CHAPTER ONE

INTRODCUTION

The date palm (*Phoenix dactylifera* L.) is a dioecious tree; it belongs to the family Palmae (Arecaceae). The world total number of date palms is about 100 million, distributed in 30 countries and producing between 2.5 and 5 million tons of fruits per year. However, it worth mentioning that accurate statistics on the number of date palms are not always available and not easy to collect. Even when some numbers are available, it is not clear to which category they belong: are they producing adults, young palms, total or both (Zaid, 2000). Date palm (*Phoenix dactylifera* L.) is widely cultivated in the arid regions of the Middle East, North Africa and arid sub-Sahra areas such as the Northern Sudan for its economic values (Purseglove, 1981). In the Sudan it is grown mainly along the Nile valley in the Northern State which extends from latitude 22ºN to latitude 15·5ºN, (Salih, 2003). Smaller numbers of date palm trees are also grown in Khartoum State, River Nile State and Darfur States (Ahmad, 2003). The population of date palm trees in the Sudan during 2006 was about 8 million bearing trees, in the Northern State the number of the trees is about 54.5% of the total population of the Sudan and about 63% of total production of the Sudan (Mohamed, *et al*., 2006). Date palm plays important role in the local economy in the Northern Sudan (El-amien, 2009). In the Northern Sudan the fruit is consumed as food for its high carbohydrates content, the trunk is used for house building or furniture, the fiber for ropes, the flower stalks for weaving baskets, pollen grains mixed with honey for human consumption and stones of fresh fruits for animal feed or mixed with milk for medicinal purposes.

The date palm trees also grown for shade ornamental values (Osman, 1979). Dates are staple food in many desert areas. The high-energy value consisting

mainly of carbohydrates and the good storability make them an ideal crop in places where they can by grown (Rygg, 1977).

"Barakawi" is the most popular dry cultivar and constitutes about 40% of the total population of date in the Sudan (Nixon, 1969, Osman, 1979, Mohamed, 1984), and 70% in the Northern State (Idris *et al*., 2006). It is available in the markets all the year round. Production per palm is 18 – 25 kg, which is very low compared to trees grown under good management condition, which could produce up to 100kg (Osman, 1977, Mohammed, 1985). However, restless efforts are exerted to increase the yield per palm through improving cultural practices, horizontal expansion by growing date in high terrace soil and promotion of extension services for the production of the crop. Fertilization has generally been found necessary to maintain the yield and quality of the fruits. Animal manure is widely used in the some date palms gardens of the old world (Nixon, 1969). The type of fertilizer seems to increase the vigor and rate of growth of young plants and the fruit bearing capacity of the adult trees (Nixon, 1969, Hayat, 1980, Albaker, 1972).Most of date palms farmers in the Arab countries, where there are about 75% of the total date palms of the world, do not care much about irrigation. They believe that date palm trees can grow and bear fruits under drought and do not require much irrigation. But on the contrary all the experiments and studies show that date palm farming and development depends on irrigating the trees with enough water to fulfill their water requirement (Ibrahim, 2009). In spite of that, Date palm trees can tolerate drought more than most of fruit trees. The date palm like any tree requires enough water to compensate the losses due to the soil surface evaporation and the

transpiration from the leaves, as well as the amount that is needed during its

growth stage and fruiting (Gasium and Hameed, 2003 and Hussein *et al*., 1983). Date palm growth and yield affected by both the magnitude of water deficit and the stage of growth subject to deficit. Insufficient water supply caused by prolongs irrigation intervals, and or decreasing the available moisture in the soil, clearly inhibit plant growth (Scatter and Habib, 2007). The reserved underground water in the Northern State is about 500 million cubic meters and only about 29 million cubic meters is now utilized (Northern State Ministry of Agriculture and Animal Wealth, 2003). The lower terrace areas irrigated from the Nile whereas the upper terrace areas irrigated from underground water "Matarat".

The land in the Northern State classified according to the type of the ownership and the soil type. According to the type of ownership, three types of lands can be distinguish in the Northern State, the governmental lands, the privately owned lands and the "Miryi" lands. The privately owned lands are the lands owned by individuals and are registered by their names as free holding known as "milik" lands. The privately owned land are bordering the River Nile (lower terrace), while the government lands are prevailing away from the Nile (upper terrace) (Al Awad, 1994).

The Northern State occupies the distant northern part of the Republic of Sudan and lies between latitudes 15.5 – 22º N and longitudes 20 – 32º E. The State lies in the arid and semi-arid zones, where the annual rainfall is less than 100 mm. The climate is characterized by two distinct seasons where summer extends from April to the end of September. The maximum temperature in summer reaches above 45°C. Winter extends from October to the end of March and it is the cold season.

The maximum winter temperature is about 30º C, while the minimum temperature is around 5ºC (Northern State Ministry of Agriculture And Animal Wealth, 1997).

The over all objective of this study was to increase yield and quality of Barakawi cultivar. The study aimed to evaluate the effects of fertilization and irrigation on yield and yield components and fruit characteristics.

CHAPTER TWO

LITERATUE REVIEW

2.1 Origin of Date Palm:

The date palm (*Phoenix dactylifera L.*) of the family Palmaceae (Arecaceae) originated in the region around the Persian Gulf where it has been cultivated since 3000 B.C (Nixon, 1951). Al-Bakr (1972) reported that the date palm originated since prehistoric times in the warm arid region that extends from Senegal to the Indus area that lies between latitudes 15-30^{o} N. The palms were introduced into the western Hemisphere by the early Spanish Missionaries, who planted date palm seeds around many of their Missions (Nixon, 1951).

