ca^{+2}., Na./K., Ca^{+2}./Mg^{+2}., and Cl^-/NO^{-3} (Grattan and Grieve, 1994). Sodium saturation may cause dispersion. Because of its relatively large size, single electrical charge and hydration status, adsorbed sodium tends to cause physical separation of soil particles. The physical separation of soil particles results in sufficient distance between individual soil particles such that repulsive forces between like molecules exceed bonding forces and dispersion occurs. (Bauder and Brock, 2001; Bauder, 2001,). Another process associated with sodium saturation is platelet and aggregate swelling. The reason that other ions such as calcium and magnesium do not have this same effect is because of their smaller, non-hydrated divalent cations, which tend to cluster closer to the clay particle (their +2 charge causes a stronger attraction to clay surfaces than sodium, which has a +1 charge). This combination of conditions does not cause the disruption to soil structure that sodium does (Hanson et al., 1999). (Figure 2) helps to illustrate this difference in physical arrangement of sodium and calcium molecules on the clay surface. Basically, attractive forces which bind clay particles together are disrupted when too many sodium ions get between the clay particles. When such separation occurs, repulsive forces begin to dominate, and the soil disperses (Hanson et al., 1999).

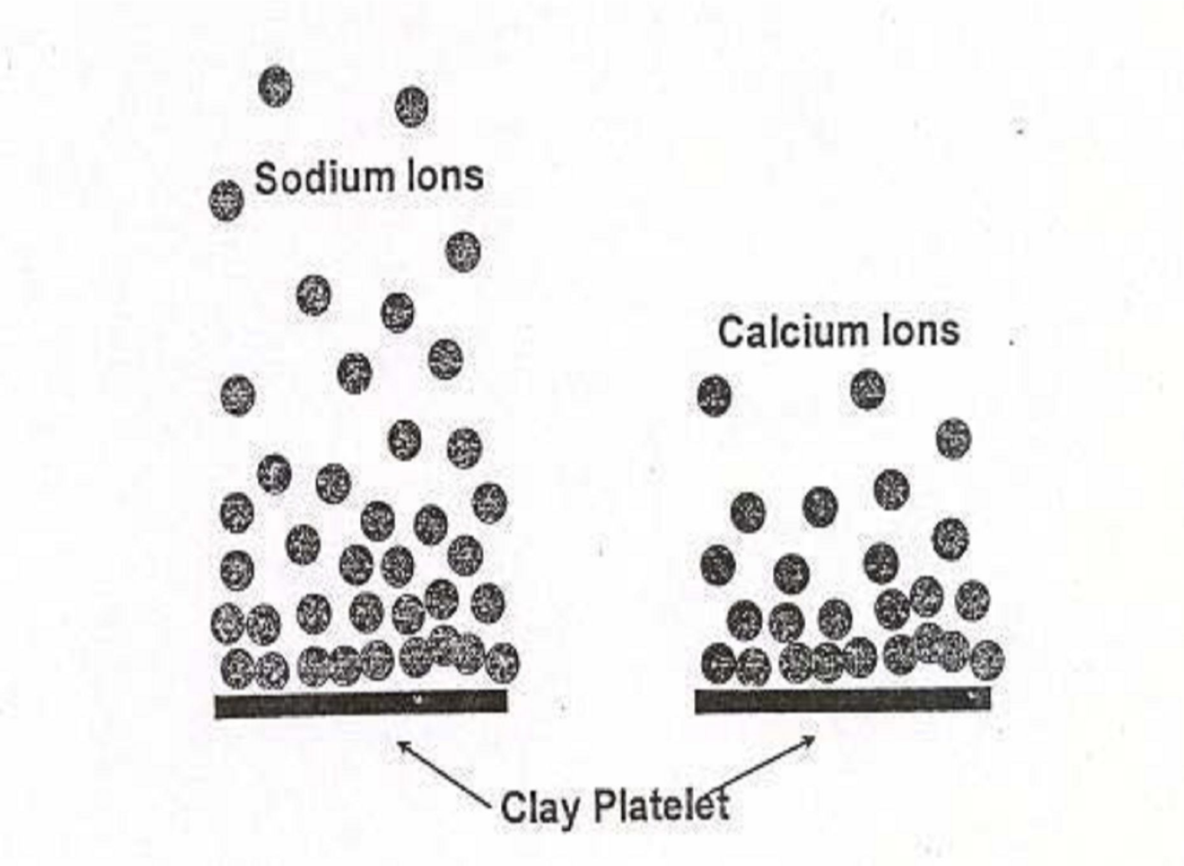


Figure 2: Behavior of sodium and calcium attached to clay particles.

Source: (Hanson et al., 1999).

1.7.8. Micronutrients in Soils

Soil fertility is an important factor, which determines the growth of plant. Soil fertility is determined by the presence or absence of nutrients i.e. macro and micronutrients. Out of the 16 plants nutrients Zinc, Copper, Iron, Manganese, Molybdenum, Chlorine and Boron are referred to as micronutrients. These elements are required in small quantities for plant growth. Although micronutrients are required in small quantities, but they have the same agronomic importance as macronutrients have and play a vital role in the growth of plants (Nazif et al., 2006). The main sources of these micronutrients are parent material, sewage sludge, town refuse, farmyard manure (FYM) and organic matter. These nutrients are presenting in small amounts ranging from few mg kg^{-1} to several thousand of mg kg^{-1} in soils. The availability of micronutrients is particularly sensitive to changes in soil environment. Perveen *et al.* (1993) studied micronutrient status of some agriculturally important soil. The study indicates that there is a positive correlation of clay contents with Iron, Copper, Zinc and Boron. Chhabra *et al.* (1996) found that available Copper increased with clay and organic carbon content and available Iron decreased with sand content. It can be observed that Iron, like the other micronutrients, decreases with the increase in soil pH. These results were supported by Rajakumar *et al.* (1996) and Chinchmalatpure *et al.* (2000) who reported negative significant correlation between Iron and soil pH.

Table 5: Critical soil values of Copper, Iron, and Zinc.

S. NO	Micronutrients	Nutrient Content (mg kg^{-1})		
		Low	Medium	High
1	Iron	<3.0	3.0-5.0	>5.0
2	Copper	<0.3	0.3-0.5	>0.5
3	Zinc	<0.9	0.9-1.5	>1.5

source: Johnson and Fixen, 1990 and Soltanpour, 1985.

1.8. Soil Salinization

There are two kinds of soil salinity: dry land salinity (occurring on land not subject to irrigation) and irrigated land salinity. Both describe areas where soil contains high levels of salt. (Carini, 1991). All soils contain some water-soluble salts. Plants absorb essential plant nutrients in the form of soluble salts but excessive accumulation of soluble salts, called soil salinity, suppresses plant growth (***Alan***, 1994). Saline or salt-affected soils are common in arid and semi-arid regions. Ions are released from weathering minerals in the soil due to natural or human induced processes The natural process is called the primary salinization and the human induced process (may be applied in irrigation water or as fertilizers) is known as the secondary salinization (Sheith, 1998). Soil salinity is a major environmental factor limiting the productivity of agricultural lands. Soil salinity causes land degradation and affects food production (Sharma & Rao, 1998). This problem is not only reducing the agricultural productivity, but is also putting far reaching impacts on the livelihood strategies of small farmers (Tanwir *et al.*, 2003).The increase in salinity with increasing in proximity to the drier areas is effected by soil texture, relief and soil age. Deep, fine textured soil are more saline thane coarser textured soils or shallow ones if the other environmental factors are similar (Dan and Yaalon, 1982). Naturally saline soils are frequent in arid areas because the potential evaporation of the soil greatly surpasses the quantity of water that gets to the soil. This enables salts to accumulate near the surface. (Plan Bleu, 2003). There are several causes for soil salinity in the West Bank. The main causes are the extremely arid to semi arid climate in most areas; the bad irrigation management and practices and the water quality (Doudeen, 2000).

1.9. Soil and Water Salinity

Due to scarcity of surface water resources especially in arid and semi-arid region for supplying irrigation water for agricultural lands, the excessive discharge of the ground water with low quality has occurred, which has imposed a further increase in soil salinization (Poustini & Siosemardeh, 2004). It is estimated that up to 20% of irrigated lands in the world are affected somehow by different levels of salinity and sodium content. ((Feizi, 1993). All natural waters contain soluble salts. The concentration of the salts determines whether the water is of high quality (drinkable or usable for irrigation without need for special precautions) or of low quality (brackish or saline). The amount of salts in the root zone (or the salt concentration in the soil solution) determines whether the soil is “normal” or “salt-affected” (saline, sodic, or saline- sodic) (El-Swaify, 1983). Salinity becomes a concern when an “excessive” amount or concentration of soluble salts occurs in the soil, either naturally or as a result of mismanaged irrigation water. Worldwide, salt-affected soils are most abundant in arid regions, and in irrigated lands the formation of salt-affected soils is the most important process of chemical soil degradation (El-Swaify, 2000). Salinity refers to the presence of the major dissolved inorganic solutes in the aqueous phase consisting of soluble and readily dissolvable salts in soil, including charged species (e.g., Na^+, K^+, Mg^{+2}, Ca^{+2}, Cl^-,

HCO_3^-, NO_3^- , $SO4^{-2}$ and CO_3^{-2}) (U.S. Salinity Lab Staff, 1954; Peterson, 1999). The predominant mechanism causing the salt accumulation in irrigated agricultural soils is evapotranspiration. The salt contained in the irrigation water is left behind in the soil as the pure water goes back to the atmosphere through the processes of evaporation and plant transpiration. (Corwin and Lesch, 2003). Evaporation from the soil surface is a major cause of the Salinization of irrigated soils in arid and semiarid regions (Noborio et al., 1996; Yakirevich et al., 1997). Overcoming soil salinity and sodicity in arid and semi-arid regions can be achieved by managing water resources, cultivating salt tolerant plants and using leaching with appropriate drainage system. (Hoffman et al., 1979).

1.9.1. Water Quality for Agriculture Purposes

Due to the diversity of water type used for irrigation, it was necessary to set up particular criteria for evaluating the quality of irrigation water. In this respect, the most important characteristics that may be considered here in determining water quality are salinity (expressed as electrical conductivity values ECw, and sodium adsorption ratio (SAR) (Alawi, et al, 1980) Water quality and quantity, the soil type, the area, the climate, the elevation and the type of crops together decide the suitability of water for irrigation. Salts in the irrigation water could negatively affect the growth of the plants by changing the osmotic pressure in the root zone. The sodium adsorption ratio (SAR), the sodium percentage, the total dissolved solids, and the electrical conductivity are used to evaluate the quality of water for irrigation.

1.9.2. Sodium Adsorption Ratio (SAR)

The expression of SAR was recommended by the United States Salinity Laboratory of the Department of Agriculture (Richrd, 1954). Sodium Adsorption Ratio (SAR) is used as index for sodium hazard in water for irrigation purposes in accordance with EC values. To assess whether or not one have an irrigation salinity problem, the irrigation water must be analysed for a number of parameters. These are electrical conductivity (ECe), and level of sodium (Na^+), calcium (Ca^{+2}) and magnesium (Mg^{+2}) ions (Peterson, 1999).

Table 6: Irrigation water classification, based on SAR values.

Classification	SAR Range	Comment
S1	<10	Low sodium water can be used for irrigation on almost all soils with little danger
S2	10-18	Medium sodium water will present an appreciable sodium hazard in fine textured soils having high cation exchange capacity
S3	18-26	High sodium water may produce harmful levels of exchangeable sodium in most soils
S4	>26	Very high sodium water is generally not suitable except at low and perhaps medium salinity.

source: (Wilcox, 1955).

Table 7: Grouping of irrigation water, based on EC and TDS.

TDS (mg/L)	EC (µS/cm)	Water Class	Remarks
<200	<250	C1	Low salinity: can be used for irrigation with most crops on most soils.
200-500	250-750	C2	Medium salinity: can be used to irrigate plants with moderate salt tolerance if moderate amount of leaching occurs.
500-1500	750-2250	C3	High salinity: not can be used on soils with restricted drainage. Can be used to irrigate plants with high salt tolerance.
1500-3000	2250-5000	C4	Very high salinity: not suitable for irrigation under ordinary conditions. Its can be used for irrigation occasionally under very especial circumstances.

source: (Richard, 1954)

Table 8: Guidelines for interpretations of water quality for irrigation

Potential Irrigation Problem	Units	Degree of Restriction on Use		
		Non	Slight to Moderate	Severe
Salinity (affects crop water availability				
Total Dissolved Solids (TDS)	mg/L	<700	700 - 2,000	>2,000
Electrical Conductivity (EC)	dS/m	<1	1 to 2.5	>3
SAR				
SAR	mg/L	0 - 4	4 - 9	>9
Specific Ion Toxicity (affects sensitive crops)				
Sodium (Na)	mg/L	<70	>70	
Chloride (Cl)	mg/L	<100	>100	
Boron (B)	mg/L	<0.7	0.7 - 3.0	>3.0
Miscellaneous Effects (affects susceptible crops)				
Nitrogen (NO3-N)	mg/L	<5	5 - 30	>30
Bicarbonate (HCO3)	mg/L	<90	90 - 500	>500

(modified from Ayers and Westcot 1985)

The ECi value can also be used to predict soil structure stability in relation to irrigation water quality. Figure (3) shows how to evaluate irrigation water quality in relation to its potential impact on soil structure using ECi and SAR values.

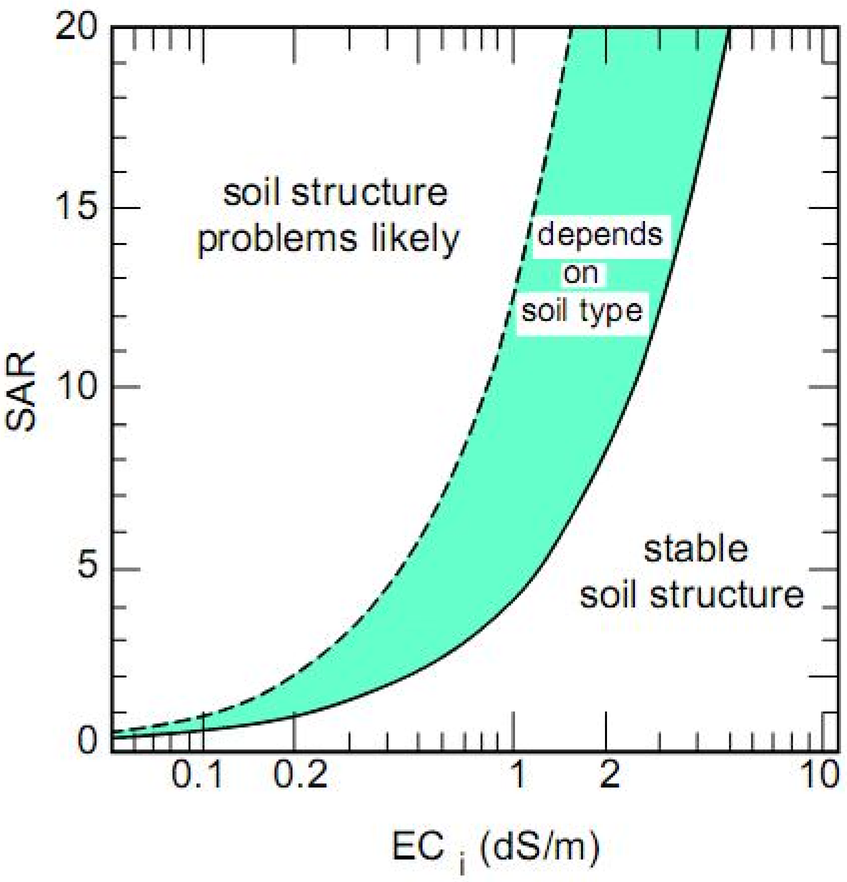


Figure 3: Potential for reduction in rate of infiltration resulting from various combinations of EC and SAR of applied water. (Source: Hanson et al., 1999).

1.9.3 Effect of Fertilization and Irrigation on Salinization

The word “fertilizer” means a substance that adds nutrients to soils so the soil can help produce high quality crops, trees, or other vegetation (Emery, 1993).

Fertilizer plays an important role among the environmental influences on crop production. Researchers have reported differential responses of different genotypes to fertilizers application (Aslam et al., 2000). Fertilizers are salts, therefore, when salinity is a concern, it is critical to pay close attention to how much fertilizer you apply, what kind of fertilizer you apply, where you apply fertilizer, and when you apply fertilizer. Different fertilizer forms have different salt indices. For example, manure salts and potassium chloride have 5.6 and 1.9 salt indexes, respectively, while phosphorous carriers have a low partial salt index less than 0.6 (Western Fertilizers Handbook, 1995; Rader et al., 1943).

Table 9: Salt Index of Some Fertilizer Materials.

Material	Salt Index
ammonium sulfate (21% N)	53.7
ammonium nitrate (35% N)	49.3
muriate of potash (50% K)	31.9
urea (46% N)	26.7
sulfate of potash (45% K)	14.1
anhydrous ammonia (82% N)	9.4
diammonium phosphate (21% N, 23% P)	7.5
monoammonium phosphate (12% N, 27%)	6.7
superphosphate (9% P)	6.4
superphosphate (21% P)	3.5

(Source: Glover, 1996)

The use of suitable fertilizers in appropriate doses is considered one of the most important factors for increased yield of crop per unit area. (Rashid and khan, 2008). The total quantity of chemical fertilizers used in the West Bank and Gaza Strip is estimated to be 49,420 tons in 95/96 growing season (Butterfield, Isaac, Kubursi and Spencer, 2000). fertilizer applications have broad effects on the existing soil physical, chemical, and biological properties of the soil(Yostet al., 2000). Not only agricultural practices including fertilization but also water quality and irrigation management affect the salinity build-up (Darwish et al., 2005).Water quantity showed the highest ECe value (8.6 dS/m) under mismanaged drip irrigation and monoculture The smallest ECe (0.7 dS/m) was under rainfed condition. In dry land agriculture, water quality is mostly adequate. Irrigated agriculture tends to be much more input intensive, including the use of chemical fertilizers. The Israeli ministry of environment has already stated that the Israeli coastal aquifer is saline due to nitrates from the large amounts of fertilizer used. This is certainly also a risk in Palestine(PIALE 1996). Salts have been a known problem for thousands of years, particularly in arid and semiarid areas where there is insufficient rainfall to leach salts from the root zone (Miller and Donahue, 1995). During the last 3 - 4 decades and due to increased demand for food, the use of irrigation has increased by about 300%. Mismanagement of fertilizer and water application results in salt buildup in the soil-groundwater systems. Fertilizer application and irrigation should be integrally managed according to the soil type, climatic factors and crop requirements (Johnston, 1997). Over-irrigation, poor scheduling of irrigation and a single large application of nutrients lead to low recoveries of water and nutrients. Under field conditions, studies showed that the utilization of N and P applied in the soil did not reach 49% for N and 15% for P (Shammas and Kishli, 1973; Shammas et al., 1973). In greenhouse vegetable cultivation, the amount of water evaporated from plants and soil is sometimes larger than that of irrigation water. When large amounts of fertilizer are applied under such conditions, salts accumulate in the soil and the growth of vegetables is inhibited by the highly concentrated soil solution (Akinori et al., 2007). In these intensive systems, poor fertilization is also based on equal NPK formulation, regardless of adaptability and suitability to local soil conditions and crop requirements (Hamze´ et al., 1991; Atallah et al., 2000a). Poor agricultural practices in greenhouses were identified to cause soil salinization (Solh et al., 1987; Atallah et al., 2000b). A large salt content in the soil solution may enhance particles aggregation and soil permeability (Richards, 1969). Soil water salinity can affect soil physical properties by causing fine particles to bind together into aggregates, increasing soil solution salinity has a positive effect on soil aggregation and stabilization. At the same time high levels salinity can have negative and potentially lethal effects on plants (Warrence, Pearson, and Bauder 2003). But the enrichment of the soil matrix with Na promotes the development of saline-sodic and sodic soils with trends to structure disruption and reduced infiltration. The dispersion of clay particles results from relative Na buildup in the soil causing unfavorable physical properties (Abrol et al., 1988). Increased amounts of calcium and magnesium can reduce the amount of sodium-induced dispersion (Warrence et al., 2003; Padole, 1991) . The combined effects of salinity and sodicity were greater than salinity alone. Uptake of N, P, K, Ca, Mg, Zn, Mn, Cu and Fe were reduced by salinity and/or sodicity of soil and irrigation water. Uptake of Na was increased by salinity and/or sodicity except at very high levels.

1.10. Research Problem

As result of increased use of intensive agriculture, soil degradation due to the widespread use of chemical fertilizers. This degradation is the result of negative changes in soil physical, chemical properties. After an exploratory examination of the soil in the area, an increase in soil salinity, especially in the protected agriculture, which at some sites EC reached 6dsm^{-1}. This growing problem due to the continued use of bad farming operations that led to a rise in soil salinity and intern affects the productivity of the soil.

1.11. Research Objectives

The main objectives in this study are:

- Attempt to identify the major reasons for the aggravation of the problem of high salinity in this region.
- Attempt to identify the form of agricultural operations exercised by the farms.
- Attempt to investigate the effect of farming cultivation on physical and chemical soil properties.
- The attempt to find a scientific solution to this problem .

Chapter Two

2. Methodology

2.1. Study Sites

The study was conducted during (2006 and 2007) on selected deferent cultivated farmlands that are located in Dura Zone of Hebron District in Palestine. (Map 1).

2.1.1. Description of the Study Area

Dura site is located 10 km Southwest of Hebron city. The elevation ranges from 850 to 900 m above sea level (Map 1). The study area is highly influenced by the Mediterranean climate (ARIJ, 2007), which is considered as semi-arid, Mediterranean climate; the rainy season starts in October and continues to the end of April. Almost 70% of the Annual rainfall occurs between November and February. January has the highest monthly rainfall in the year. The average annual rainfall in the study area varies from 350 mm to 450 mm, Figure (5) represent the annual rainfall during the last 15 years at the study site (Hebron meteorological Station, 2007; MOA, 2007). The study area has approximately 8194.5ha of Arable land, cultivated 5903.2ha (protected irrigated farmlands 34.5ha, open irrigated farmlands 184.3ha and non-irrigated (rain fed) farmlands 5684.3ha) (MOA, 2007). Soil taxonomy is Brown Rendzinas and Pale Rendzinas (Awadallah and Owaiwi, 2005). Due to the absence of water harvesting and collective irrigation system, farmers rely heavily on groundwater for irrigation purposes. Depending on SSP and SAR classification of water, all the springs and dug wells were suitable for irrigation purposes according to Ikhlil, (2009). Agricultural practices are intensive with high water and fertilizer inputs.

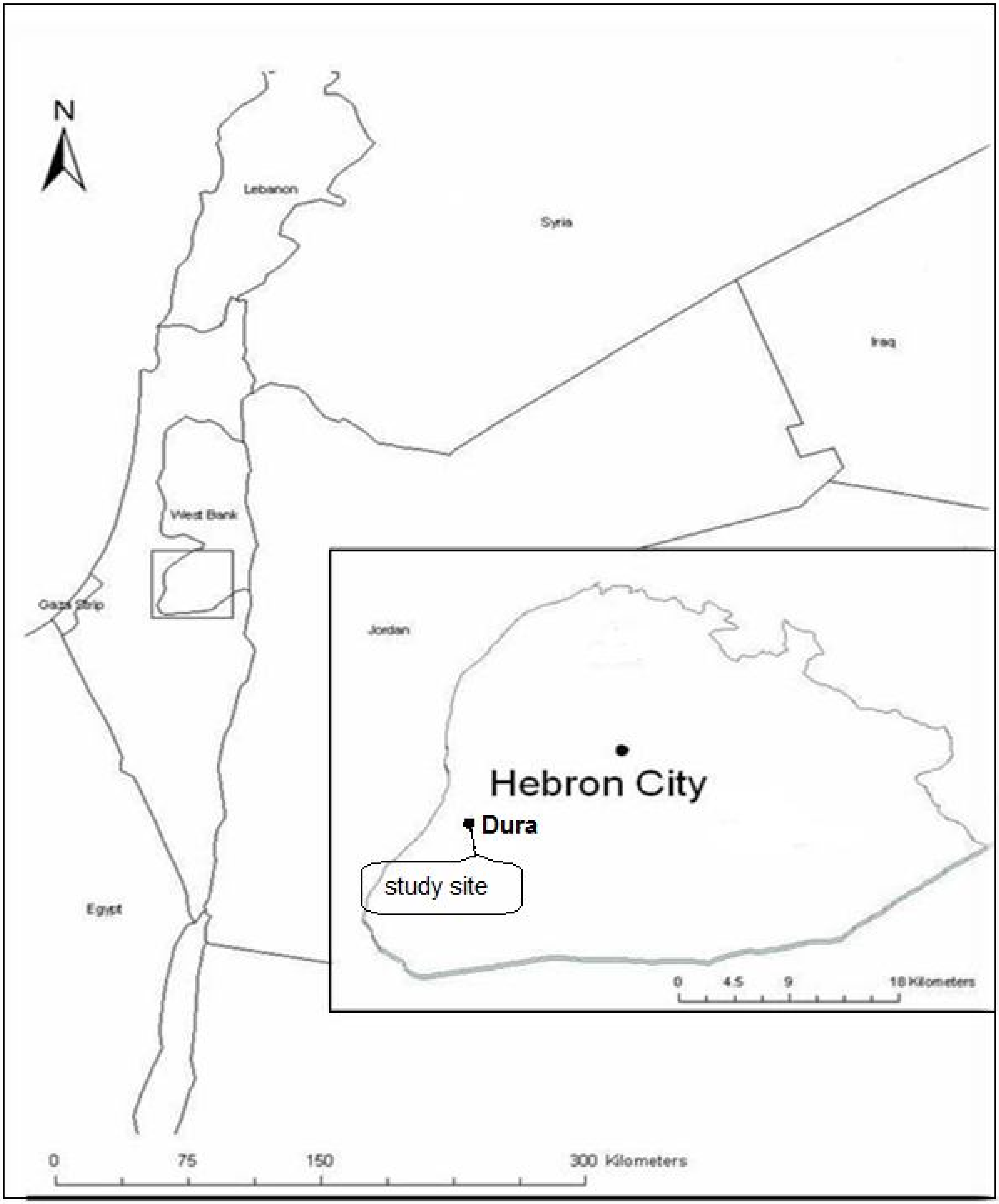


Figure 4: map of Study site.

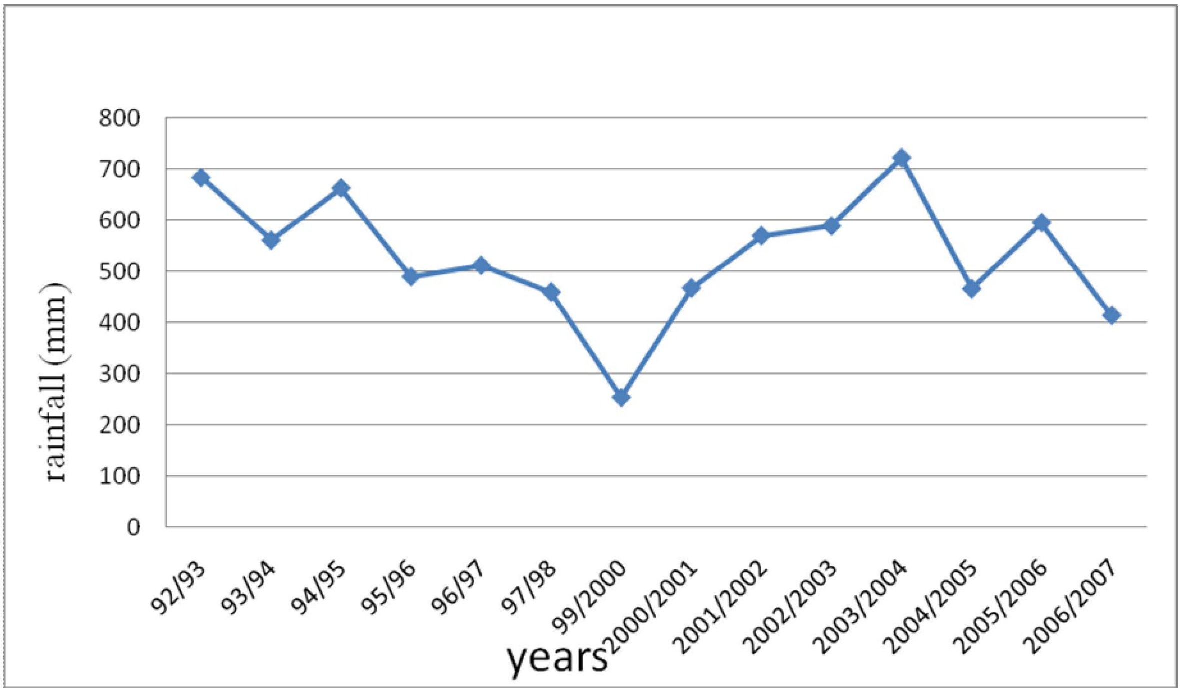


Figure 5: Annual rainfall at Dura site 1992-2007.

2.2. Treatments and Sample Collection

The aim of this research was to Study the Impact of Fertilization and Irrigation on soil chemical and physical properties under Different Cultivation Systems. It is divided into two parts.

First: information was collected by the interview containing information that identifies the soil sample with the field. This information includes the field name or number, fertilization, irrigation and previous crop in the field.

2.2.1. Nutrient management and the related agricultural practices

1. **Practices in greenhouses**: According to the interview, excess water and fertilizer use is a very widespread practice. Greenhouses are distributed on a wide range of the study site. The covered crops include vegetables. Vegetable production is very high, covering 100 % of the greenhouses. Cucumber followed by tomato dominates with high percentages. The use of organic and chemical fertilizers is very common and a wide range of fertilizer grades is available on the market. Fertilizer retailers are the key persons to make recommendations. Generally, excess fertilizer was use, especially N, P, and K fertilizers, is very common. Soil preparation, generally, starts with addition of different types of manure, which is generally not less than 30-40 t/ha, and sometimes even up to 100 tons, and fertilizer input exceeding 1800 kg/ ha per season and more than 400cubic meters of water. In some cases, poultry manure is also used. Regarding the chemical fertilizers, (NH4)2SO4 and NPK fertilizers are widely used. However, the amount of applied fertilizers varies greatly. Fertigation is very common in all sites and the application of liquid fertilizers has expanded rapidly in conjunction with micro irrigation. Fertigation starts 10-15 days after planting. Traditionally, only water is applied in the first 10 minutes of irrigation and further on chemicals are injected into the system. Fertigation also ends with irrigation. Conventionally in the fertigation program of the two predominant crops, tomato and cucumber, 18-18-18 or 20-20-20 compounds widely consumed as N, P, K sources. With respect to development stages, there is a wide consumption range in the fertigation

programs as well. According to the demand of the growers and to the recommendations of the retailer.

2. **Practices in Open filed:** According to the interview, excess water and fertilizer use is a very widespread practice, but less than greenhouse which is distributed on a wide range of study site. The covered crops include different vegetables. Vegetable production is very high, covering 100 % of the open irrigated system. The use of organic and chemical fertilizers is very common; also fertilizer retailers are the key persons to make recommendations. Generally, excess fertilizer is uses. Large amount of irrigation water was applied.
3. **Practices in Rain fed**: According to the interview, the covered crops include different Cereals (Wheat, Barley and Others). The use of different organic fertilizers is very common in large quantity.

Second: representative Soil and irrigation water samples were collected. Soil samples as shown in table (10) were collected to monitor soil physiochemical properties in relation to agricultural practices, (irrigation and fertilization). Soil samples were collected from three different soil cultivation, (greenhouse, irrigated open field and rain fed), within transects at five sites (S1, S2, S3, S4, & S5). These sites have different range of salinity, depending on this range the sites were choosing. Sample collected three times (T1) initial or before planting during April/2006, (T2) after six month during October/2006, and (T3) at the end of planting year during April/2007. A survey was conducted in five locations in Dura. The different cultivation systems are adjacent to one another, soil was sampled using cores (10 cm diameter) to depth of 30 cm. and sent to Hebron University for the analysis of soil physical and chemical properties. These chemical and physical soil properties are; Organic matter (OM%), soil reaction (pH), Electrical Conductivity (EC), Calcium Carbonate (CaCO3), sulfate (SO_4^-), calcium (Ca^{++}), magnesium (Mg^{++}), available potassium (K^+), sodium (Na^+), available phosphorous (P), nitrate (NO_3^-), Ammonium ($NH4^+$) and micronutrients, (Fe, Zn, Cu).

Irrigation water was also sampled to test in the lab, (the water use in irrigation). Five springs were sampled and tested for different water quality parameters (EC, pH, Na^+, K^+, Mg^{+2}, Ca^{++}, NO_3^-, SO_4^{-2}, Cl^-, HCO_3^-) for two time readings; the first one in April 2006 (the winter reading) when groundwater recharge from rainfall is at its peak, and the second one in October 2006 (the summer reading) when groundwater recharge is not existing, when long drought period has passed and so large amounts of water have been pumped from wells. Soil and irrigation water samples were collected and analyzed according to the methodologies used in the laboratory soil and water at Hebron University.

Table 10: diagram explain how soil was sampled at depth (0-30).

Sampling time	greenhouse	irrigated open field	rain fed
	5-sites	5-sites	5-sites
Before planting	3 samples	3 samples	3 samples
after planting	3 samples	3 samples	3 samples
end of planting	3 samples	3 sample	3 samples

2.3. Measurements and Data Collection

2.3.1. Soil Properties

Soil sample was collected from the layer (0-30 cm) of each irrigated (protected and adjacent open farmlands) and adjacent non-irrigated farmlands, from each location many samples was taken and mixed thoroughly together and a representative sample were taken. The samples were immediately placed in a plastic bags, well closed, and then taken to the laboratory, air dried at room temperature, crushed with a pestle and mortar and passed through a 2-mm sieve, were the following chemical and physical analysis were done:

2.3.2. Soil Physical Analysis

Soil particle size distribution was determined using the pipette method (Bouwer, 1986). Bulk density determined by clod method (Kim, 1996). Mineral density was measured based on finding the volume of the particles contained in a known weight of oven-dry soil by measuring the volume of a liquid displaced by these particles. Soil moisture content was measured using the gravimetric method.

2.3.3. Soil Chemical Analysis

Soil pH was determined by using an electrode pH-meter for a saturated soil past (1:2.5) using distilled water, the electrical conductivity (EC) was also measured in a saturated past (1:2.5) (Skoog and West, 1976; FAO 1980). Organic matter was determined by using the Walkey and Black method (Nelson and Summers, 1982). Extractable bases (Ca^{++}, Mg^{++}, K^{+}, Na^{+}) were determined following displacement with 1 M NH_4OAc (Thomas, 1982). The Olsen method was used to determine extractable phosphorus using a molybdate reaction for colorimetric detection (Olsen and sommers, 1982), $CaCO_3$ content determined by using the calcimeter instrument. Fe, Zn, Cu, were extracted by DTPA-TEA according to Lindsay & Norvell (1978). The reading was done using an atomic absorption. The DTPA test is presently being used as the soil test for Zn. Chlorides was determined by using the Mercury Thiocyanate Method of Cl (Drymalski and Gelderman. 1990), sodium adsorption ratio {(SAR=Na/[(Ca+Mg)/2]$^{.5}$)} was calculated according to the formula developed by the U.S Salinity Laboratory (USSL)(Richards, 1954).