2.2 Historical Background and World Production:

The palms are probably the oldest cultivated trees in the world. Its culture was established as early as 3000 B.C in Shatt- el- Arab area of Iraq (Al-Bander, 1980). The date palm has also been in Egypt since prehistoric times but its culture did not become important until some what later than in Iraq (Nixon, 1951, Al-Bander, 1980). From this location it has spread to other countries of the world. The date palm lands of Asia and Africa stretched from Indus Valley in the east to the Atlantic coast in the west. This region produces the bulk of the world production of the date palm and has over 90% of the total number of palm trees stretching from about 35^{o} N in Iraq to around 10^{o} N in Somalia. Also, date palm is cultivated in southern California and in small patches in Mexico, Peru, Brazil, Argentina, South Africa, Australia, Kenya and Tanzania. The total number of date palm trees in the world was estimated according to (Al-Bander, 1980)

as one hundred million trees distributed over 30 countries and their annual production of dates is between 1,300,000 and 1,800,000 tons (table 1) while (Hussein, 1972) reported that the total number of date palms in the world was 90.25 millions, 35% of this number was grown in Iraq and the rest in 26 countries.

Table (1) Total world production, number of trees and areas of date .palm

Country	Total numbers	Total area (ha)	Total production/metric
Iraq	22,300,000	125,000	498,000
Algeria	7,500,000	45,000	185,000
Egypt	7,000, 000	45,000	409,000
Saudi Arabia	6,685,000	45,000	262,000
Morocco	5,042,000	84,500	102,000
Libya	4,600, 000	27,500	65,000
Pakistan	4,375,000	26,414	200,000
Tunisia	2,250, 000	10,000	46,000
Sudan	1,333,300	56,250	105,000
Oman	1,000,000	---------	50,000
Yemen	800,000	6400	42,000
U.A.E	359,500	3,437	---------
Somalia	204,300	354	6,000
Bahrain	200,000	3,700	16,000
Kuwait	38,700	---------	1,000
Syria	12,000	---------	---------

Source: Al-Bander 1980 (F.A.O).

The export of dates have been fluctuating; in 1976 Iraq was the leading exporting country and exported around 300,000 tons which amounted to 85-90 % of the total exports from Arab countries. Following Iraq were Algeria, Saudi Arabia and Tunisia, during the same year Syria, Yemen, Somalia were

reported as the main importers in Arab countries (Al-Bander, 1980). However before 1976 Sudan was one of the five countries reported to export large quantities of dates (Nixon, 1960). According to the fluctuating nature of production, date palm productivity per tree differs from one year to another. Statistic showed that in the year 1976 the world production per tree was about 33.81kgs. There are variations from location to location even within the same country and for the same variety (Al-Bander, 1980). The distribution region by region finds that Asia is the first position with 60 million date palms, while Africa is the second position with 32.5 million date palms. Mexico and USA have 600000 date palms, followed by Europe with 32000 date palms (Djerbi, 1995). Table 2 shows the ten producing countries.

Table (2): Date palm producing countries:

Countries	Total production (tones)
Egypt	1,313,69
Iran	1,000,000
Saudi Arabia	982,54
United Arab Emirates	755,000
Pakistan	557,52
Algeria	526,92
Iraq	440,000
Sudan	332,000
Oman	255,87
Libya[	175,000
World Total	6908,90

Source: FAO, (2007).

2.3 Botanical Description:

Date palm is one of the most important members of the family Palmaceae (Arecaceae) which contains 210 genera and 1500 species (Dinkhan, 1980, Anon 1982).The genus *Phoenix* consists of about 12

species, several of these are well known for various purposes, such as *Phoenix canariensis* that is used as an ornamental plant and *Phoenix sylvestris* which is cultivated in India as a source of sugar (Blatter, 1929, Nixon, 1951 and Al-Bakr, 1972). The main characteristic distinguishing *Phoenix dactylifera* from other species of the family is the production of off-shoots in combination with the tall columnar relatively thick trunk (Al-Bakr, 1972). The date palm is a woody monocotyledon with an erect columnar trunk that may extend to a height of 24m or more. The tree has no true branches, however, it produces off-shoots, which when left, may grow to a size second to that of the parent tree and resembles the parent plant in leaf and fruit characteristics. Like most of the monocotyledonous plants, date palm has no cambium and therefore, the trunk does not increase in diameter (Nixon, 1951).

The top of the trunk is surrounded by 60-150 leaves at various stages of development. The leaf is compound with pinnate or leaflets ranging from 60-130 on each side of the rachis. At the base of the rachis the leaflets are suppressed to form spines. The leaf is protected against excessive loss of moisture by small sized stomata and a thick waxy layer commonly noticed in xerophytic plants. The spines vary in numbers from about 10 to 60 and may be single or in groups of 2-3. The arrangement is not the same on both sides of the midrib. The date palm being a monocotyledon has no taproot. Shortly after the primary root has emerged from the seed, secondary roots appear.

The roots form a dense cluster and are approximately of the same diameter throughout their length. The roots produce short lateral roots of the same type (Nixon, 1951, Dinkhan, 1980 and Anon, 1982). Date palms are dioecious; the staminate and pistillate flowers are produced by separate plants. The date palm inflorescence is a branched spadix with 25-100

spikelets of 15-90 cm long attached to a thick axis. The inflorescence is enclosed in a hard tough spathe which bursts open when flowers mature. The male spathes are shorter and wider than the female ones. The length of the spathe varies from about 25-100cm. The number of spathes borne by a palm in a year varies from 0-25 in females and to even more in males. The flowers are small yellowish, sessile and borne at the bends of the spikelets. The male flower is sweet scented, has 3 sepals connate in copular 3 toothed calyx, 3 petals obliquely ovate and valvate, 6 stamens with short subulate filaments and erect dorsified anthers. The female flower on the other hand has 3 sepals connate in a globase crescent calyx, 3 rounded imbricate petals and 3 free carpels with erect ovules and sessile hooked stigmas. Upon pollination, usually two carpels abort and only one ripens. The aborted carpels persist as two brown spots on the calyx of ripened fruits (Anon, 1982). The fruit stalks are classified as being short when less than 91 cm long, medium when ranging between 91-152cm and long when more than 152cm in length (Nixon, 1951). The fruit, depending on the variety and growing conditions, varies in weight from 2 to 60g, in length from 18 to 110mm and in width from 8 to 32mm. It is a berry, oblong or ellipsoidal in shape but some dates are spherical, some are long and tapering and others are like a cylinder with the width the same as the length (Anon, 1982 and Dinkhan, 1980). The seeds vary in weight from less than 0.5 to 4g, in length from about 12-36mm and in width from about 6-13mm.