2.3.4. Water Properties

The analysis of the water samples was conducted in the laboratory of soil and water at Hebron University. The samples were analyzed for chemical parameter (Ca^{+2}, Mg^{+2}, Na^{+1}, K^{+1}, Cl^{-1},HCO_3^{-1}, SO_4^{-2} & NO_3^{-2}), and physical parameter(pH & EC) using the standard method for the examination of water and waste water (APHA,1995). EC& pH determined by using an electrode pH-meter, Ca^{+2} were determined by Titration with Na_2-EDTA using Murexide indicator, titration carried out rapidly until color change from red to blue, Mg^{+2} were determined by Titration withNa_2-EDTA using Eriochrome black T indicator, titration carried out rapidly until color change from red to blue, Na^{+1}& K^{+1} by using Flame photometer, NO_3^{-2} determined by Spectrophotometer method (λ=420nm): sodium salicylate was added to water samples and the mixture was evaporated to dryness then concentrated sulfuric acid, water and titrate solution were added, finally the solution was placed into graduated flask which was filled with water, then photometric determination was made, Cl^{-1} Titration with $AgNO_3$ using Potassium Chromate as indicators, titration carried out rapidly until color change from greenish yellow to reddish-brown. Gravimetric method was used for SO_4^{-2} , where hydrochloric acid was added to water samples then the mixture was boiled then barium chloride was added and the mixture left over night then filtering.

Chapter Three

3. Results

3.1. Physical Soil Properties

3.1.1. Soil Texture

The results of soil Texture analysis for each five sites (S1, S2, S3, S4 & S5) from different cultivation systems (greenhouse, irrigated open field and rain fed) are shown in table (11).

Table 11: soil texture (Sand, Silt & Clay) for each of the five sites.

Site	Time	R (Rain fed)			G (Greenhouse)			O (open irrigated)			Class
		%Sand	%Silt	%Clay	%Sand	%Silt	%Clay	%Sand	%Silt	%Clay	
S1	T1	12.3	39.2	48.5	15.74	39.18	45.08	12.38	36.16	51.46	C
	T2	12.56	35.62	51.82	12.36	39.34	48.3	12.38	33.36	54.26	C
	T3	12.56	35.35	52.12	15.18	37.22	47.6	16.16	35.18	48.66	C
S2	T1	11.5	42.22	46.28	13.3	46.1	40.6	9.38	43.02	47.6	SC
	T2	12.88	41.74	45.38	15.76	43.78	40.46	10.8	40.5	48.6	SC
	T3	10.44	41.16	48.5	13.8	42.78	44.22	10.78	40.22	49	SC
S3	T1	14.5	35.6	49.9	12.52	38.54	48.94	17.12	32.1	50.78	C
	T2	13.6	36.7	49.7	14.44	36.22	49.34	12.02	37.26	55.82	C
	T3	12.4	34.8	52.8	14.44	39.96	45.6	12.02	34.68	53.3	C
S4	T1	15.12	31.22	53.66	15.2	38.4	46.4	17.32	32.9	49.78	C
	T2	14.9	34.7	50.4	15.54	36.6	47.86	12.85	37.03	50.12	C
	T3	12.5	33.8	53.7	17.1	33.81	49.09	12.5	36.2	51.3	C
S5	T1	13.44	40.89	45.67	12.3	46	41.7	11.2	44.1	44.7	SC
	T2	14.74	40.5	44.47	12.5	45	42.5	10	41.1	48.9	SC
	T3	10.3	43.2	46.5	14.04	42.16	43.8	13	43.1	43.9	SC

C means clay, SC means silty clay

Between site Clay content rang from (45.08-55.82) in (S1, S3 & S4), the soil texture was clay. In (S2 & S5) Clay content rang from (40.46-48.9), the soil texture was silty clay. Silt content at (S2 and S5) was higher than silt content in the (S1, S3 & S4) sits, it ranges from (40,22 - 45.50) and from (31% - 39.96) respectively. The highest value of sand was (17.32%) at S4 while the lowest value is (10%) in S5. Within sites, cultivation systems did not affected the soil textures in the sites significantly.

3.1.2. Bulk Density

The results of soil Bulk & Mineral Density for each of the five sites (S1, S2, S3, S4 & S5) from different cultivation systems (greenhouse, irrigated open field and rain fed) are shown in table (12).

Table 12: soil Bulk & Mineral density for each five sites

Site	Time	R (Rain fed)		G (Greenhouse)		O (open irrigated)	
		BD(g/cm3)	MD(g/cm3)	BD(g/cm3)	MD(g/cm3)	BD(g/cm3)	MD(g/cm3)
S1	T1	1.4	2.55	1.67	2.63	1.65	2.66
	T2	1.25	2.61	1.6	2.71	1.57	2.68
	T3	1.3	2.65	1.66	2.69	1.42	2.7
S2	T1	1.44	2.5	1.73	2.55	1.59	2.5
	T2	1.51	2.45	1.72	2.6	1.53	2.63
	T3	1.24	2.6	1.7	2.63	1.45	2.65
S3	T1	1.42	2.55	1.7	2.63	1.72	2.6
	T2	1.45	2.56	1.57	2.72	1.56	2.7
	T3	1.36	2.63	1.71	2.7	1.71	2.69
S4	T1	1.4	2.43	1.71	2.55	1.61	2.64
	T2	1.42	2.48	1.7	2.59	1.6	2.63
	T3	1.22	2.55	1.6	2.63	1.54	2.67
S5	T1	1.47	2.63	1.72	2.56	1.64	2.65
	T2	1.5	2.58	1.7	2.6	1.63	2.7
	T3	1.41	2.67	1.62	2.63	1.66	2.6

Dry Bulk density is the ratio of oven dried weight of soil to its volume. Higher value of Bulk density means more weight per unit volume. So, when more soil was packed in the same volume, the soil became more compact and defective from agriculture point of view. Due to less pore space these soils were impermeable to water. By decrease of the value of bulk density, soil became more porous and effective for root respiration and water permeability. The data in (table 12) indicated that bulk density values were different in different cultivation systems. Results indicate that rain fed system has the lowest soil bulk density; it is 1.22 g cm-3 at S4 which had the highest clay (Figure 6). The difference in bulk density was significant compared with all other cultivated system.

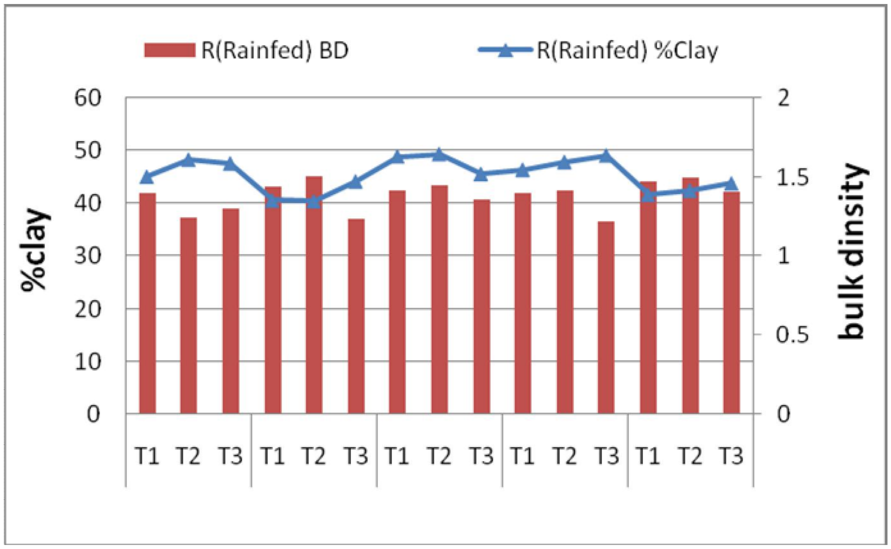


Figure 6: Correlation between percentage of clay content and bulk density (g/cm3) of rain fed system at three times in all sites.

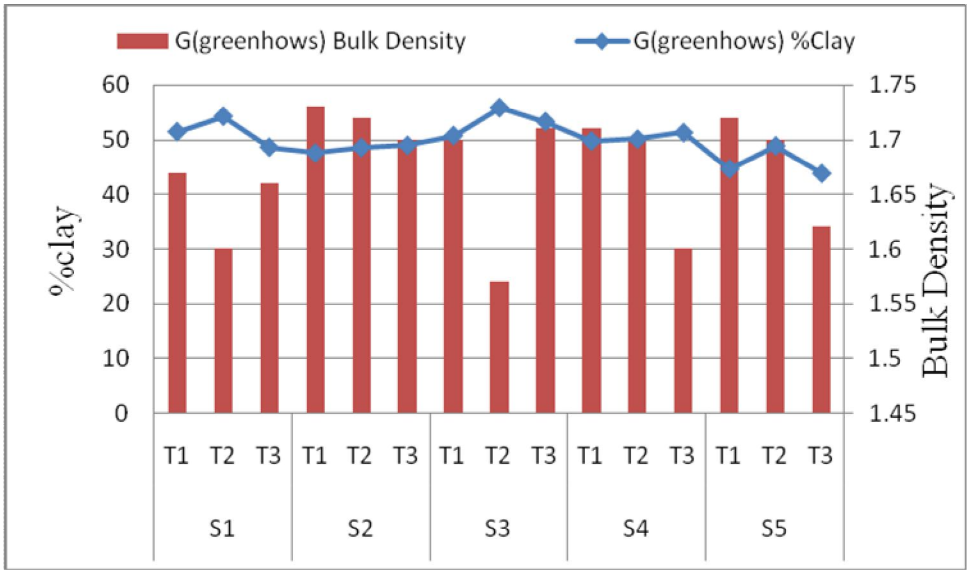


Figure 7: Correlation between percentage of clay content and bulk density (g/cm3) of Greenhouse system at three times in all sites.

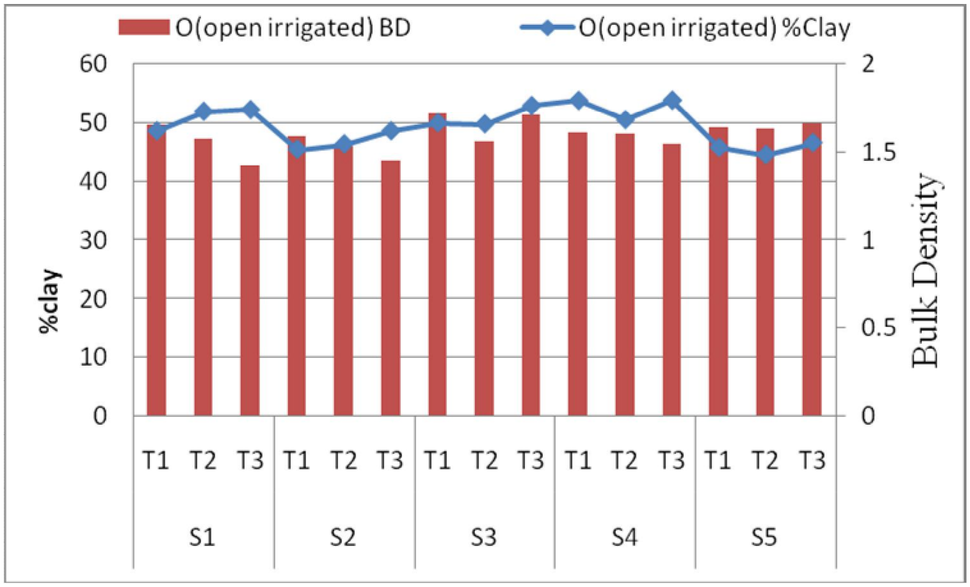


Figure 8: Correlation between percentage of clay content and bulk density (g/cm3) of open irrigated system at three times in all sites.

Figure (6,7 &8) show that there is reveres relationship between clay content and bulk density, also bulk density value was decreased form time (T1) to time (T2) or at time (T3) in all sites for the three different cultivation systems. The bulk density classified as high in protected cultivated soil in all sites, except at (T2) for S3 it will be moderate. In open cultivated soil it will be classified as moderate in all sites, except at (T1 and T3) for S3 it will be high. In rain fed soil it will be classified from low to moderate. Also for the mineral density, S3 at protected cultivated soil had the highest value (2.72 g cm-3); while S4 at rain fed soils had the lowest value (2,43 g cm-3).

3.1.3. Soil Moisture Content

Soil moisture content is defined as the ratio, which expressed in percentage of weight of water in a given soil mass to the weight of the solid particles. However, variability in soil moisture content were measured periodically under different cultivation system during the specific months in 2006 and 2007 where it showed variability of soil moisture at the three cultivation systems as shown in Table (13).

Table 13: H_2O% for each five sites

Site	Time	H_2O%		
		R (Rain fed)	G (Greenhouse)	O (open irrigated)
S1	T1	6.8	8.9	7.1
	T2	5.1	9	8.1
	T3	6	8.9	7.3
S2	T1	6.1	7.9	7.8
	T2	5	8.6	9.7
	T3	5.9	7.3	7.55
S3	T1	6.9	8.44	8.9
	T2	5.8	10.3	7.7
	T3	6.1	8.1	7.2
S4	T1	6.5	8.9	8.9
	T2	4.9	10.26	10.9
	T3	6	9.8	6.5
S5	T1	6.3	8.9	7.8
	T2	4.9	9.85	9.89
	T3	5.7	7.9	7.8

Data in figure (9) showed that soil moisture content was lower in rain fed system than the other irrigated (open and protected) in each time where %H_2O value ranges between (4.9 – 6.9), while the Greenhouse moisture was the highest

(%H2O value range between 7.3 – 10.3). %H2O value in rain fed at T1 &T3 is lower than %H2O value at T1 for all sites, but it was higher at T2 than at T1 & T3 in protected and open irrigated systems for all sites.

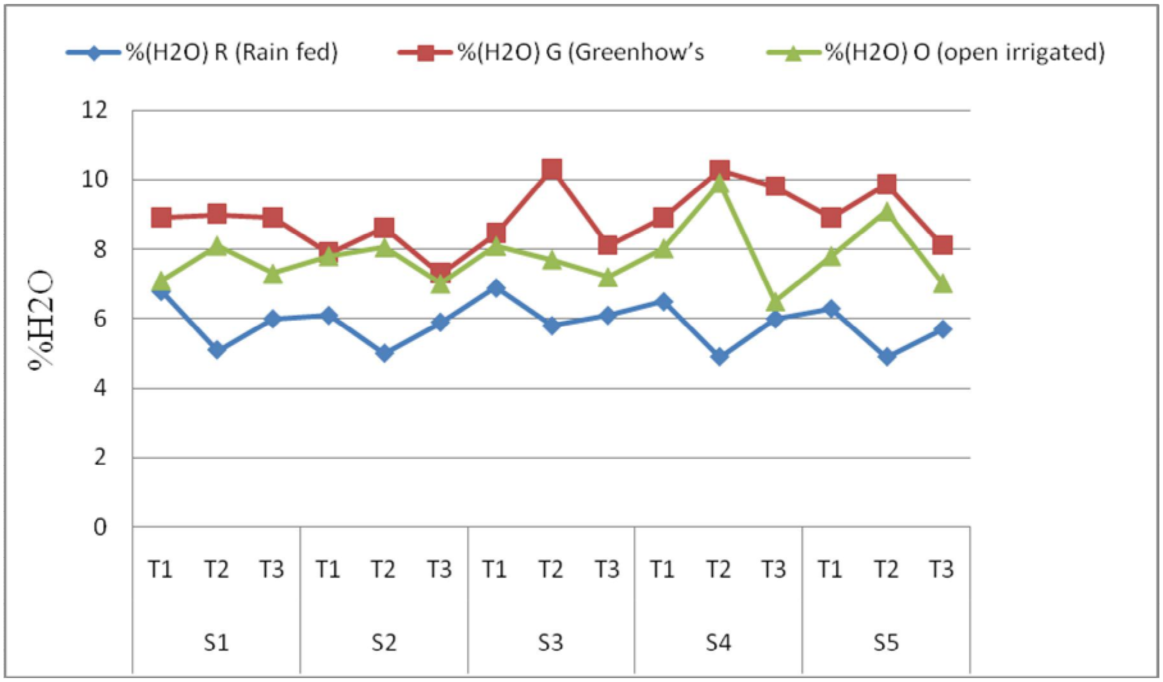


Figure 9: percentage of H2O with three different cultivated systems (Greenhouse, irrigated open field and rain fed) for each five sites.

3.2. Chemical Soil Properties

3.2.1. Organic Matter (OM %)

Soil organic matter (OM) for the irrigated farms (open & protected) and the adjacent non-irrigated farmlands (rain fed) are presented in Table (14).

Table 14: OM% for each five sites

		OM%		
Site	Time	R (Rain fed)	G (Greenhouse)	O (open irrigated)
S1	T1	2.4	1.95	1.77
	T2	3	2	1.9
	T3	2.50	1.99	2.10
S2	T1	2.80	1.83	1.79
	T2	2.50	1.90	2.05
	T3	3.10	2.00	2.20
S3	T1	2.21	1.67	1.79
	T2	2.02	1.75	1.95
	T3	2.45	1.59	1.90
S4	T1	2.70	1.70	1.89
	T2	2.60	1.85	2.01
	T3	3.10	2.00	2.30
S5	T1	2.50	1.69	1.70
	T2	2.00	1.70	1.90
	T3	2.70	1.80	1.65

The results showed that the OM contents in all irrigated farmlands (open & protected) were lower than the non-irrigated farmlands (rain fed). The OM contents ranged from 2.02 to 3.1% in non-irrigated farmlands (rain fed). On the other hands, the OM contents of the irrigated farmlands ranged from 1.65 – 2.3% & 1.59 – 2% in (open & protected) respectively. In non-irrigated farmlands (rain fed) OM% decrease from T1 to T2 then return to rise at T3 in all sites, but in irrigated farms (open & protected) the lower OM% at T1 & increase toward (T2 & T3) nearly in all sites figure (10).

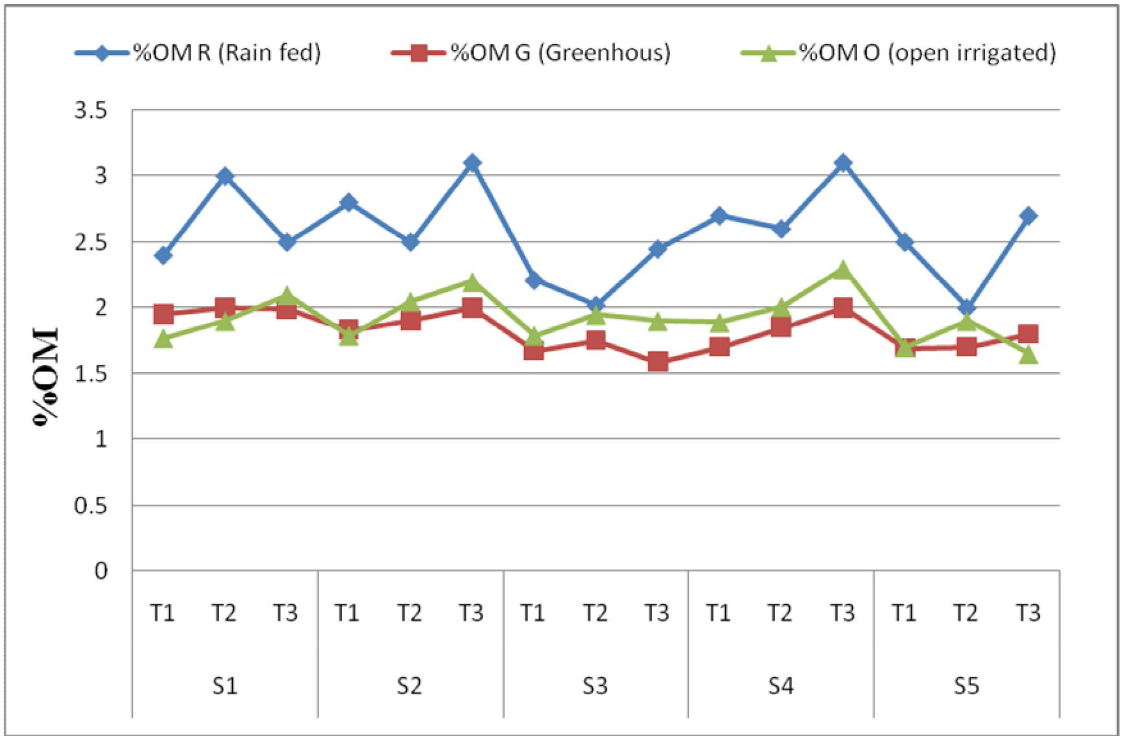


Figure 10: percentage of OM with three different cultivated systems (greenhouse, irrigated open field and rain fed) for each five sites between each cultivation system.

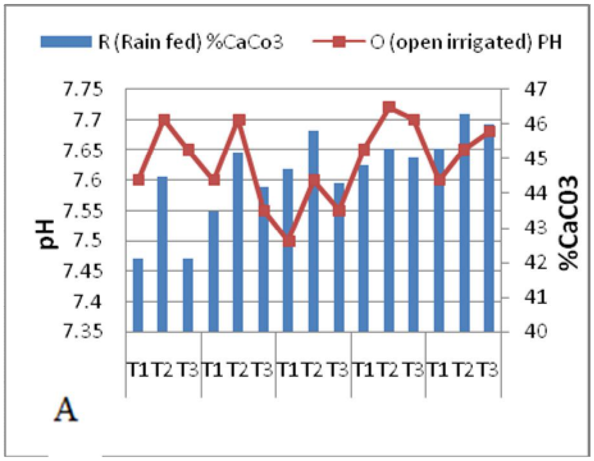
3.2.2. Soil pH, Calcium Carbonate & Soil Electrical Conductivity (ECe)

Soil pH may be one of the most important parameters which pinpoint the over all changes in soil chemical properties. However, data in table (15) showed that soil pH values which were measured in each different cultivation system at the five sites are located in the optimal range of plant growth, which range from 7.1 to 7.72. According to Marx et al., (1999) the soil is classified as neutral to moderately alkaline soil in all site.

Table 15: %CaCo3 & pH for each five sites

Site	Time	R (Rain fed)		G (Greenhouse)		O (open irrigated)	
		%CaCo3	pH	%CaCo3	pH	%CaCo3	pH
S1	T1	42.1	7.6	40.8	7.5	40	7.2
	T2	44.5	7.7	39.6	7.4	41.1	7.3
	T3	42.1	7.65	39.1	7.3	40.8	7.24
S2	T1	43.5	7.6	42.1	7.5	42.6	7.4
	T2	45.2	7.7	41.3	7.45	41.8	7.35
	T3	44,2	7.55	41.1	7.4	42.5	7.4
S3	T1	44.7	7.5	43.4	7.45	41	7.3
	T2	45.8	7.6	42.5	7.37	40.4	7.2
	T3	44.3	7.55	41.6	7.34	41.5	7.33
S4	T1	44.8	7.65	40.3	7.24	43.1	7.4
	T2	45.3	7.72	40	7.21	42.1	7.3
	T3	45.05	7.7	39.55	7.2	44	7.45
S5	T1	45.3	7.6	41.7	7.35	42.6	7.2
	T2	46.3	7.65	40.21	7.15	41.04	7.15
	T3	46	7.68	40	7.2	41	7.1

Soil pH within sites was different at each cultivation system, irrigated farms (open & protected) and the adjacent non-irrigated farmlands (rain fed). Figure (11-A) indicates that in non-irrigated farmlands (rain fed), pH recorded ranged between (7.5 -7.72), the highest value at (T2) in all sit, the soil was classified moderately alkaline in all site According to Marx et al, (1999), In protected farmlands the soil reaction (pH) ranged from (7.2 – 7.5), the highest value at (T1) Figure (11-B). In irrigated farms (open) the soil reaction (pH) ranged from (7.1 – 7.45), the soil was classified as neutral to moderately alkaline soil in irrigated farms (open & protected) in all site Figure (11-C).



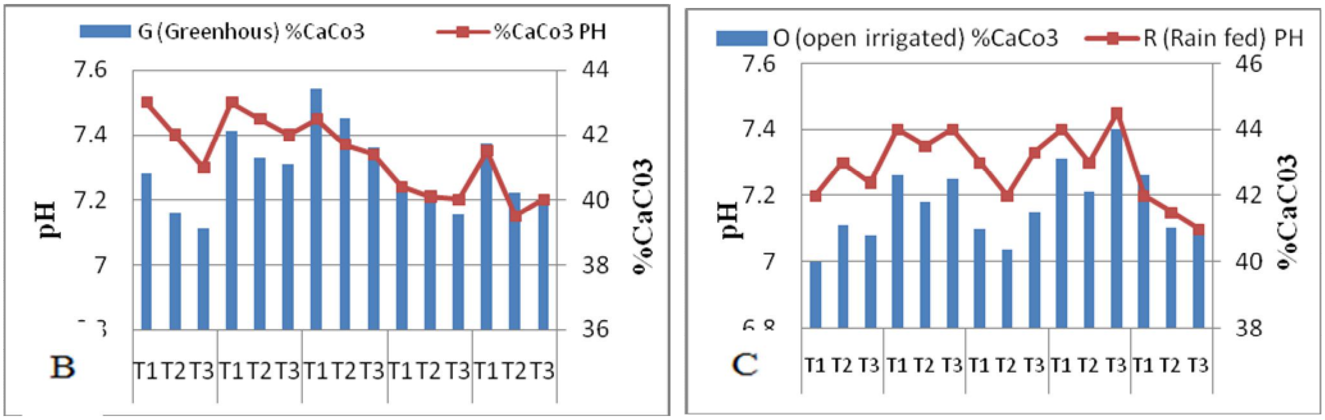


Figure 11: Correlation between Soil pH & (%CaCo3) within three different cultivated system (A) rain fed, (B) greenhouse, (C) open field for each five sites.

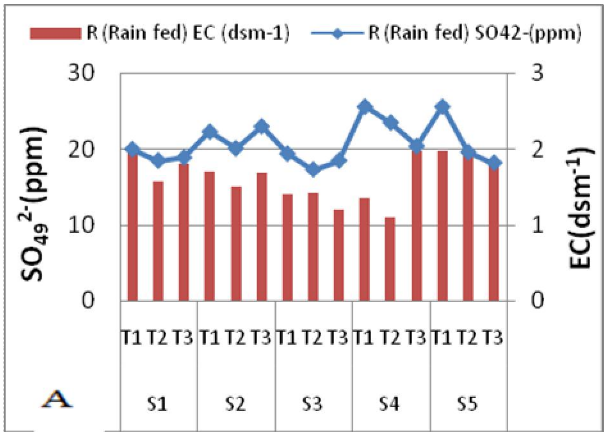
Calcium carbonate content is generally similar in irrigated (open & protected) system as shown in table (15), but it is higher in rain fed system. In figure (5-a, b &c) data showed that there are close relationships between pH values and calcium carbonate content (CaCO3) However, soil pH increased as a result of CaCO3 increases in all sites.

Table 16: EC & SO_4^{2-} for each five sites

Site	Time	R (Rain fed)		G (Greenhouse)		O (open irrigated)	
		SO_4^{2-}(ppm)	EC (dsm^{-1})	SO_4^{2-}(ppm)	EC(dsm^{-1})	SO_4^{2-}(ppm)	EC(dsm^{-1})
S1	T1	20	1.98	40	3.5	45.2	2.46
	T2	18.5	1.56	42	5	40.4	2.9
	T3	18.9	1.80	42.2	4.33	42.30	2.35
`S2	T1	22.3	1.7	43	5	45.6	1.9
	T2	20.1	1.5	44.1	5.2	40.7	2.86
	T3	23	1.68	42.2	4.81	45.30	2.43
S3	T1	19.4	1.4	41	3.2	41.8	2.2
	T2	17.3	1.41	43.6	4.1	40.6	2.6
	T3	18.5	1.20	42.2	3.80	45.1	2.1
S4	T1	25.6	1.34	43.5	3.5	41.3	2.1
	T2	23.5	1.1	45.1	4	43.4	2.05
	T3	20.4	1.98	44.2	3.90	44.50	2.02
S5	T1	25.6	1.97	41.6	3.2	40.01	2.5
	T2	19.6	1.96	45.6	3.72	40.2	2.94
	T3	18.2	1.80	43.1	3.50	42.1	2.3

Soil Electrical conductivity (ECe): data in table (16) showed that (EC) significantly different between sites. According to Marx et al, (1999) the soil between sites ranged from medium to high electrical conductivity. Within site significant differences were found between different cultivation systems. Rain fed land showed the lowest EC values, it ranges from (1.1 to 1.98) dsm^{-1}, it will be low salinity according to Marx et al, (1999). Open irrigated system showed medium to high salinity, EC value range from (1.9 to 2.94) dsm^{-1}. The highest EC recorded in protected cultivation system, value ranged from (3.2 to 5.2) dsm^{-1}. It is high according to Marx et al, (1999). Within type of cultivation system, in rain fed EC value generally are similar but the highest at (T1). The same trend in open cultivation system but the highest EC at (T2). In protected system it rises from (T1 to T2) and then dropped in (T3).

Sulfate content generally similar in irrigated (open & protected) system as shown in table (16), but it is lower in rain fed system. In figure (12-A, B &C) data showed that there are close relationships between EC values and sulfate content (SO_4^{2-}) However, soil EC increased as a result of sulfate content (SO_4^{2-}) increases in all sites.



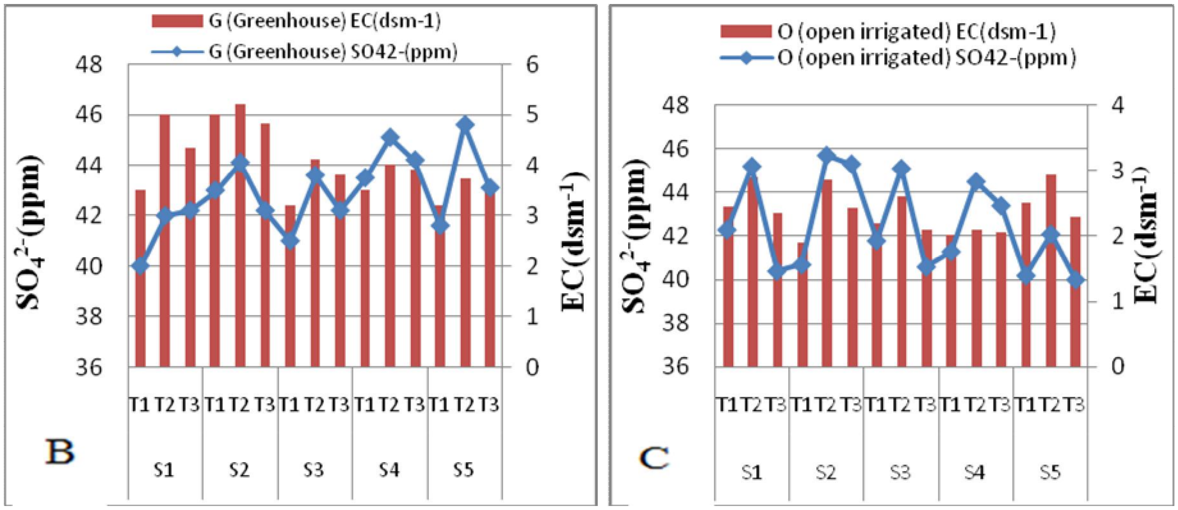


Figure 12: Correlation between EC & sulfate content within three different cultivated system (A) rain fed, (B) greenhouse, (C) open field for each five sites.

3.2.3. Available Nitrogen (NH_4^+, NO_3^-) and Phosphorus (P)

Plant available forms of nitrogen are nitrate (NO_3^-) and ammonium (NH_4^+). Results showed that soil available nitrogen (NH_4^+ & NO_3^-) in the five sites at different cultivation system is different (Table 17).

Table 17: ($NH_4^{+,}$ NO_3^-) &(p) for each of five sites.

Site	Time	R (Rain fed)			G (Greenhouse)			O (open irrigated)		
		NO_3^-(ppm)	NH_4^+(ppm)	P(ppm)	NO_3^-(ppm)	NH_4^+(ppm)	P(ppm)	NO_3^-(ppm)	NH_4^+(ppm)	P(ppm)
S1	T1	44.6	22.6	19.6	390.8	32.5	501	144	33.3	40.1
	T2	35.8	15.3	12.3	500.6	44.2	670	166	43.5	50.3
	T3	45.1	17.1	12.3	400.1	39.2	600	156	41.9	49
S2	T1	46.5	23.2	12.1	380.3	34.6	453	143	35.6	42.4
	T2	37.5	15.4	8.5	680.5	39.3	871	156	44.7	47.7
	T3	41.6	18.3	10.3	430.9	33.9	701	144	35.1	47.5
S3	T1	53.1	20.9	13.5	350.7	34.8	467	134	41.3	39.9
	T2	37.9	14.6	7.7	559.8	38.9	655	155	45.1	45.6
	T3	44.7	18.5	10.6	385.2	35.7	560	146	39.8	34.5
S4	T1	47.3	19.6	10.6	359.3	36.7	460	146	37.7	45.3
	T2	33.9	14.5	6.6	597.5	40.4	671	167	46.3	51.1
	T3	41.4	17.7	11	396.7	35	532	159	42	49.6
S5	T1	46.7	21.2	16	400.6	33.1	444	154	36.7	39.9
	T2	36.23	16.8	9.1	650.8	38.9	798	166	41.6	47.6
	T3	43.1	17.1	13.2	420.1	35.5	659	165	41	46

According to Marx et al., (1999), available nitrate (NO-3) considered low to excessive in the five sites during the study year. Figure (13), showed the different nitrate contents in the different cultivation systems for each site.

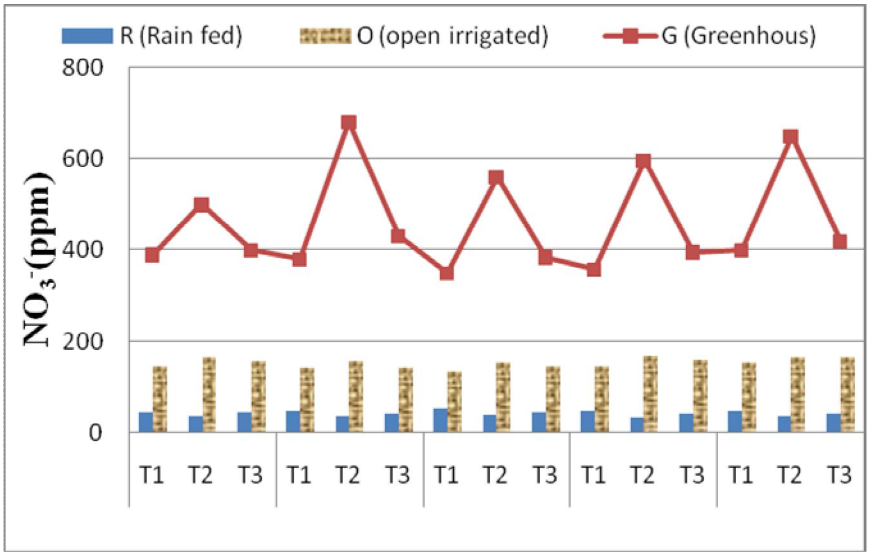


Figure 13: NO_3^-(ppm) in three different cultivated system (greenhouse, irrigated open field and rain fed) for each five sites.

Within site, significant differences were found between different cultivation systems. Rain fed land recorded the lowest NO_3^- values, it ranges from (33.9 to 47.3) ppm, it is low to medium according to Marx et al, (1999). Open irrigated system nitrate range from (133.9 to 167.1) ppm, it is considered as excessive value. The highest NO_3^- values recorded in protected cultivation system, value ranged from (350.7 to 680.5) ppm. It is considered to be excessive value according to Marx et al, (1999). Within type of cultivation system, in rain fed NO_3^- values generally are similar but it decreases from (T1 to T2).

The same trend In open cultivation system but it rises from (T1 to T2). Also in protected system it will be rise from (T1 to T2) and then decreased in (T3).

Ammonium (NH_4^+): Data showed that irrigated cultivation system have higher available ammonium, it ranges from 32.5 to 46.3 ppm, compared to rain fed (NH_4^+) where it was range from 14.5 to 22.6 ppm. (NH_4^+) decrees from (T1 to T2) in the rainfed area opposite to the trend in nonirrigated agriculture cultivation system where it was increase from (T1 to T2) and then decreased in (T3).