The seed is oblong, ventrally grooved with small embryo, and with a hard endosperm composed not of starch only, but of cellulose deposits on the in side of the cell walls (Anon, 1982).

2.3.1 Vegetative Organs

2.3.1.1 Root system

Being a monocotyledon, the date palm has no tap root. Its root system is fasciculate and fibrous, similar to maize plant. Secondary roots arise upon the primary roots which develop directly from the seed (Zaid, 2002). These secondary roots produce lateral roots (tertiary roots and so on) of the same type with approximately the same diameter throughout their length (Zaid, 2002).

2.3.1.1.1 Root morphology and distribution

2.3.1.1.1.1 Primary roots

According to (Zaid 2002), their origin is the trunk, form a cylinder of average length 4 up to 10m, average diameter 7-12.5mm, without root hair, the conical tip is called auxirhyzes or the main roots.

2.3.1.1.1.2 Secondary roots

Average length 0.2-0.25m average diameter 3.5mm, called mesorhyzes.

2.3.1.1.3 Tertiary roots

Origin secondary roots, average length 0.02-0.1m, average diameter 0.3-1.5mm, low growth, short and abundant, called brachy. All date palm roots possess pneumatics, which are respiratory organs found as far as 25m from the palm and deeper than 6m, but 8.5 percent of the roots are distributed in the zone of 2m deep and 2m on both lateral sides in a deep loamy soil (Munier, 1973).

It worth mentioning that date roots can withstand wet soil for many months (Obeid, *et al* 1991), but if such conditions extend over longer periods, it become harmful to the health of the roots and to fruit production, (Zaid, 2002). According to (Oihabi 1991), the date palm root system is divided into special zones. These are the respiratory zone, which is localized at the palm bases surrounding area with no more than 25cm depth and a lateral distribution of a maximum of 0.5m away from the stripe. Only roots of

primary and secondary nature are found here. Most of these roots have a negative geotropism and play a respiratory role.

The nutritional zone on the other hand contains the higher proportion of primary and secondary roots. It could contain 1000 roots per m2 and more than 1.60gm of roots/100gm soil (Oihabi, 1991). They develop between 0.90 and 1.50m depth and could laterally be found outside of the projection of the tree's canopy. In the case of Deglet Nour variety, lateral roots were found up to 10.5m from the trunk (Bliss, 1994). At one year old roots of newly planted off-shoots could reach 1m, while 3m depth is easily reached at the second year. Another zone, the absorbing zone, is dependent on the type of culture and on the depth of under ground water. It is usually found at depth of 1.5 to 1.8m. Mostly primary roots with a decreasing density from top to bottom are found here. The density of this zone is lower than in zone (2). Only about 200 roots are found per m2. When the ground water is deep, roots of this zone could reach a greater depth. They are usually presented as vessels with a positive geotropism. Date palm roots development and distribution depends on soil characteristics, type of culture, depth of the underground water and the variety (Zaid, 2002).

2.3.1.2 Trunk

The date palm trunk, also called stem or stripe (Zaid, 2002), is a vertical cylindrical and columnar stem of the same diameter all the way up. The width does not increase once the canopy of fronds has fully developed (Obeid, *et al*, 1991 and, Moarri 1995). It is brown in color, lignified and without any ramification. Its average circumference is about 1 to 10m up to 24m in height to the growing point (Barreved, 1993). The trunk is composed

of tough, fibrous vascular bundles cemented together in a matrix of cellular tissue, which is much lignified near the outer part of the trunk. Being a monocotyledon, date palm does not have a cambium layer, (Moarri ,1995 and Nasor Taha, 1991). It is covered for several years with the bases of the old dry fronds, making it rough, but with age these be come loose and weather and the trunk becomes smoother with visible cicatrices of these looses. Vertical growth of date palm is ensured by its terminal buds, (Zaid, 2002, Moarri, 1995, Nasor Taha, 1991). Horizontal or lateral growth is ensured by extra fascicular cambium which soon disappears, and which results in a constant and uniform trunk width during the palm's entire life. However, the terminal bud could experience an abnormal growth caused by a nutritional deficiency, which leads to shrinkage of the trunk, this is mainly caused by drought conditions (Zaid, 2002). Sometimes date palm show a branching phenomenon which was found to be attributed to several causes. According to (Zaid, 1987) and (Fisher, 1974) branching in date palm is the result of either dichotomy auxiliary's bud development polyembryonic or attack by disease. Branching date palms are fertile and can produce as much fruit as a single headed palm. It is necessary to study in vitro the regeneration capacity of divided portions of the apical-meristem and maxillary's buds of these specimens in the hope of establishing a rapid mass propagation technique for the date palm.

2.3.3 Leaves

Leaves are formed from buds, slightly ascending and spiral around the growing point, at rate of 10-30 per year, depending on variety, age of palm and environmental conditions, (Zaid, 2002 and Barreveld, 1993). With an average life span of 3-7 years the numbers of leaves per palm varies from

30-140. Initially, the young leaf is enclosed in a leaf sheath of tender tissue, which at a length of 20cm will open to give way to the extruding leaf (Barreveld, 1993).