Phosphorus (p): data in table (17) showed that phosphorus (P) was different between sites. The value ranges from 6.6 ppm in rainfed system to 870.5 ppm in greenhouse. According to Marx et al, (1999) the soil content of phosphorus between sites ranged from low to excessive. Figure (14- A, B) showed the variability of phosphorus content between sites.

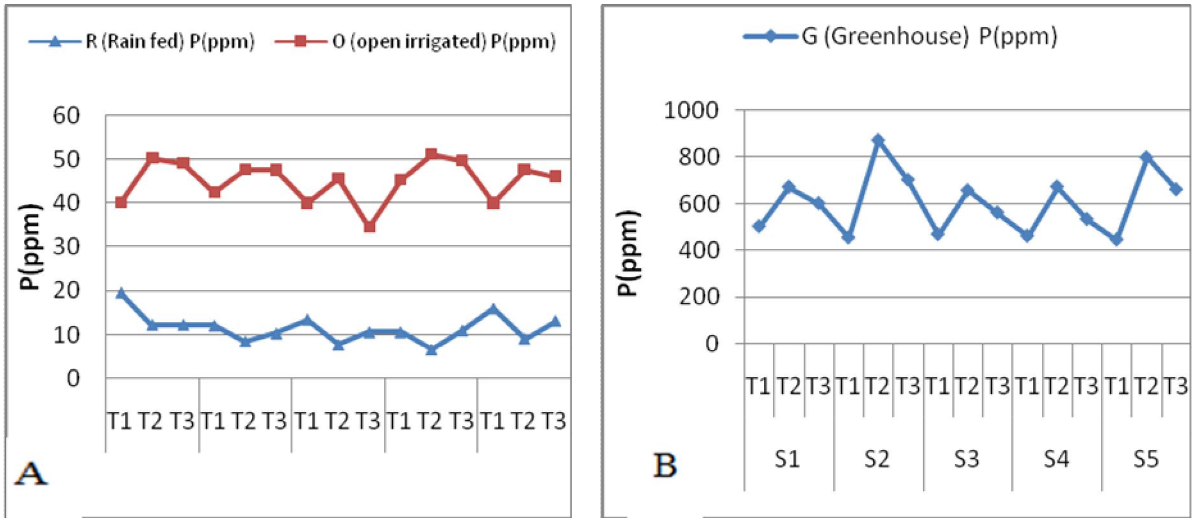


Figure 14: phosphorus (ppm) in the three different cultivated systems, (A) non-irrigated (rain fed), (B) irrigated (greenhouse, & open field) for each of thefive site.

Within site, significant differences were found between different cultivation systems. Rain fed land showed the lowest phosphorus values, it ranges from 6.6 to 19.6 ppm, it considered as low to medium according to Marx et al, (1999). Open irrigated system showed high to excessive phosphorus value ranges from 34.5 to 49.6 ppm. The highest phosphorus recorded in protected cultivation system where the value ranged from 443.8 to 870.5 ppm. It is considered to be excessive according to Marx et al, (1999). Within type of cultivation system, in rain fed phosphorus value are different, it decreased toward T2. In open cultivation system it rises from T1 to T2. Also in protected system it rise from T1 to T2 and then decreased in T3.

3.2.4. Calcium, Magnesium & Potassium

The extractable soil calcium from the study sites ranges from 9.05 to 13.54 meq/100g, Table (18) showed that calcium concentration was different between sites. Magnesium concentration ranges from 2.97 to 4.73 meq/100g. Potassium concentration ranges from 0.43 to 1.33 meq/100g. According to Marx et al., (1999) these soil have medium to high level of calcium concentration, high level of magnesium concentration and medium to excessive potassium concentration.

Table 18: (Ca, Mg & K) for each five site.

Site	Time	R (Rain fed)			G (Greenhouse)			O (open irrigated)		
		meq/100g								
		Ca	Mg	k	Ca	Mg	k	Ca	Mg	k
S1	T1	10.83	3.20	0.67	12.95	3.78	1.07	11.59	4.65	0.80
	T2	11.00	3.25	0.53	13.16	3.33	1.20	12.64	4.40	0.85
	T3	8.50	2.99	0.61	10.70	3.00	0.99	9.88	3.68	0.83
S2	T1	10.91	3.50	0.72	12.58	4.50	1.09	11.09	3.65	0.80
	T2	10.62	3.42	0.60	13.10	4.73	1.33	12.39	3.50	0.93
	T3	9.05	3.15	0.67	11.60	4.15	1.20	10.93	3.60	0.77
tS3	T1	10.61	3.30	0.69	12.57	4.05	1.04	11.39	3.42	1.04
	T2	10.87	3.34	0.61	13.54	4.63	1.09	12.60	3.60	1.07
	T3	10.50	2.97	0.64	12.13	4.06	1.07	11.47	3.58	1.08
S4	T1	9.50	3.33	0.56	11,32	4.58	1.07	10.90	3.42	0.80
	T2	11.45	3.45	0.43	12.90	4.08	1.12	11.90	4.01	0.87
	T3	11.00	3.25	0.53	11.90	3.50	1.09	11.70	3.46	0.84
S5	T1	9.50	3.42	0.67	11.38	4.17	0.82	10.96	3.83	0.80
	T2	10.98	3.30	0.53	12.70	5.48	1.25	11.80	3.00	1.01
	T3	10.65	3.25	0.64	11.09	4.42	1.20	10.55	3.50	0.97

Within site differences were found between different cultivation systems. Rain fed land recorded the lowest calcium, magnesium and Potassium values, concentration (9.5 to 11.45ppm, 2.97 to 3.33 ppm and 0.43 to 0.72 ppm respectively). According to Marx et al, (1999), the soil classified as (medium to high) calcium concentration, high magnesium concentration and medium to high Potassium concentration. In Open irrigated system calcium, magnesium and Potassium values ranges from 9.88 to 12,64, 3 to 4.65 ppm, and 0.8 to 1.07 ppm respectively. The soil was medium to high for calcium and high for magnesium and potassium. The highest is In the protected cultivation system, calcium, magnesium and Potassium values ranges from 10.7 to 12.7 ppm, 3.33 to 5.58 ppm and 1.04 to 1.33ppm respectively. The soil was high in calcium and excessive in potassium. Within time calcium value generally rises from T1 to T2 and decrees toward T3 and the same trend for potassium and magnesium except magnesium in many site decrease from T1 to T2 then rises toward T3 but note to the same value.

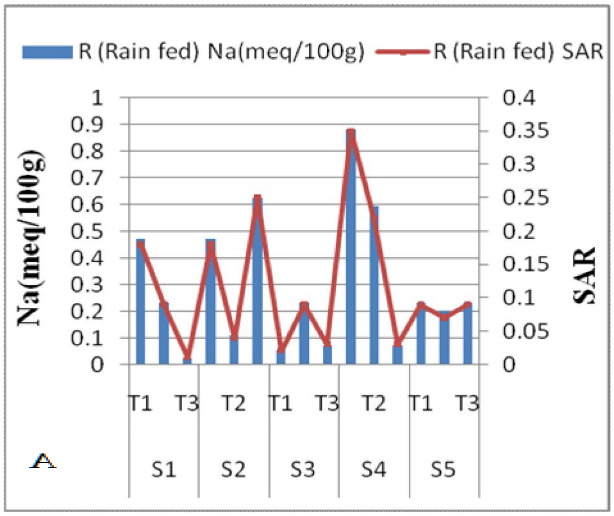
3.2.5. Sodium and Sodium Adsorption Ratio (SAR)

The extractable soil sodium for the study sites ranges from 0.02 to 1.870 meq/100g. Table (19) showed that sodium concentration was different between sites.

Table 19: Na(meq/100g &SAR for each five sites

Site	Time	R (Rain fed)		G (Greenhouse)		O (openirrigated)	
		Na(meq/100g)	SAR	Na(meq/100g)	SAR	Na(meq/100g)	SAR
S1	T1	0.47	0.18	0.88	0.21	0.76	0.21
	T2	0.23	0.09	0.70	0.21	0.17	0.20
	T3	0.02	0.01	1.12	0.25	0.52	0.25
S2	T1	0.47	0.18	1.78	0.24	1.36	0.26
	T2	0.11	0.04	2.19	0.25	0.53	0.27
	T3	0.62	0.25	1.87	0.26	0.92	0.27
S3	T1	0.05	0.02	1.30	0.23	1.42	0.24
	T2	0.23	0.09	0.35	0.18	0.17	0.19
	T3	0.07	0.03	1.12	0.22	0.22	0.23
S4	T1	0.88	0.35	1.48	0.24	0.59	0.26
	T2	0.59	0.22	0.35	0.19	0.17	0.19
	T3	0.07	0.03	1.22	0.24	0.77	0.24
S5	T1	0.23	0.09	0.41	0.20	0.41	0.20
	T2	0.20	0.07	0.88	0.20	0.11	0.22
	T3	0.23	0.09	0.92	0.22	0.22	0.23

sodium concentration Within site was different between cultivation systems, irrigated farms (open & protected) and the adjacent non-irrigated farmland (rain fed). Rain fed land recorded the lowest sodium values, it ranges from 0.02 to 0.88 meq/100g. In Open irrigated system sodium value ranges from 0.17 to 1.42 meq/100g. The highest record value was in protected cultivation system, where it ranges from 0.35 to 1.870 meq/100g. Within time sodium value was variable, in some site rise from (T1 to T2) and decreases toward T3 and in others the opposite trend occur in the deferent cultivation system in all site. SAR have similar trend as sodium within sites and within time.



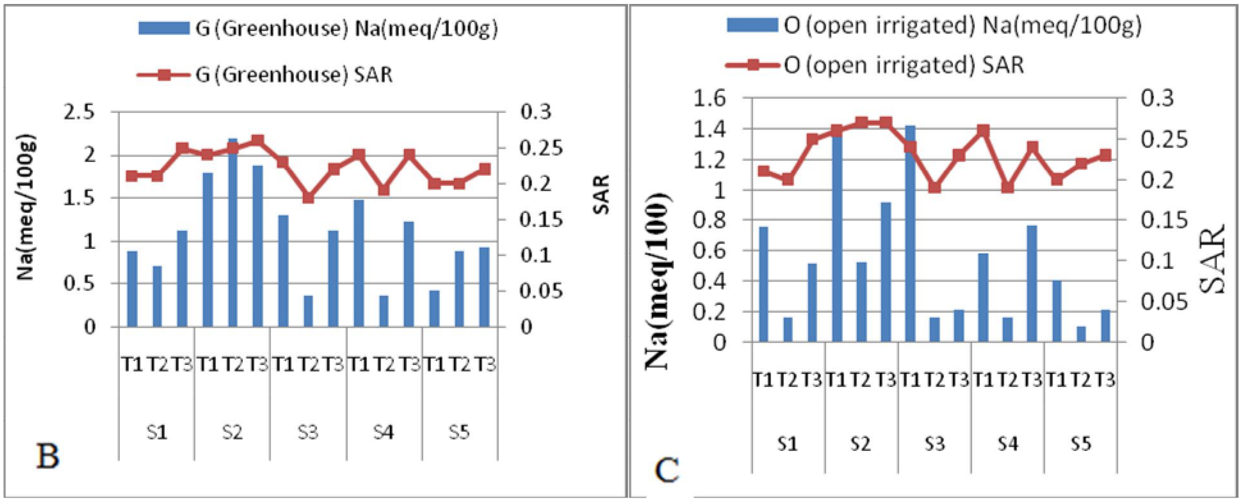


Figure 15: Correlation between SAR & sodium content within the three different cultivated systems (A) rain fed, (B) greenhouse, (C) open field for each of the five

sites. Figure (15) showed the positive relation between Na content and SAR in the different cultivated systems.

3.2.6. Micronutrients

The values of micronutrient are presented in Table-20. By comparing the extractable micronutrients (Iron, Copper, and Zinc) contents with the established criteria of Soltanpour (1985) and Johnson and Fixen, 1990, (Table 5), all the soil sites were found to have low to medium Iron, Copper and Zinc contents at non-irigated (rain fed) cultivation system, medium to high Iron, Copper and Zinc contents at irrigated (greenhouse) cultivation system, and medium in Iron, Copper and Zinc contents at irrigated (open) cultivation system.

Table 20: micronutrient (Fe, Zn, & Cu) for each five sites

Site		R(Rainfed)			G(greenhouse)			O(open irrigated)		
		Nutrient Content (ppm)								
		Fe	Zn	Cu	Fe	Zn	Cu	Fe	Zn	Cu
S1	T1	3.24	0.84	0.31	6.10	1.54	0.81	4.52	1.01	0.49
	T2	3.13	0.91	0.29	6.61	1.43	0.85	4.11	1.09	0.45
	T3	3.2	0.89	0.3	6.21	1.4	0.9	4.5	1.04	0.47
S2	T1	2.31	0.74	0.25	4.52	1.12	0.6	3.36	0.93	0.38
	T2	2.2	0.78	0.24	4.71	1.09	0.63	3.3	0.91	0.39
	T3	2.39	0.72	0.26	4.41	1.01	0.65	3.32	0.92	0.36
S3	T1	3.45	0.86	0.32	5.43	1.52	0.81	4.95	1.08	0.44
	T2	3.36	0.91	0.29	5.65	1.44	0.85	5.01	1.05	0.46
	T3	3.39	0.89	0.31	5.76	1.36	0.91	4.9	1.07	0.45
S4	T1	3.34	0.91	0.31	6.13	1.57	0.91	4.55	1.13	0.46
	T2	3.11	0.99	0.28	6.54	1.51	0.95	4.68	1.1	0.47
	T3	3.25	0.96	0.3	6.61	1.49	1.1	4.33	1.22	0.44
S5	T1	2.27	0.76	0.26	4.92	1.12	0.71	4.31	0.93	0.36
	T2	2.19	0.79	0.24	5.32	0.99	0.79	4.29	0.91	0.37
	T3	2.1	0.81	0.22	5.1	1.05	0.76	4.37	0.9	0.39

Between sites there is variability in the value of micronutrient (Iron, Copper, and Zinc), the lowest content at S2 & S5 for the three different cultivation systems. Value of micronutrient (Iron, Copper, and Zinc) compared with pH, and has negative relation with Iron, & Copper (figure 16), and positive relation with Zinc (figure 17).

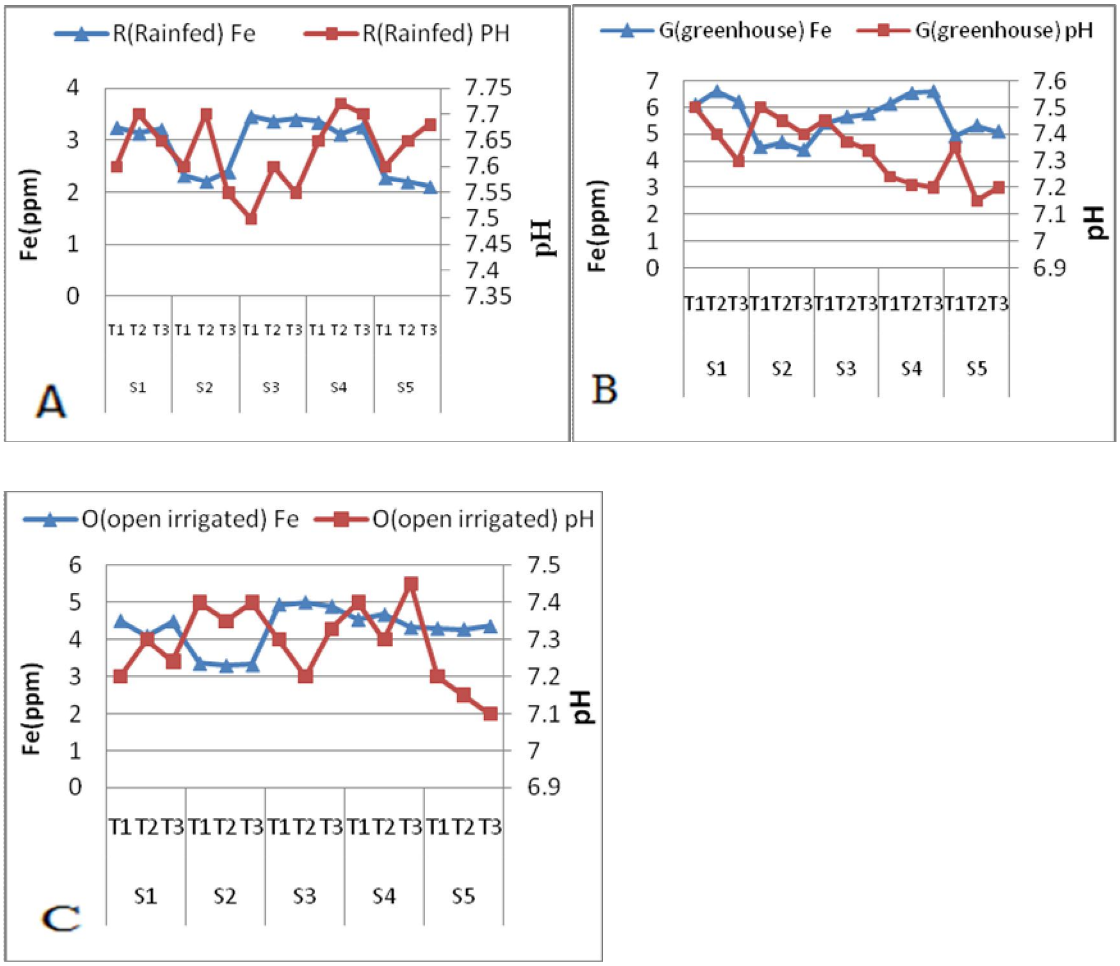


Figure 16: Correlation between Fe content & pH within the three different cultivated systems (A) rain fed, (B) greenhouse, (C) open field for each five sites.

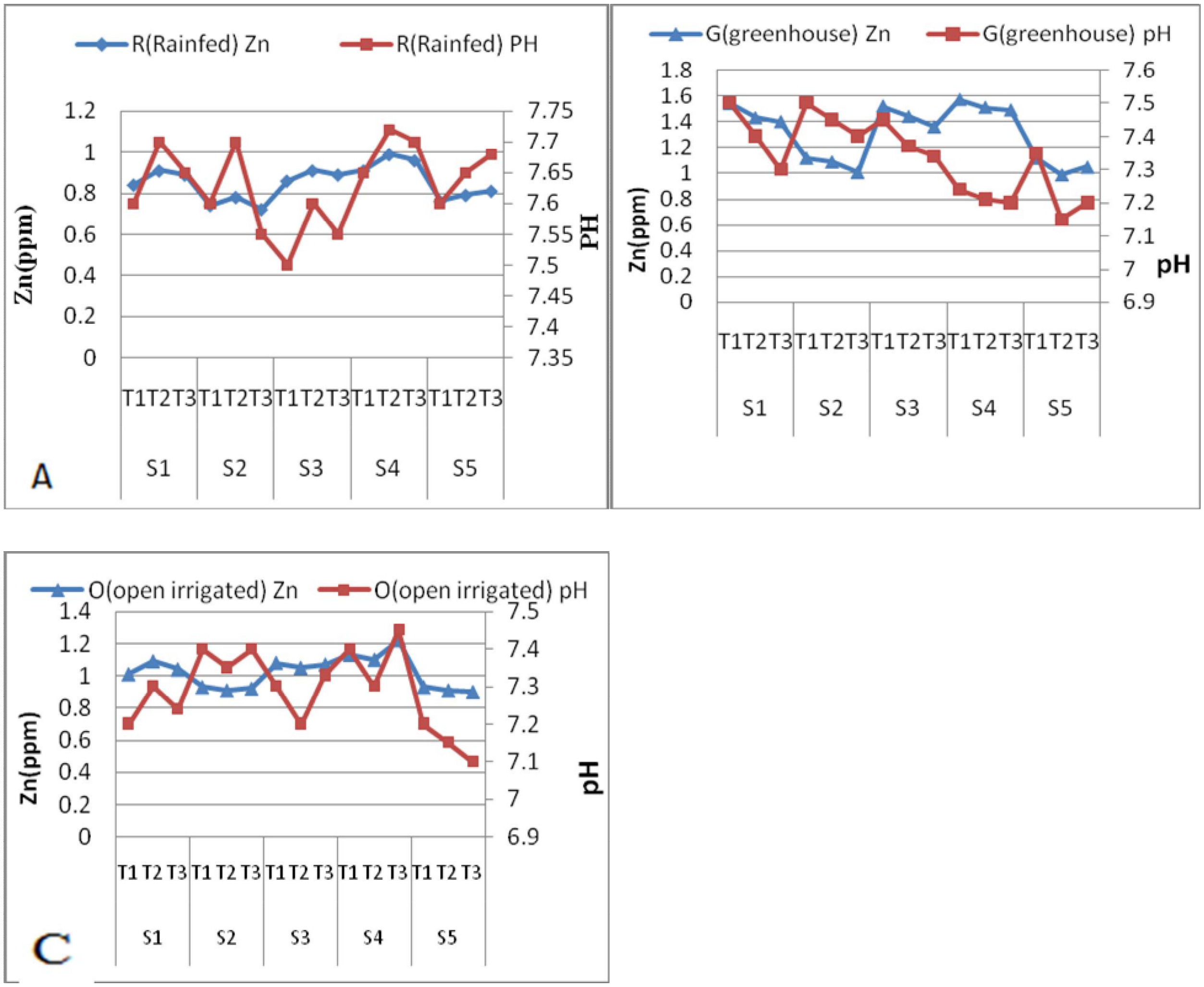


Figure 17: Correlation between Zn content & pH within the three different cultivated systems (A) rain fed, (B) greenhouse, (C) open field for each of the five sites.

3.3. Water Properties

The water samples from the five source of irrigation water (springs) was analyzed for the chemical and physical water properties. The results in table (21) showed the variability in the chemical and physical characteristics of the spring with time.

Table 21: water chemical analysis.

T1 (April)												
Test	**EC (µS/cm)**	**TDS(mg/l)**	**PH**	**Ca(mg/l)**	**Mg(mg/l)**	**Na(mg/l)**	**HCO3(mg/l)**	**NO3(mg/l)**	**CL(mg/l)**	**K(mg/l)**	**SO_4(mg/l)**	**SAR**
SP1	0.56	358.4	7.5	70	24.3	32.3	146.4	20.6	85.1	13.6	20.5	0.86
SP2	1.59	1018	7.8	70.1	36.5	58.4	195.2	42.6	151.2	31.4	23.9	1.42
SP3	0.54	345.6	7	123	74.3	41	148.8	25.9	125.1	8.3	35	0.71
SP4	0.53	339.2	7.6	56.1	36.5	23.6	178.1	10.8	70.1	8.7	23.7	0.6
SP5	0.535	342.4	7.4	40.1	31	23.6	158.6	34.1	60.1	8.7	22.6	0.68
T2 (October)												
SP1	0.58	371.2	7.5	66.1	17.9	21.7	195.2	17.6	56.7	12.3	21.3	0.59
SP2	1.62	1037	7.2	56.1	28	61.4	183	36.4	106.8	40.1	20.1	1.69
SP3	0.613	392.3	7.1	96.2	62.6	50	146.4	20.3	106.8	8.1	20.9	0.99
SP4	0.574	367.4	7.1	42.5	24.5	28.3	170.8	4.8	53.4	8.1	15.6	0.89
SP5	0.59	377.6	7.4	24	22.8	28.3	146.4	32.5	53.4	9.1	23.4	0.99

3.3.1. Suitability of Water for Irrigation Purposes

Water from these springs is used mainly for irrigation purposes, but is this water suitable for irrigation or not? Sodium Adsorption Ratio answered these questions.

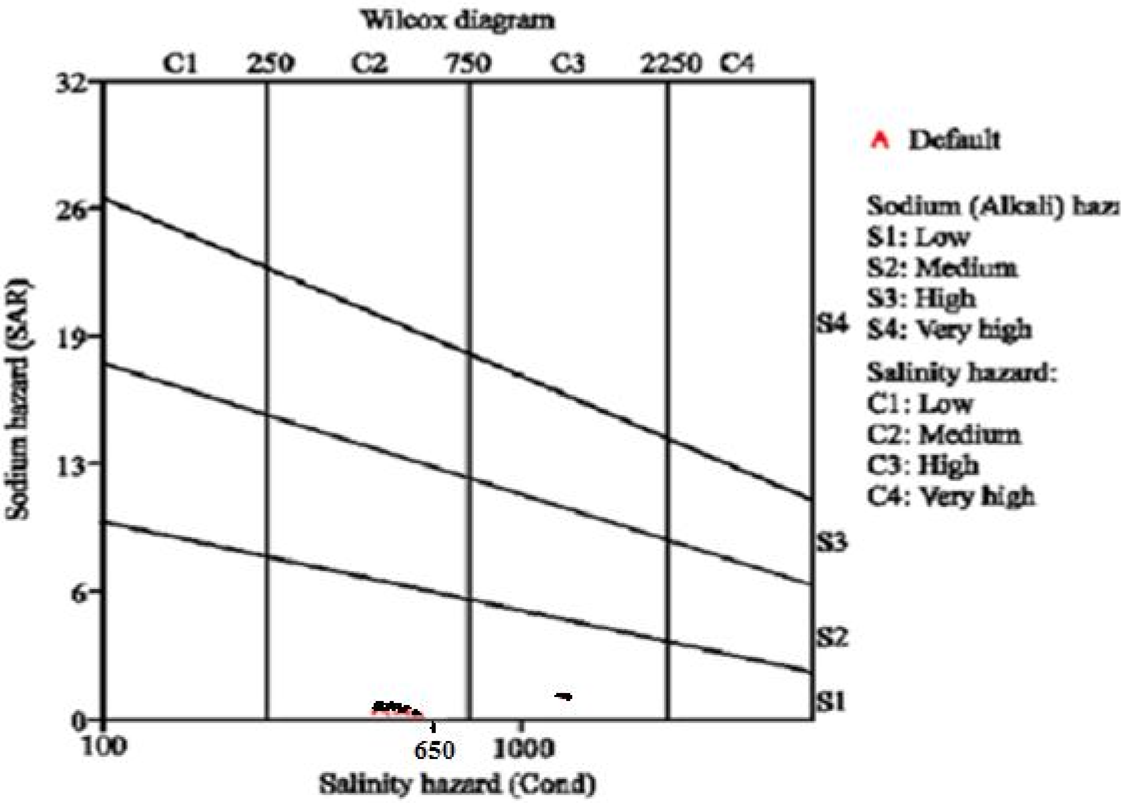


Figure 18: classification of the source of irrigation water in irrigated cultivation system according to Wilcox.

This figure showed that the value of SAR are less than 1 and less than 650 µs cm^{-1} for EC in all the spring except (SP2) which has a SAR more than 1 and more than 650 µs cm^{-1} for EC.

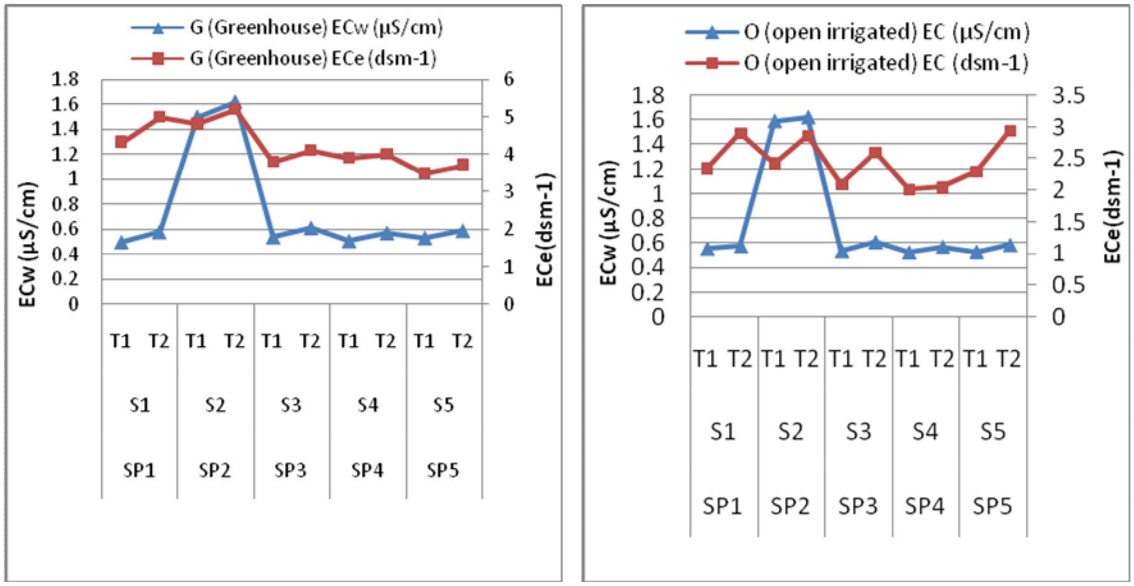


Figure 19: relationship between ($EC_{w)}$ & (ECe), (A) Protected irrigated cultivated system (greenhouse), (B) Open irrigated cultivated system for each five sites.

Figur (19- A), show the positive relation between water electrical conductivity and soil electrical conductivity in protective cultivation system. Figure (19-B), show the positive relation between water electrical conductivity and soil electrical conductivity in open cultivation system

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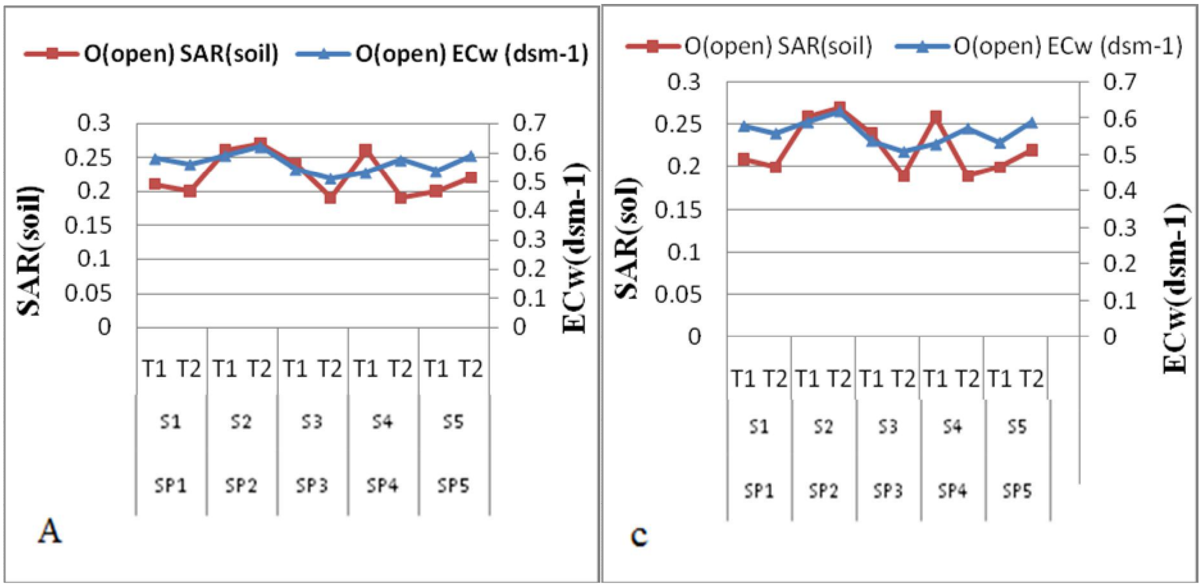


Figure 20: relationship between (ECw) & (SARsoil), (A) Protected irrigated cultivated system (greenhouse),(B) Open irrigated cultivated system for each five sites.

Figure (20) show the positive relation between water electrical conductivity and sodium adsorption ratio of soil.

Chapter Four

4. Discussion

4.1. Soil Physical Properties

Almost all soil properties that have been under investigation in this research was exhibited variability as a result of dynamic interaction between agriculture practices as fertilization and irrigation.

4.1.1.Soil Texture

Data in (table 11) show that there are different in soil texture between sites, S1, S3 & S4. They have more clay content compared to (S2 &S5), soil classified as clay. But the lower clay content in (S2 &S5), soil classified as silty clay. According to Land Research Center (2006), the soil has heavy fine texture and classified as Clay in S1, S3 ad S4 sites, whereas in both S2 and S5 sites it is classified as silty clay. Such differences may be the result of the change in micro environment climatic that is caused by irrigation. This agrees with Zehetner and miller (2006), AL-Seikh (2006), who found that soil shows significant variation along the studied climatic gradient. Although, the history of land use and the long term effects of the land degradation process as runoff and soil erosion, which is considered as the main reason effecting the particle size distribution (AL-Seikh 2006). Since the sites locations are distributed and cover large different geological and morphologic form in the study area, so may difference will be due to the movement of clay particles with surface water runoff from adjacent high land. Similar results were observed by (Rezaei, et al 2005, and Oztas, et al 2003).

Within sites there is no variability, this could be could to the fact that chemical weathering didn’t have effect on soil structure in short term. Protected irrigated system is lower in clay than the open and rain fed, this trend could be the result of leaching of clay particles caused by the high amount of water applied.

4.1.2. Bulk & Mineral density

Dry Bulk density is ratio of oven dried weight of soil to its volume. Higher value of Bulk density means more weight per unit volume. So, when more soil was packed in the same volume, the soil became more compact and defective from agriculture point of view. On decrease of the value of bulk density soil became more porous and effective for root respiration and water permeability. The results of soil Bulk & Mineral Density for each of the five sites (S1, S2, S3, S4 & S5) from different cultivation systems (greenhouse, irrigated open field and rain fed) in table (12) shows different variability within site and time in all sites. Bulk density of soil mainly related to soil texture, organic matter, and soil management. When the value of these variable were higher, this lead to decrease bulk density and higher porosity and vice versa. This agree with Wilcox et al., (1988), who found that increase the soil organic carbon content, reduce bulk density and increase hydrolic conductivity (Balliette et al., 1986). The increase in soil organic carbon may enhance biological activity, which in turn result in increased porosity and therefore decreased bulk density (Kay, 1998). In protected cultivation system it is worth mentioning that soil with high bulk density indicate very poorly physical condition, especially for plant growth, and this soil are very compacted. the affect of organic matter and clay contend on bulk density were visible in rain fed cultivation system (figure 7). Bulk density is a dynamic property that varies with the structural condition of soil (Daraghmeh et al., 2008). This condition can be altered by cultivation, trampling by animals, agriculture machinery and weather; i.e., raindrop impact (Arshad et et al., 1996). Compact soil layers have high bulk densities, restrict root growth, and inhibit the movement of air and water through the soil (Arias et al., 2005). In the five sites soil bulk density showed different variability at different cultivation system irrigated (open and protected) and non irrigated (rain fed) (Table 12). Low bulk density in non irrigated (rain fed) system may be attributed to high clay and high organic matter comparing to irrigated (open and protected) system. In irrigated (open and protected) system bulk density was the highest. This could be to bad management agricultural practices, however soil bulk density and soil structure are sensitive to soil formation factor and land management (Rezaei et al., 2005). Mineral density has positive relation with clay content which is clear in all sites at different cultivation system (table 7 &8), this agrees with Abu-Rmaileh, (2009). Mineral density was higher in irrigated (open and protected) than the rain fed, which may be attributed to the high of sand and silt content.

4.1.3. Soil Moisture

Soil moisture is one of the primary limiting factors for plant growth in semiarid regions. However, variability and the change in soil moisture content were measured periodically for the soil samples in each site at the three different cultivation systems, irrigated (open and protected) and non irrigated (rain fed).