The sheath tissue will dry out and eventually only the fibrous tissue, known as palm fiber will remain at the base of the leaf. Leaves may reach a length of 6m, with an average of 4m (Dowson, 1982). Under natural conditions, the leaves after their useful life is over, will dry and bend down alongside the trunk where they would stay for quite a while before dropping to the ground. The leaflets (pinnate) of the compound leaf (frond) may range in length from 15cm to about 1m with a width ranging from 1 to 6.5cm.Total number of leaflets on one frond may vary from 120 to 240. Intermediate zone having spine-like leaflets are also called leaflets like spines. At the tip of a leaf there may be a single leaflet or two forming a "V" shape leaf structure which is variety and environment dependent (Zaid, 2002). Furthermore, leaves which are four years old are about 65 % efficient in photosynthesis per unit area, compared to leaves of one year old (Nixon and Wedding, 1956).

Under good cultural conditions a leaf can support the production of 1 to 1.5 kg of date (Zaid, 2002). Depending on their position in palm canopy, leaves could be divided into: Outside leaves which are green and photo synthetically active, and leaves inside at the palm heart, which are juvenile leaves not yet photosynthetic, with a white colour. A ratio of 8 leaves per fruit bunch will indicate how many bunches to leave on the palm.

At the base of each leaf, there is an auxiliary bud which could yield an inflorescence at the palm top level or an offshoot at the base. According to Bouguedaura (1982) there are three distinct developmental growth phases, these are:

1- Juvenile phase which is sterile and leads the palm to produce vegetative bud than inflorescence one, which will abort very soon.

2-Mostly vegetative phase, where vegetative and flowering buds are produced in equal numbers, however, vegetative buds are ones which develop.

3- Adult phase: usually after the palm is more than 10 years old, most of the buds produced are flowering ones.

2.3.4 Inflorescence / Flowers

Date palm is a dioecious species with male and female flowers being produced in clusters on separate palm. These flowering clusters are produced in axils of leaves of the previous year's growth. In rare cases both pistillate and staminate flowers are produced on the same spike while the presences of hermaphrodite flower in the inflorescence has also been reported (Mason, 1925, 1951 and Bashab 1997). Palms are known as polygamous, (Zaid, 2002). The inflorescence, also called flower cluster, in its early stage is enclosed in a hard cover known as spathe which splits open as the flowers mature exposing the entire inflorescence for pollination.

The yellowish flowers are small, attached directly to the spikelets; male flowers are sweet scented and have six stamens. Female flower consists of three carpels, of which normally only one will develop into a fruit. For fruit setting, fertilization of the female flowers by male pollen is required. The spathe protects the delicate flowers from being shriveled up by the intense heat until they are mature and ready to perform their function. The spathe at the beginning is greenish becoming brown when near splitting. The male spathes are shorter and wider than female one and the inflorescence carries large tiny flowers, as many as 8000 to 10000 females and more males. (Chandler, 1958). The annual number of spathe borne by palm varies from none to about 25 females and to even more males, but the average is a dozen for female and more for males (Zaid, 2002).

Only one ovule per flower is fertilized, leading to the development of one carpel which in turn gives a fruit called date, the other ovules abort. The aborted carpels persist as two brown spots in the calyx of ripe fruits.

2.3.5 Date Palm Pollination:

Under cultivation only few males are left to grow. Pollination is undertaken by man. Pollination was practiced by putting 3-4 strands of the male flowers in the middle of the female flower cluster or sections of strands cut to length of 10-15cm and tied in a little bundle with a piece of fiber from the spathe or leaf-let and the bundle is wedged between the strands of the newly-opened female flower cluster without tying (Nixon, 1969, Osman, 1979, Mohamed, 1984 and Bashab, 1997).

The date palm is dioecious, that is the male and female flowers are borne on a separate palm. The unisexual flowers are pistillate (female) and staminate (male) in characters. The flower stalks are produced from the axils of the leaves in similar positions to those in which off- shoots are produced. The inflorescence in its early stages is enclosed in a hard sheath known as spathe which splits open as the flowers mature exposing the entire inflorescence for pollination. The spathe protects the delicate flowers from being shrivelled up with the intense heat until they are ready to perform their function. The spathe at the beginning is greenish in colour, becoming brown just prior to splitting (Malik, 1980). The time of flowering varies from place to place depending on the local climatic conditions and cultivars. Most dates come to flowering and are pollinated from January or February to March and sometimes April (Malik, 1980, Smead and Chaudhry, 1972). The pollens are produced in abundance; the number of male trees required for pollination would depend on the method of pollination. For example, for natural pollination (by insect or wind) about 50% male palm would be required,

whereas by artificial method of pollination 5 males trees to every 100 females would be sufficient (Malik, 1980, Ahmed and Farooqi, 1972). The artificial pollination of date palm is a practice that arose so early in the evolution of date culture that its origin was lost in antiquity.

Though the earliest records of artificial pollination are from ancient Mesopotamia since 300 B.C, the antiquity of the practice in widely separated centers of date culture has led some authorities to believe that it was probably developed spontaneously and independently in several different places (Nixon, 1959, Bashab, 1997).

2.3.5 .1 Method of pollination:

2.3.5 .1.1 Wind pollination

It would be of interest to mention, prior to describing artificial pollination in date palm, that at a few places, dates are still produced without artificial pollination. These are seedlings raised palms and about half of them are males, hence there is a fair set of fruit from the natural method of wind pollination (Nixon, 1959, Anon, 1982). Date flowers also tend to set fruit parthenocarpically if they are not pollinated. The fruit will be seedless and generally of poor quality. It will be smaller and tend to ripen later than embryo contained fruits (pollinated fruits). However, their taste is about the same (Malik, 1980).