During the three times 2006 and 2007. Table (13) showed the variability of soil moisture within site and between different cultivation systems. Data in figure (9) showed that soil moisture content was lower in rain fed system than the other irrigated (open and protected) in each time, Soil moisture value ranges between 4.9 – 6.9, while the Greenhouse moisture was the highest, Soil moisture value ranges between 7.3 – 10.3. This might be due to large quantity of applied irrigation water to irrigated system, which has high organic matter and clay content; this agrees with Allen-Diaz (2001) who found that soil moisture increases as clay content increase. In rain fed the highest Soil moisture at (T1) and the lowers Soil moisture at (T2) for all sites, but it was higher at (T2) than (T1 & T3) in protected and open irrigated systems for all sites. In rain fed this might be due to quantity of water held by the soil, the sample collected beginning in April(T1), while there is rainfall and less evaporation rate at soil surface compared to October (T2) with higher evaporation rate at soil surface and no rain fall. The opposite trend in irrigated system, at (T1) there's no planting, with no irrigation, at (T2) there is planting so water is being used in irrigation. This agree with Katwbeh,(2006) who found that soil moisture content for soil sample collected in October has low moisture content.

4.2. Soil Chemical Properties

4.2.1. Organic Matter (OM %)

Soil organic matter is an important soil quality, which provides nutrients for plant growth; on the other hand it almost influences all soil properties (Rezaei et al, 2005). Soil organic matter (OM) for the irrigated farms (open & protected) and the adjacent non-irrigated farmlands (rain fed) are presented in Table (14). According to marx et al., (1999) accurate measurement of soil organic matter is difficult. The analysis of five site show that, the higher amount of organic matter content wase measured in the non-irrigated farmlands (rain fed) This agree with Bosatta and Agren (1997), who found that soil organic matter content is often positively correlated with the clay content of the soil. The organic matter contents ranged from (2.02 to 3.1) %. On the other hands organic matter ranged from (1.65-2.3)% & (1.59-2)% in (open & protected) respectively which is clear in figure (10). Farming practices affect soil organic matter content and physical properties (Hao et al., 2001). Khresat et al. (1998) reported that organic matter content increased as the precipitation increased, as will as the clay content increased and vegetation cover increased. The result show conformity with what mentioned above, since the organic matter contents of the irrigated farmlands is lower than in rain fed, which subjected to farming practices like plouging and cleaning, this agree with Vance (2000), who found that tillage operation disrupt soil structure and accentuate soil organic matter oxidation by increasing aeration, which stimulate microbial activity. Soils under cultivation using irrigation and tillage generate optimal conditions for decomposition of SOM (Ortega *et al*., 2002). Also Wetting and drying of the soil by irrigation, cultivation and tillage activities increase microbial activity and reducing SOM (Quiroga *et al*., 1998). According to Six et al. (2000), soil disturbance by tillage is major cause of organic matter depletion and reduction in the number and stability of soil aggregates when native ecosystems are converted to agriculture. Also agree with (Getaneh et al., 2007) who found that the lower values of organic matter in irrigated (open & protected) farmlands are attributed to the continuous cultivation throughout the year. However, Continuous cultivation with frequent tillage results in a rapid loss of OM through increased microbial activity (Shepherd et al. 2001). Moreover, relatively optimum soil moisture content throughout the year created favorable condition for organic matter oxidation. The frequency of cultivation was high in irrigated farmlands. Moreover, crop residues were immediately removed from farmlands used for irrigation agriculture. This implies that little above ground crop residues remained on the land for decomposition as compared to the adjacent lands used only for rain- fed agriculture. There were also variations among the irrigated farmlands in organic matter, This could be due to the variations in the times of irrigation, topography, climatic factors, slope, soil type and the soil management practices adopted for the land management. In non-irrigated farmlands (rain fed) organic matter decrease from T1 to T2 then return to rise at T3 in all sites, but in irrigated farms (open & protected) it will be rise at T2 & decrease in T1 & T3 in all sites (figure 10). However, this variability in OM value between time for the irrigated farmlands and non-irrigated farmlands and the high content of OM at some time and low content at other can be attributed to different soil fertility management practices and depend on farmers, when apply manure. This result agree with (Lockeretz et al., 1981; Rega- old, 1988; Sommerfeldt et al., 1988; Drinkwater et al., 995), who found that Higher soil OM levels are typically found in soils managed with organic inputs, including animal manure.

4.2.2. Soil pH & Calcium Carbonate

Soil pH may be one of the most important parameters which pinpoint the over all changes in soil chemical properties. However, According to Marx et al., (1999) data in table (15) showed that soil pH values which were measured in each different cultivation system at the five sites are located in the optimal range of plant growth, which range from (7.1 to 7.72). Higher soil pH was observed in the non-irrigated farmlands than in irrigated farmlands. The higher pH could be attributed to the different management practices. Although High pH denotes the dominance of calcium carbonates. Data of Table 15 indicates that this important chemical parameter increased at non-irrigated (rain fed) farmlands in all site compared to irrigated (open &protected) farmlands. acidity was lower in the irrigated farmlands than the adjacent non-irrigated farmlands that agree with established facts where the soil pH and exchangeable bases are negatively associated with exchangeable acidity. The highest exchangeable acidity percentage was observed in irrigated (open &protected) farmlands. The higher pH values at non-irrigated (rain fed) in all site is probably due to high calcium carbonate (CaCO3) in these treatments (Figure 11,A) and (Table 15). Khresat and Taimeh (1998) found that pH increases as the calcium carbonate increase. High pH denotes the dominance of sodium among the cations and carbonates/bicarbonates from anions. On the other hand. lower pH in the irrigated (open &protected) farmlands in all site compared to non-irrigated (rain fed) farmlands during the research year, this result could be related to increased NH4+ from addiding the dung manure and fertilizer , which through nitrification produced NO-3 plus hydrogen ions (Mapfumo, et al 2000). In addition, soil moisture affected pH value due to the dilution effect of the solution of the soil, that decrease the pH value , this reason might be explain the low soil pH value in irrigated (open &protected) farmlands compared to non-irrigated (rain fed) in all sites, which have high soil moisture Fig (14). On the other hand, in rain fed cultivation system, there's no inorganic fertilizer, farmer use manure to provide soil amendment, but irrigated (open &protected) farmlands they applied the two types, organic and inorganic fertilizer. It might be due to this that pH changes positively or negatively in the different cultivation systems, irrigated (open & protected) and non-irrigated. Similar results were obtained by Haq (1966), Muhammad et al. (1969), and Muhammad and Khaliq (1975), They found that farm yard manure (FYM) had no-significant effect on the soil pH in comparison with minimum pH value that recorded with area using organic and inorganic fertilizer as H2SO4, FYM. This agree with our study, high pH in rain fed may be due to manure applied and the dominate of calcium carbonate, and lower pH in irrigated system may be due to the different types and amounts of chemical and organic fertilizer. Lowered soil pH while using a complex fertilizer may result from an intensive removal of alkaline elements along with the crop (Buckman and Brady, 1971; Lityn ski and Jurkowska,1982). The cations are then replaced with hydrogen ions. Whalen et al. (2000) reported that effects of manure on soil pH depend on the manure source and soil characteristics. Malhi et al. (2000) reported that the soil acidification was the greatest with ammonium sulfate, followed by ammonium nitrate and urea, with no effect of calcium nitrate. The use of synthetic ammonium fertilizer is known to cause a rapid shift in soil chemical properties which are initiated by microbial nitrification; this shift may result in soil acidification (Stamatiaadis et al., 1999). Other studies have found a significant decrease in soil pH with organic fertilizer application (Tunney, 1981; Eghball, 1999; Clement, 2003). Chang et al. (1990) reported that soil pH in the top 15 cm of a calcareous soil (pH 7.8) amended with cattle manure annually for 11 consecutive years decreased by 0.3 to 0.7 units, and the decrease was greater in plots receiving three times the recommended rates for manure application. Smiciklas et al., (2002), Pattanayak et al., (2001) and Yaduvanshi (2001) also observed a decrease in soil pH after the use of organic materials. The production of organic acids (amino acid, glycine, cystein and humic acid) during mineralization (ammonization and ammonification) of organic materials by heterotrophy and nitrification by autotrophy would have caused this decrease in soil pH. Decrease in soil pH may also be attributed to the production of carbonic acid and nitrification of NH_4^+ released from mineralization of organic fertilizers in the soil (Chang et al., 1991). They reported a 0.3 to 0.7 unit decline in the pH of a calcareous soil (pH 7.8) in the top soil following eleven years of cattle manure application. This decrease was attributed to the nitrification of NH_4^+ as well as the organic acid produced during the decomposition of the organic fraction of the manure. Differences in pH were not, however, significant for one- and two-year applications of the fertilizers as compared to no applications of the fertilizers , probably because of the high carbonate content and buffering capacity of the soil. Similar results have been reported by Tunney (1981). In the contrast other study showed that the short term effect of applying fertilizer, Smethurst et al. (2001) declare that immediately after the first broadcast application of fertilize at the highest rate {(NH4)2SO4 & triple supper phosphate} decreased pH by up to (.5), Wei et al. (2007) also reported that large amount of nitrogen fertilizer markedly decreased soil pH value, particularly using ammonium sulfate as a nitrogen source in a solar greenhouse. In our study, soil pH within sites was different at each cultivation system, irrigated farms (open & protected) and the adjacent non-irrigated farmlands (rain fed). Figure (11-A) indicate that in non-irrigated farmlands (rain fed), pH recorded ranged between (7.5 -7.72), the highest value at (T2) in all sites, the soil was classified moderately alkaline in all site According to Marx et al, (1999), In protected farmlands the soil reaction (pH) ranged from (7.2 – 7.5), the highest value at (T1) Figure (11-B). In irrigated farms (open) the soil reaction (pH) ranged from (7.1 – 7.45), the soil was classified as neutral to moderately alkaline soil in irrigated farms (open & protected) in all site Figure (11-C). Calcium carbonate content generally similar in irrigated (open & protected) system as shown in table (15), but it is higher in rain fed system. In figure (5-a, b &c) data showed that there are close relationships between pH values and calcium carbonate content (CaCO3) However, soil pH increased as a result of CaCO3 increases in all sites. Dissolution and redistribution of carbonate trade off govern the level of soil carbonates in a wide variety of soil type, and has been considered an important soil shaping process in Mediterranean soil (Yaalon et et al., 1996). The result which present in table (15), showed that the soil calcium carbonate is relatively similar in irrigated system. This might be due to carbonate derived from parent material that formed the soil.

4.2.3. Electrical Conductivity & Sulfate

Electrical conductivity of the soil extract indicates concentration of soluble salts in the soil solution. The changes in ECe are given in Table 16, showed that (EC) significantly different between sites. According to Marx et al, (1999) the soil between sites ranged from medium to high electrical conductivity. This trend could be attributed to the variability in Appling fertilizer or irrigated water. Within site significant differences were found between different cultivation systems. Rain fed land showed the lowest EC values, it ranges from (1.1 to 1.98) dsm^{-1}which is of low salinity according to Marx et al, (1999). Open irrigated system showed medium to high salinity, EC value range from 1.9 to 2.94 dsm^{-1}. The highest EC recorded in protected cultivation system, value ranged from 3.2 to 5.2 dsm^{-1}. It is high according to Marx et al, (1999). According to (Calif. Fertilizer Assoc. 1995) significant differences in EC were found below levels considered to be potentially problematic for crop growth, when used organic fertilizer, they found that animal manures has not resulted in increased salinity. May be the lower Electrical conductivity in rain fed comparing to irrigated system due to used animal manures. This agrees with Darwish, (2005) who found that the effect of agricultural practices on soil salinity revealed no significant correlation between the amount of added manure and the soil salinity. Al-Bakeir, (2003) fond that EC reached 1.6mmhos cm^{-1} in rainfed system at Al-Arroub Experimental Station. In contrast with irrigated system, the farmer applied high amount of synthetic and organic fertilizer. This may be resulte of high EC in irrigated cultivation system especially in greenhouses in all sites. The small increment may be due to the additional salt applied with irrigation water (Costa *et al.*, 1991). This agrees with (Sarwar et al., 2008), they found that Electrical conductivity showed an increasing trend with the application of fertilizer and compost to the soil. Such similar results have been reported by (Sarwar et al., 2003; Niklasch & Joergensen, 2001; Selvakumari et al., 2000), which indicated that EC increased in acidic as well as alkaline soils when organic materials of different nature were applied to the soil. The decomposition of organic materials released acids or acid forming compounds that reacted with the sparingly soluble salts already present in the soil and either converted them into soluble salts or at least increased their solubility. Hence, the EC of soil was increased e.g., CaCO3 (ever present in the soils of arid and semi-arid regions) may be converted to CaHCO3 or even to Na2CO3 which are more soluble forms. However, the quantum of increase will depend on how much quantity of the acids or acid forming substances was produced which will in turn relay upon the amount of the organic materials applied. As in our result the electrical conductivity (ECe) of the irrigated cultivation system amended with fertilizers increased significantly as compared to the rain fed (Table 16) probably due to the soluble salt content of fertilizers and the release of organic and inorganic soluble species such as NO3-. The magnitude of the increase was proportional to the rate of applications and the number of years that fertilizers were applied. (Tarchitzky and Magen, 1997) found higher ECe value (8.6 dS/m) under mismanaged drip irrigation and monoculture, and the smallest ECe (0.7 dS/m) was under rain fed condition. Poor agricultural practices in greenhouses were identified to cause soil salinization (Solh et al., 1987; Atallah et al., 2000). Within type of cultivation system, Comparing the soil samples quality in three time intervals showed a trend of increased proportion of EC at (T1) in rain fed, at (T2) In open cultivation, and In protected system it will be rise from (T1to T2) and then dropped in (T3). Over-irrigation, poor scheduling of irrigation and a single large application of nutrients lead to low recoveries of water and nutrients. Under field conditions, studies showed that the utilization of N and P applied in the soil did not reach 49% for N and 15% for P (Shammas and Kishli, 1973; Shammas et al., 1973). In fact, the ECe in the three different cultivation system especially in greenhouses presented significant differences through the time. The high ECe values corresponded to the maximum crop growth and salinity build-up by evapotranspiration. In these cases, the crop was started in April, the observations, the smallest ECe values occurred especially in greenhouses where the time is the beginning of a new growing cycle. During this period, growers, fertilization and over-irrigation is heavily practiced. Such practice was reported to cause salt rising. Also Evaporation could be raising the salts to the surface in the absence of adequate leaching fraction. Thus, a salt build-up could be expected in the top layer of the soil. For each time, in this study in irrigated system especially in the five greenhouses, showed higher salinity levels. This result could be associated with the expected above. This agree with (Darwish et al, 2005). Sulfate content generally similar in irrigated (open & protected) system as shown in table (16), but it is lower in rain fed system. In figure (12-A, B &C) data showed that there are close relationships between EC values and sulfate content (SO_4^{2-}) However, soil EC increased as a result of sulfate content (SO_4^{2-}) increases in all sites. Farmers apply excess manure and synthetic fertilizer without understanding the chemical properties (solubility, salinity index) about what they applied .Fertilizers have a partial salinity index which has differens effect on soil salinity. Depending on the quantity and type of fertilizer. As the salt index increased, the positive relation between electrical conductivity and sulfate might be due the high salt index of sulfate.

4.2.4. Available Nitrogen (NH_4^+, NO_3^-) and Phosphorus (P)

Plant available forms of nitrogen are nitrate (NO_3^-) and ammonium (NH_4^+). Results showed that soil available nitrogen (NH_4^+ & NO_3^-) in the five sites at different cultivation system is different (Table 17). In our research, similar trend was observed about nitrogen, ammonium and phosphorous. Farmers applying excess different amount and type of fertilizer in different time depending on the time of beginning of planting, the stage of crops and on the type of cultivation system. As a resulte, the excess nutrient are remained after crop harvest and accumulate in greenhouse soil, even harmful level for crop cultivation, In irrigated system high amount and different types of fertilizer applied in different times, since this affect the concentration of this nutrient in soil. Figure (17) showed this fact. Excessive concentration in irrigated (the highest in greenhouse) and low to medium in rain fed according to Marx et al, (1999). Jung et al., (1998). Found that average account of available (P2O5) was (1092 mgk-1) compared to the optimum level of (350-500) mgkg-1 (Dobermann and Fairhurst 2000). Jung et al., (1998), they found that soil nitrate nitrogen (NO3-N) was also higher than the optimum level; 155 $mgkg^{-1}$ in greenhouse, the nutrients accumulation in soil may eventually cause negative impact on soil and water environments in addition to crop yield and quality. Accumulation of toxic substances such as nitrate nitrogen (Jin et et al., 2004), and leaching loss nutrient which cause pollution of ground water and surface water by NO3-N and K (Lee and Lee, 2004). Nitrogen and Phosphorus status of soil was improved significantly when chemical fertilizer and compost were added to the soil. (Sarwar et al., 2008) found that the amount of available P was 5.72 mg kg-1 that reached to the highest value of 27.55 when used (compost 24 t ha-1 as fertilizer). This trend of increase in available P was not only maintained after wheat but was further enhanced. Beside other factors, phosphorous availability is controlled by soil pH, clay content, calcareousness and organic matter percentage of the soil. The ideal pH for maximum availability of phosphorus ranges from 6.5 to 7.5 Brady (1990). Availability of phosphorus is also affected by the presence of CaCO3 in the calcareous soils. Thus, the available phosphorus starts becoming unavailable. When an organic source of nutrition is applied, the bond of phosphorus compounds with CaCO3 is broken. Resultantly, phosphorus is kept at higher amounts of available form. Earlier scientists also determined availability of phosphorus in the soil by using various organic materials and their findings supported the above results (Pattanayak et al., 2001; Parmer & Sharma, 2002; Verma et al., 2002; Singh et al., 2002). AL-Sech found that available nitrogen ($NH4^+$, NO-3) and phosphorus (P) were increased as a result to high organic matter. Getaneh, (2007), found that available nitrogen and phosphorus were higher in the irrigated farmlands than the non-irrigated farmlands. This could be due to applied fertilizers. Figure (17) showed phosphorus concentration in three different cultivated system (greenhouse, irrigated open field and rain fed) for each five sites. Crisanta et al., (2009) found that Olsen P ranged from 1.2 to 40.3 mg kg−1 in non irrigated soil, the highest in soil that received Fertilizer and lowest in that did not receive any phosphorus application. Mineralizable N (NH4+NO3−) ranged from 0.5 to 85.7 mg kg−1in cultivated soil (Dobermann and Fairhurst 2000). (Bader, 2006) found that nitrate concentration ranging from (76.2 to 443) ppm, also he found that ammonium concentration is less than nitrate, it ranges from (17.2 to 20.3)ppm. The above agree with my observation in this research, that within site significant differences were found between different cultivation systems. Rain fed land recorded the lowest NO_3^- values, it ranges from (33.9 to 47.3) ppm, it will be low to medium according to Marx et al, (1999). Open irrigated system nitrate range from (133.9 to 167.1) ppm, it was excessive value. The highest NO_3^- values recorded in protected cultivation system, value ranged from (350.7 to 680.5) ppm. It is excessive value according to Marx et al, (1999). Within type of cultivation system, in rain fed NO_3^- values generally are similar but it decreases from (T1 to T2). The same trend in open cultivation system but it rises from (T1 to T2). Also in protected system it will be rise from (T1 to T2) and then decreased in (T3). This agrees with Seo et al., (2007) who found that higher amount of residual nitrate, phosphorus, and potassium were detected in soil after harvesting. The result implies that soil testing and fertilization adjustment in salt accumulation greenhouse soil need to be performed to keep long term crop productivity and reduce the potential of contamination of soil and aquatic environment with residual nutrient.