According to Milne (1918) and Chauder (1958), an interesting behavior was shown by the 3 carpels of the date flowers. When date flowers were pollinated, all 3 ovules became fertilized and developed and when the fruit reached about the size of bean, 2 of the 3 young fruits abscise and one was left to develop and ripen in each flower. However, when fertilization was not accomplished, all the 3 carpels remained and developed into 3 small fruits of

no value. If only one carpel was fertilized a fruit may develop but the other 2 carpels became small parthenocarpic fruits at its base.

2.3.5.1.2 Artificial pollination

2.3.5.1.2.1 Hand pollination

Dowson (1961) reported a very primitive method of pollination in Libya and Muritania that consisted of placing an entire male inflorescence in the crown of the female tree and leaving it for wind pollination. This method could not be utilized as a reliable technique to obtain uniform good fruit set unless a large amount of pollens were available throughout the flowering season. The most common method of hand pollination is to cut the strands of male flowers from a freshly opened male inflorescence and insert 2 or 3 of them between the strands of the female flower cluster. This is usually carried out during the first 2 or 3 days after the female spathe has opened. Sometimes the male flowers are just wedged among the strands of the female cluster (AL-Bakr, 1972, Malik, 1980, Smead and Chaudhry, 1972, Nixon, 1951, Anon, 1982, Miremadi, 1970, Bashab, 1997). Nixon (1951, 1959) Tate and Hilgeman (1966) described a better practice as to invert the male strands and place them in the centre of the female cluster and leaf-let (in slipiknot) tied around the cluster to hold the male flowers in place and also to prevent the strands of the female bunch from becoming damaged during the rapid growth that follows pollination.

One good male palm can supply sufficient pollen for at least 50 female palms if the pollen can be served and applied by hand (Smead and Chaudhry 1972, Nixon 1959). Brown and Bahgat (1938) reported other methods used in Spain and Egypt respectively. In this technique a stick made of date leaf midrib with a hole at one end to which a loop of 10-12.5 cm diameter made from date leaf-let was attacked.

This was known as "laggaha" in Egypt. An operator climbs the palm by means of a rope girdle and when he gets up to the lower leaves , rather than making an extra effort of climbing, he reaches the centre of the crown with the stick and puts the loop over the top of spathe just beginning or a bout to split and pull it downward. This breaks the spathe and frees some of the strands within. Then a spring of male flowers was placed in a slit in the other end of the stick and inserted in the female flower cluster. In certain occasions the male inflorescence was left to dry and shatter.

In such case, the dried pollens were generally applied by dusting or by placing one or two pollen saturated cotton pieces about the size of walnut between the strands of female cluster (Nixon, 1951, Rashid and Ali, 1972, Smead and chaudhry, 1972, Bashab, 1997).

2.3.5 .1.2.2 Mechanical pollination

Mechanized pollination method is needed to substantially reduce the labour cost required for pollination. For mechanized pollination method to be successful, it must have the following characteristics:

a- It should result in enough fruit set and yield and grower returns at least equal to those of hand pollination.

b- It should be dependable throughout the pollination season and from year to year.

c- It should fulfill the first objectives without exceeding the quantity of pollen that is usually used.

d- It should not require more labour, considering the fact that the bunches still needed to be thinned and tied down by hand.

Mechanical pollination method divided into two main groups: ground level and pollination by aircraft

2.3.5 .1.2.2.1 Ground level method of pollination:

2.3.5 .1.2.2.1.1 Blow pollinator:

Alexander (1952) developed a pollinating tool called blow pollinator which could be used to blow dry pollen into newly opened bloom from the ground rather than using the conventional methods of hand pollination. The blow pollinator is essentially a labour and time saver. It can pollinate two acre garden in about 1 hour. In the mean time two days were required to pollinate the same area using cotton balls (Alexander, 1952, Bashab, 1997).

2.3.5 .1.2.2.1.2 Pesticide duster

Few growers were observed to apply pollen grain with pesticide duster especially when blooming occurred quickly and there was not much time available to carry out normal hand pollination method. Careful application and favorable weather conditions sometime result in good yields (Nixon, 1951, Malik, 1980, Brown and Perkins, 1969, Bashab, 1997).

2.3.5 .1.2.2.1.3 Hand – operated instrument for pollination

Ahmed and Sheikh (1972) devised a small hand operated instrument which had a number of advantages over the traditional methods. Besides being time and pollen saver and perform perfect pollination, this method requires no trees climbing. This device is operated by filling a jar with dried date pollen and its mouth is tightly closed. About bent copper tubing fixed to plastic pipe that plugged to the instrument 0.6 cm diameter mouth is inserted in between the female strands and pollen is blown up with help of an inflator joined with 1.25 cm plastic tube. Care should be taken that judicious pollen is put on flowers. The success of the method depends on the dryness of pollen and air tightness of the mouth of the jar (Ahmed, Sheikh, 1972 and Bashab, 1997).

2.3.5 .1.2.2.1.4 Use of date harvesting tower

The method was conceived and developed by the employers of the Field Department of California Date Growers Association, as referred to by Brown

et al, (1972) and Bashab (1997). A date harvesting tower was used to move a worker around the bloom area as he applied dry pollen to the emerging bloom with a compressed air bloom duster based on the principle described by Alexander, 1952and Bashab (1997). The bloom operated at a static pressure of 30 – 40 psi and used a tube of 0.3 cm inside diameter and about 60 cm long to direct the pollen into the bloom. This method required 2 workers per tower (one operator and one pollinator) and had an expected work rate of about 50 palms/hour (one acre/hour) (Brown and Perkins, 1972, Bashab, 1997).

2.3.5 .1.2.2.1.5 Use of trailer – mounted palm duster

The use of this pollinator was conceived and developed by Brown and Perkins, 1972 and Bashab (1997). Normally a duster operator stood on a fixed platform about 3.6 m feet above ground level and directed a delivery pipe at the palm bloom. The delivery pipe was counter- balanced and mounted in the floor of the platform. The pipe within the operator's reach was 7.5 cm PVC plastic (for electrical safety) and upper portion beyond the reach of operator was 5 cm aluminum irrigation pipe topped by 1.9 cm nozzle was about 90 cm above ground level. A "Root" type blower provided about 125 CFM of air to carry a pollen-flour mixture (1pollen + 6 parts flour) at about 450 mph as it passes the nozzle.

Since dusting materials can not be conveyed through this type of blower, it was necessary to meter the pollen mixture into pressurized air stream from an air tight hopper. This method of pollination required 2 workers per duster (one tractor driver and one pollinator). The fruit set resulting from the use of the bloom duster was equal to or better than that resulting from hand pollination.

2.3.5 .1.2.2.2 Pollination by aircraft:

Aircraft pollination was pioneered by Preston (1964-1966) and Nixon (1966) who used fixed-wing crop duster aircraft. Later, Brown and Perkins (1972) developed metering and distribution equipment for helicopter which applied bands of pollen to date palms. The pollen bands were then dispersed and continued to swirl in the tops of the palm as they were carried in the vortices of the rotor wake.

The effectiveness of different pollination methods on fruits was studied by Brown and Perkins (1972).

They reported that when temperature and weather conditions were favourable for good fruit set, both the helicopter and fixed-wing plane method of application resulted in less fruit set compared to hand pollination methods. However, un thinned bunches pollinated by helicopter repeatedly every second day resulted in an equal or greater yield than hand pollinated and normally thinned bunches. When temperatures were unfavorable for good fruit set, the helicopter method resulted in substantially lower yield than hand pollination. Aircraft method of pollination was normally used to pollinate large acreage if labour for hand pollination was unavailable and weather conditions were favourable (Brownn and Perkins, 1972, Bashab, 1997). Nevertheless, other areas of the world growing date palm may benefit from those techniques if the weather conditions are favourable.

Preston (1964) observed low percentage of pollination when a few spathes opened early and late in the blooming season and high percentage occurred during the highest incidence of new blossoms. It was preferred to use hand pollination early and late in the season and airplane application of pollen in the mid season. This approach was found to substantially reduce the labour needed for pollination. Brown (1960) reported that aerial pollination will probably not eliminate the necessity to thin and tie the strand up to prevent enlargement of the fronds and fruit scarring. This would probably avoid the

peak of labour requirements during pollination and lengthen the period needed for tying up and thinning of bunches.

2.3.5 .1.2.2.3 Pollination time:

The experiments were conducted in the Horticulture nursery and a farmer's orchard at Elgureir for two and three seasons on Mishrig Wad Khateeb (MWK) and Barakawi palms, respectively, with the objective of determining the optimum time for pollination in the two cultivars.

The results showed that the best time for pollination was 4-5 days after spathe opening in Barakawi and 3-5 days after spathe opening in (MWK), which gave fruits with best characteristics of shape, size, weight, bulb/seed ratio and higher yield (Elhasan, 2005).

2.3.5.1.2.2.3.4 Female flowers' receptivity:

It is worth mentioning that the female flowering period is variety and temperature related and does not exceed 30 days (ALBekr, 1972). According to Munier (1973), this period is between 30 to 50 days and could even be longer when the daily average temperature is low. In the northern hemisphere, it is located during February, March and April, while in the southern hemisphere it is from July until early October. The length of the receptivity period of the pistillate flowers could, in general, vary up to 8 or 10 days depending on the variety (Albert, 1930; Pereau- le Roy, 1958). According to Djerbi (1995), the receptivity period for North African cultivars varies from one variety to another (30 days for Bousthami Noire, 7 for Deglet Nour, 8 days for Jihel and Ghars and only 3 days for Mejhool, Boufeggous and Iklane). Beyond these limits, the percentage of parthenocarpic fruits is higher than 40 %. In Iraq, receptivity of "Ashrasi" variety was found to be optimum before the natural opening of the female spathe, while another variety (Barban) until approximately 20 days after the spathe's opening (Dowson, 1982).Al-Heaty (1975) found that the stigmas of

Zahidi variety have a receptivity period for 10 days. Oppenheimer and Reuveni (1965), in work conducted on the varieties Khadrawy, Zahidi and Deglet Nour, found that fruit set declined significantly when pollination was delayed 10 days or more after the spathe cracked. According to Ream and Furr (1969) female flowers of the Deglet Nour variety, do not become receptive for possibly 7 days or more after the spathe cracks. Further delay to 13 days caused moderate reduction in fruit set and delays exceeding 13 days greatly reduced fruit set. Within the pollination period, during which the percent fruit set obtained does not differ statistically, there was a day on which maximal fruit set was obtained: in Khadrawi, on the day of spathe crack; in Zahidi, on the day after and in Deglet Nour, on the seventh day after spathe crack (Reuveni, 1970). Another interesting fact, especially noted with Deglet Nour, is that the day of optimum receptivity varies in different inflorescences of the same date palm. As mentioned earlier, satisfying pollination results are usually obtained within 2 to 4 days after the female spathe has opened followed by a second pollination passage 3 to 4 days later. Furthermore, and as a conclusion, it is well confirmed that the longer pollination is delayed after the opening of the spathe the poorer the fruit, set and if more than a week lapses the yield is usually greatly.

2.3.5.1.2.2.3.5 Metaxenia:

It is well known that the pollen not only affects the size of the fruit and seed (affected more by fruit thinning) but also the time of ripening (Swingle, 1928).