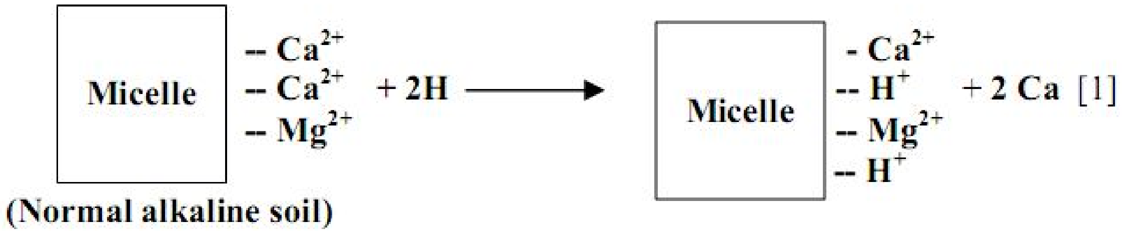
4.2.5. Soil Exchangeable Cations

Parent material composition strongly influences soil and soil-solution chemistry (Hornung et al., 1990), which in turn regulate soil fertility. In particular, the nutrient statues of soil largely depend on its pool of exchangeable base cations (Reynolds et al., 1988). The most common cations in arid and semi arid areas are calcium, magnesium, and sodium. Each of these cations is base-forming, meaning that they contribute to an increasing OH^- concentration in the soil solution and decrees in H^+ concentration. They typically dominate the exchange complex of soil, having replaced aluminum and hydrogen. Soil saturated with calcium, magnesium, and sodium has a high base saturation and typically high PH values (Miller and Dooahue, 1995). For that reason, the study site with different cultivation systems show medium to high level of calcium concentration, high level of magnesium concentration and medium to excessive potassium concentration. Between sites value of these cations is generally similar but it is variable within site. Higher value observed in irrigated system. This might be due to the addition by fertilizer or by irrigation water. In greenhouse, Seo et al., (2007) found that average content of (K) was 1-1.27 cmlkg-1 compared to the optimum level of (0.7 -0.8) cmkg-1. This agrees with Getaneh et al., (2007) who found that the exchangeable bases were higher for the irrigated farmlands than their in non-irrigated farmlands. This could be attributed to different soil fertility management practices. Farmers apply farmyard manure, and use crop rotations for the irrigated farms while they usually use only inorganic fertilizers for the adjacent non-irrigated farmlands. The high exchangeable bases in the irrigated farmlands could be attributed to the transportation of exchangeable cations by erosion from the higher land in open irrigation farmlands located at the lower slope . Some sites in irrigated cultivation system highest magnesium found at the beginning (T1) and decreased at (T2). This trend similar to Komosa et al., (1999) who reported that fertigation with ammonium nitrate caused leaching of magnesium directly underneath the dripper. Whitney et al., (1991). declared that the upper soil layer (6-15cm) of N-fertilizer had reduced PH, available phosphorus and exchangeable Ca^{2+}, Mg^{2+} and Na^{+} and increased nitrate-N, ammonium-N.(Roz alski, 1998). Fertigation with ammonium nitrate caused leaching of magnesium directly underneath the dripper and accumulation of magnesium 20-40 cm from the dripper (Ko- mosa et al., 1999ab). Leaching of magnesium under the dripper also occurred when urea was applied (Belton and Goh, 1992). Treder et al. (1998) investigated changes in magnesium level in the soil solution and found that soon after fertigation with ammonium nitrate, the magnesium level rapidly increased, and then dropped when the fertigation was stopped. A higher soil pH was recorded in the wetting area where only irrigation was applied, which agrees well with earlier results reported by Kidder and Hanlon (1985) and Treder et al. (1995 and 1997). In these studies and in the earlier studies cited above, the increase in soil pH was caused by the accumulation of magnesium and calcium. The lowest extractable sodium was at non-irrigated (rain fed) system, this might be related to low weathering compared to relatively optimum soil moisture content through the year created favorable weathering condition in irrigated cultivation system, so sodium was higher in irrigated especially in greenhouse. Also could be resaved by fertilizer. Thus soil dispersion which is the primary physical process of soil structure degradation is associated strongly with sodium concentration (Bauder and Brock, 2001; van de Graaf and Person, 2001). Also soil structure is the primary soil response to an excess of exchangeable sodium in combination with low salinity, which result in decline in soil air and water permeability (Ostar and shainberg, 2001). Sodium concentration has positive relating with SAR; it could be too increased in the sodium content.

4.2.6. Sodium Adsorption Ratio (SAR)

The data of various treatments on the sodium adsorption ratio (SAR) of the soil are presented in Table 19. Sodium adsorption has the same trend of sodium concentration. Sodium adsorption ratio (SAR) used to measure the sodicity of a soil. Sodicity is the accumulation of sodium ion in excessive quantities, which hinder plant growth directly or through the impairment of physical soil conditions. The effect of compost was favorable chemical fertilizer. Rain fed has the lowest

SAR comparing to irrigated cultivation. It could be to the effect of organic fertilizer. This agrees with Zaka et al., (2003). They attributed the reduction in SAR of the soil with organic materials due to the release of organic acids causing mobilization of native calcium present as CaCO3 in the soil. This agrees with our result that the lower value of SAR record in rain fed cultivation system, which has the manure fertilizer. The values of SAR become lesser either due to an increase in divalent cations (Ca + Mg) or decrease in mono-valent cation (Na). Values of Na could decrease during leaching while Ca + Mg increase due to reactions of organic acids with CaCO3 after the application of compost. The chemical reactions proposed under section above further elaborates how a net increase in Ca + Mg and decrease in Na in the soil solution occurred. The acid or acid forming substances expelled Na or Ca + Mg from the clay micelle, the hydrogen ion taking their place. Sodium salts being readily water soluble left the soil system and went into the lower depths of soil profile. The divalent cations (Ca + Mg) increased the net concentration of the soil solution. However, a part of these would have also precipitated with carbonates (CO_3^{2-}) and bicarbonates (HCO_3^{1-}) present in the soil. The released Ca (equation 1) increased the Ca concentration of the soil solution resulting in decrease of soil SAR.



Equation (1): chemical reactions elaborate how a net increase in Ca + Mg and decrease in Na in the soil solution.

The decrease in SAR was essentially due to the removal of exchangeable sodium from the soil complex. The results are in agreement with those of Chaudhry and Warkentin (1968).

4.2.7. Micronutrient

The soil PH, calcium carbonates, and electrical conductivity are among the major important soil chemical properties, because they have a major role in controlling the solubility of most essential element of plant growth. Figure 16 shows that the soil pH was negative with Iron content. It can be observed that Iron like the other micronutrients decreases with the increase in soil PH. Also the results showed that Iron had a negative correlation with calcium carbonate content. These results were supported by Rajakumar *et al.* (1996) and Chinchmalatpure *et al.* (2000) who reported negative significant correlation between Iron and soil pH, and Chattopadhyay *et al.* (1996) who reported that Iron was negative significant correlated with lime content. Data in (table 20) compared with (table 11) shows that there was a positive correlation between Iron and clay. These findings were supported by Sharma *et al.* (1996) and Haque *et al.* (2000) who found positive correlation between Iron and clay. The positive correlation may be due to the strong bond between clay and micronutrient that protect it from leaching. Negative correlation between Copper and soil pH results were supported by Khattak *et al.* (1994), and Sudhir *et al.* (1997) who calculated negative correlation between Copper and soil PH. The data given in (Table-20) compared with (table-11) shows that Copper was positively correlated between Copper and clay. These findings are in agreement with Perveen *et al.* (1993), and Chhabra *et al* (1996) who reported positive correlation between Copper and clay content. In contrast (Figure-17) shows positive correlation between Zinc and soil PH. Similar results were studied by Sheeja *et al.* (1994), Sadashiva *et al.* (1995), and Patiram *et al.* (2000). The result was positive between Zinc and clay . The result was in agreement with Patil and Sonar (1994) and Sharma *et al.* (1996). Also it is clear that the high available iron was found in case of using the different rates fertilizer. From (Fig 16), it is clear that the high contents of iron are found in irrigated cultivation system especially in greenhouse; in case of using different amount of organic and in organic fertilizer. The result was in agreement with Ramadan et al.,(2007)

4.3. Water Chemical Properties

To answer the question whether water suitable for irrigation or not, Wilcox diagram a answered, yes. (SAR) index in accordance with EC value, while SAR is calculated according to formula: $\{(SAR=Na/\ [(Ca+Mg)/2]^{.5})\}$, where all concentration are in me/l. sodium hazard starts at value of SAR>1 and EC>650 $\mu S/cm^{-1}$respectively (Shalsh and Ghanem, 2008). The value of SAR are <1 and EC <650 $\mu S/cm^{-1}$ in all the spring except (SP2) which mean that water from these spring is recommended for unrestricted irrigation. Based on EC and SAR ratio. Water from this spring can be classified for irrigation according to Wilcox diagram figure (21). This result is in accordance with Ikhlil, (2009), she found the similar result. Mostafazadeh–Fard et al., (2007) found the positive relation of water salinity on soil sodium adsorption ratio (SAR). As the irrigation water salinity increased, the SAR increased.

Conclusions and Recommendations

- Great variability in chemical soil characteristics between different cultivation system which is likely due to irrigation management, cultural practices, and site history. We documented a greater accumulation of salts in soils that were irrigated especially in greenhouse. The soil parameters analyzed to evaluate the changes of the soil chemical and physical characteristics showed variability between different cultivation systems (irrigated – open and protected – and non irrigated –rain-fed). The soil organic matter content in the irrigated soil lower than non-irrigated soil. According to the data of this study, the soil organic matter was affected by the agriculture practices, may be due to more decomposition of SOM occurred because soils under wetting and drying increased microbial activity.
- Soil pH decreased from non-irrigated system to irrigated system. The lowest soil pH values were found in greenhouse. Also. This soil property was lower throughout time due to the salts deposited by irrigation water or by applying fertilizer. The electrical conductivity did not show consistency in the results. This soil variable present changes through time for irrigated areas. However, the electrical conductivity values from non-irrigated areas were lower than those from irrigated areas. The highest electrical values were found in greenhouse. Electrical conductivity showed an increasing trend with the application of fertilizer and compost to the soil.
- The Soil exchangeable cations showed highly differences in values between deferent cultivation systems. The value of irrigated areas was higher than the value of non-irrigated areas. Also, the values raised from non-irrigated areas

to irrigated areas. The highest value in greenhouse was observed under mismanaged drip irrigation, and the smallest was under rain fed condition. Poor agricultural practices in greenhouses were identified to cause soil salinization.

- Most of the changes in soil chemical and physical properties caused by applying different fertilizer and irrigated water. Long-term changes in soil pH occur largely as a result of displacing cations or adding sources of acidity which may be attributable to factors such as changes in fertilizer prac tices, rotation effect, and plant residue management.
- For irrigation purposes and depending on Wilcox diagram and SAR classification of water all the springs were suitable for irrigation purposes. Irrigation should be managed so that it could minimize adverse effects on soil quality.
- Farmers irrigate their crop without taking into consideration the value of the water where they add water as well as they want and they select any crops without taking into consideration the amount of water needed.
- Salinity risks are increased by the mismanagement of fertilizer application and irrigation.
- Mismanagement of fertilizer and water application results in salt buildup in the soil-groundwater systems. Fertilizer application and irrigation should be integrally managed according to the soil type, climatic factors and crop requirements. The type of fertilizer and method of application significantly influence soil chemical properties.

- The presence of naturally occurring mineral element in irrigation water caused a greater accumulation of these elements in the soil under the drippers.
- Fertilizers are salts. Therefore, when salinity is a concern, it is critical to pay close attention to how much fertilizer you apply, what kind of fertilizer you apply, where you apply fertilizer, and when you apply fertilizer.
- Apply only the amount of fertilizer that will achieve maximum economic yield. Additional fertilizer will increase soil salt content and cost more, but will not increase yield. Base fertilizer application rates on annual soil sampling. This practice will help you know how much fertilizer you actually need and prevent over-application. Use a reputable laboratory that understands your salinity management goals. Avoid unnecessary application of potash or micronutrient fertilizers.
- Different fertilizer forms have different salt indices. In other words, you can apply the same amount of nitrogen using different fertilizers and apply vastly different amounts of salt in the process. Choose fertilizers that will supply the crop’s needs and have the lowest salt indices. Anhydrous ammonia has the lowest salt index of all nitrogen fertilizers. Among phosphorus fertilizers, triple superphosphate has the lowest salt index, considerably lower than mono ammonium phosphate (MAP) or di ammonium phosphate (DAP). If you need potassium fertilizer, potassium sulfate has a much lower salt content than potassium chloride (muriate of potash).

- The closer that fertilizer is applied to seeds or growing plants, the greater the risk of salt burn. Do not apply fertilizer with the seed if the crop yield is already below optimum due to salts. Never apply urea or ammonium fertilizers directly with the seed. Banding phosphorus fertilizer doubles its efficiency. Therefore, banding keeps fertilizer rates down and helps to avoid excess salts. Be careful to avoid banding too close to the seed. to determine how close you can put the fertilizer band without causing a salt burn. You will need to know the soil texture and the amount of N and K2O you intend to apply.
- Crops are most sensitive to salts when they are in the seedling stage. Salinity also reduces germination. Therefore, it is wise to avoid fertilizer application during the early growth stages. If you have salinity problems, avoid starter fertilizers and apply as much of the N as a side dress as possible, eliminating pre-plant N applications. Coated fertilizers can reduce early season salinity by gradually releasing nutrients into the soil. Fertigation is a good practice in saline soils because it allows you to spoon feed the N in small doses through the sprinkler system. However, do not pump anhydrous ammonia into irrigation furrows because this will increase the Sodium Adsorption Ratio (SAR) of the irrigation water and increase the sodicity risk.
- Applying fertilizer only at required rates, choosing fertilizers with low salt indices, banding fertilizer away from the seed, and delaying fertilizer application until after plants are established will help to protect your crop from excess salinity due to fertilizer application.

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Abstract (Arabic)

دراسة تاثير التسميد والري على صفات التربة الكيميائية والفيزيائية تحت انظمة زراعية مختلفة

هذا البحث يوضح تاثيربعض العمليات الزراعية لبعض المزارعين على تدهور التربة من خلال الفعل المتكامل للتسميد والري على صفات التربة الكيميائية والفيزيائية تحت انظمة زراعية مختلفة - مروية (محمية ومكشوفة) وغير مروية (بعلية). العمليات الزراعية في المناطق شبه الجافة تتصف نوعا ما بالزراعة المروية المكثفة، المحمية والمكشوفة. ففي ظل مناخ البحر الابيض المتوسط ، حيث النظام البيئي الهش، هذه الممارسات الخاطئة والمتزايدة، كنتيجة لعدم وجود الادارة الجيدة خلال ممارسة العمليات الزراعية من ري وتسميد،هذا يؤدي الى تدهور في صفات التربة الكيميائية والفيزيائية، ويزيد من ضعف هذا النظام.

الهدف من هذه الدراسة هو دراسة تاثير التسميد والري على صفات التربة الكيميائية والفيزيائية في ظل انظمة زراعية مختلفة - مروية (محمية ومكشوفة) وغير مروية (بعلية).

اجريت هذه الدراسة على مدى عام زراعي في خمسة مواقع زراعية مختلفة من مدينة دورا، 10كم جنوب محافظة الخليل، كل موقع زراعي يمثل ثلاثة انظمة زراعية مختلفة- مروية (محمية ومكشوفة) وغير مروية (بعلية). اظهرت نتائج البحث انه هناك تباين في صفات التربة الكيميائية والفيزيائية بين هذه الانظمة الزراعية، فحموضة التربة، كربونات الكالسيوم والمادة العضوية تحت نظام الزراعة البعلية اعلى منها في النظام المروية (المحمية والمكشوف). قد يكون احد اسباب انخفاض نسبة المادة العضوية هو توفر الظروف الملائمة من رطوبة، حرارة وتهوية مما يسارع من اكسدتها وتحللها بالمقارنة مع النظام البعلي. اختلاف انظمة الزراعة لم يكن له تاثير على قوام التربة حيث كانت متشابهة في نفس الموقع وتحت ظل جميع الانظمة الزراعية. اظهرت النتائج ايضا ان محتوى التربة من الفوسفور، البوتاسيوم، النيترات والعناصر الغذائية الصغرى تحت نظام الزراعة المروية (المحمية والمكشوفة) اعلى منها في النظام الغير مروي (بعلي). قد يكون احد الاسباب هو الاضافة العالية لهذه العناصر من خلال اضافة الاسمدة العضوية وغير العضوية اوما يضاف مع مياه الري. بشكل عام، محتوى التربة من هذه العناصرهو الاعلى تحت نظام الزراعة المروية (المحمية) والاقل تحت نظام الزراعة البعلية.