Metaxenia is not to be confused with Xenia, which is the effect of the pollen on the endosperm (embryo and albumen). Metaxenia effect was verified by several investigations in the USA (Nixon and Carpenter, 1978), in Israel (Comelly, 1960), in Pakistan (Ahmad and Ali, 1960) and in Morocco (Pereau-leRoy, 1958). The effect of pollen on the time of fruit ripening was

proven to be beneficial and is actually considered as the most important practical application of metaxenia. Producing and selling date fruits at high prices early in the season, along with the aim of having more uniform and short ripening period (avoiding a prolonged harvest) are the two main objectives of using selected pollen of high metaxenia effect.

A third useful application of metaxenia is where the development period of the plant is characterized by an insufficient sum total of heat for the fruit ripening of late varieties. It is worth mentioning that metaxenia effect could also be successfully used to speed up the fruit maturity and consequently escape the rain damage that is usually expected at the end of the fruit development period (Algeria, Tunisia, USA, etc.); The use of the Fard 4 male has advanced the maturation stages of various varieties all around the world by two weeks. However, under a summer-rain season, (India, Pakistan, Namibia, Republic of South Africa, for example) late ripening could be more desirable and the selection of males with late ripening effect is recommended.

2.3.6 The date palm fruit:

Upon successful pollination depending on the variety, environmental conditions and the technical care given, the fruit will start to develop through different distinguishable stages until it reaches maturity. Date palm fruit involves several external and internal changes. These changes are often classified on the basis of change in color and chemical composition of the fruit, as five distinct stages of fruit development known in Arabic terms and have been internationally used as such (Zaid, 2002), these stages are :

2.3.6.1 Hababouck stage:

This is the stage soon after fertilization and continues until the beginning of Kimri stage. It usually takes 4-5 weeks to complete and is characterized by loss of the two unfertilized carpels and a very slow growth rate. Another characteristic of the fruit at this stage is that the fruit is immature and is completely covered by the calyx and only the sharp end of the ovary is visible. Its average weight is one gram. (Al-Bakr, 1982, Awad, 2004, Khalifa, 1994).

2.3.6.2 Kimri stage

This is a green stage and also called Khimri or Jimri. At this stage the fruit is hard, and the color is apple green and it is not suitable for eating. This stage lasts from small green berry to almost full sized green date. It is the longest stage of growth and development of date and lasts a total of 9-14 weeks, depending on varieties. (Al-Bakr, 1982, Awad, 2004, Khalifa, 1994).

2.3.6.3 Khalal stage

This is the colored stage. The fruit is physiologically mature, and color changes completely from green to greenish yellow, yellow pink, or red depending on the variety.

It lasts for 3-5 weeks depending on varieties with a relatively low average weekly increase in weight of (3 to 4%). The date fruit reaches its maximum weight and size. Some varieties are consumed at this stage, as they are very sweet, juicy and fibrous. However khalal date fruit must be eaten immediately after harvesting as they will keep for only a few days without cold storage. (Al-Bakr, 1982, Awad, 2004, Khalifa, 1994).

2.3.6.4 Rutab stage

Rutab meaning wet and soft ripe stage. At this stage the tip at the apex starts ripening, changing in color to brown or black and becomes soft, and starts acquiring a darker and less attractive color from the previous stage.

However, some varieties turn green at this stage. There is a continuous decrease in fresh fruit weight, mainly due to loss of moisture. The average weekly decrease in fresh fruit weight is 10% during the last week of the rutab stage (Zaid, 2002). The fruit at this stage is very sweet. However, it is important to be consumed or it will be of no commercial value. (Al-Bakr, 1982, Awad, 2004, Khalifa, 1994).

2.3.6.5 Tamar stage

At this stage when the date are fully ripe, also called full ripe stage or the final stage in the ripening.

They completely change the color from yellow to dull brown or almost black. The texture of the flesh is soft; the skin in most varieties adheres to the flesh, and wrinkles, as the flesh shrinks. The color of skin and underlying flesh darken with time. (Al-Bakr, 1982, Awad, 2004, Khalifa, 1994).

2.4 Uses of Date Palm

The food and medicinal values of date palms are repeatedly mentioned in the Holy Quran. Our prophet Mohammed (peace be upon him) has said that the best property of date palm is that it cures many diseases and causes no harm; therefore he urged Muslims to eat the date fruit and encouraged tree cultivation. Date fruits are considered as a complete diet for heir high nutritive value. It is presumably the most nutritive and energy producing food. It is a chief source of food to those living in desert and arid regions. The high nutritional value of date fruit is due to its very high content of carbohydrates (about 65-75%) which is a major source of energy. The date fruit carbohydrates are easily digestible and quickly absorbed into the blood stream and body cells to provide energy and heat. The fruits are also good source of proteins, fats, minerals and vitamins (Hussein, 1972, Ahmed and Farooqi ,1972, Al-Bakr, 1972, Khan *et al* 1980).

The merit of date palm is not just for its fruit but also provides raw materials for local cottage industries and industrial date products. It is used for syrup, jam, industrial alcohol, vinegar, animal feed, organic acid, pharmaceuticals and date by products. The tree is used for various construction requirements such as the use of trunk for beams and water channels, and leaflets are used in preparation of fans, matting, brooms and baskets. The whole leaves are used for rope making. The main axis is used for chairs, cages, and fences. Dried fruit stalks are used as brooms and fiber materials are used in ropes (Anon, 1982, Jagirdar, 1980, Hussein *et at* ,1972, Ahmed and Farooqi, 1972, Nixon, 1960).

2.5 Date Palm Composition:

(Rashid and Niaz ,1972, Osman ,1980, Malik and Ahmed ,1972) forwarded the following classification of date fruits according to the fruit characteristics:

a- Soft date: The moisture content of the fruit exceeds 30%. The fruits generally pass through rutab stage and remain soft to tamar stage. The sugars are mostly reducing types with no or little sucrose.

b- Semi-dry dates: The moistures of the fruits content in the range of 20-30%. The fruits pass through rutab stage but make a dryish to tamar. Sugars are of reducing type and low sucrose.

c- Dry dates: This group of fruits is characterized by a moisture content of less than 20%. The fruits do not pass through rutab stage. The sugars are mostly of sucrose type.

It is worth to mention that the texture or firmness of the fruit is related to the proportion of inverted and cane sugars content of the fruits. (Cook and Furr , 1979, and Hussein ,1972 and Fattah ,1927) reported that the date dried fruits composed mostly of carbohydrates (sugars) with small amount of other constituents such as protein, fats, vitamins and minerals, all in an easy

assimilable form. The general chemical composition of date fruits is shown in Table 3. However, (Nixon, 1951) found that a flesh fruit that contained about 20% moisture had 60-65% sugars.

It has been reported by several investigators, (Osman and Boulous, 1977, Rygy, 1977, Yousif, *et al*, 1982 and Sawaya, *et al*, 1983) that the soft dates contain higher quantities of reducing sugars and low quantities of sucrose than semi-dry and dry types. The composition of Sudanese varieties of dates is shown in (Table 4), (Khalifa and Osman, 1988).

Table (3) Chemical composition of date fruit.

Type of dates	Moisture content (Fresh-weight basis) %	Total sugar (Dry-weight basis)%	Reducing sugar (Dry-weight basis)%	Sucrose (Dry-weight basis)%
Soft date	13.6 – 37.3	74.5 – 84.8	74.5 – 84.8	0 – 3.4
Semi-dry date	13.6 – 24.1	75.7 – 78.2	38.6 – 70.7	5.3 – 38.5
dry date	15.5	78.0	40.9	32.1

Cook and Furr, (1952).

Table (4) Chemical composition of Sudanese date fruit varieties.

Type of dates	Reducing sugars (on dry-weight basis)%	Sucrose (on dry-weight basis) %
Soft date	62.102 – 83.75	1.25 – 7.92
Dry date	36.67 – 56.67	15.21 – 58.18

Khalifa and Osman, (1988).

2.6 Climatic Requirements:

(Nixon, 1951, Jagirdar, 1980, Ahmed and Abdur Rahim, 1972) stated that the long hot summer, moderate winter, with no severe frosts, absence of rain and cloudy weather during pollination and fruit setting and at the time of fruit ripening (during late summer and early autumn) are responsible for rapid development of date industry in most of the date growing tracts. Since rain

occurring any time from early summer through the harvest season, it is likely to cause more or less damage to the fruit. Alight shower accompanied by prolonged periods of cloudy weather and high humidity may cause more damage than a heavy rain followed by clear weather and drying winds, (Nixon, 1951). The date can tolerate long periods of drought, for heavy bearing, it has a high water requirement. This is best supplied by periodic flooding from the rivers in North Africa and by subsurface water rather than by rain (Parapandi, 2000).

2.7. Soil Requirement:

Date palms are grown on a wide variety of soils, maximum water holding capacity consistent with good drainage is desirable (Nixon, 1951). The date palm trees are capable to grow in soil containing more alkalinity or salts than many other plants, however saline soils are unfavorable for palm growth.

Although the trees can grow in varying types of soils, but generally sandy loams are the best (Ahmad and Farooqi, 1972, Jagirdar, 1980, Nixion, 1951).

2.8. Propagation:

Date palm may be grown from seeds or off-shoots. (Nixon ,1951) stated that when grown from seeds approximately half of the palms will be males and half will be females. No two seedling palms are like and relatively few of them are likely to produce fruit of good quality. A date palm variety whether male or female can be alternatively propagated by off-shoot which is now a universal practice. The off-shoot is known to form from auxiliary buds on the trunk chiefly during the early life of the palm. The size of off-shoot when ready for cutting varies with variety and commonly ranges from 40 to 100 pounds (18 to 45 Kg) in weight, from 20 to 35cm in maximum diameter. Special care and skill, which can be acquired only by experience, are required. Polythene bag or tin filled with moist wood soil has been used

successfully for rooting of off-shoots at higher elevation (Osman, 1979, Raz, 1959). A recent advance in date palm propagation is the in vitro technique of micro propagation which is assumed to produce large number of true to type trees (Schroedar, Reuveni and Kippnis, 1970, Mohammed, 1982, Bashab, 1997).

2.9. Harvesting:

Harvesting means physically detaching the fruit from the palm. There are differences in the state of maturity of the fruit; there are visible signs, such as the fruit color and the degree of ripeness and invisible signs such as the percentage of water and sugar and the activity of various enzymes, (FAO, 1998). Dates are harvested at three stages of their development depending on varietal characteristics, climatic conditions and market demand. These stages are Khalal stage is physiologically mature, moisture content (50 – 85%), bright yellow or red in color and perishable, Rutab is partially brown, reduced moisture content (30 – 45%) and perishable, Tamar stage colored from amber to dark brown, moisture content reduced below 25% to 10% and texture from soft pliable to firm to hard, (FAO, 2002).

When the fruits reached the harvesting stage, they are collected by shaking the trunk of palm, (Chuk and Cooke, 1972). Harvesting by mechanical appliance represents 45% of the total production of dates, which emphasize the need for mechanization of harvest, (FAO, 2002).

2.10. Packing house operation and marketing:

The post harvest field operation and marketing channels of date fruits.

2.11. Irrigation:

The date palm is a drought resistant plant, capable of surviving for long period without irrigation. A number of workers emphasized the importance of irrigation for a good palm growth and high yields of good quality fruits.

As in other crops, the frequencies of irrigation of date palm trees depend on soil type and weather conditions. A recommended practice of irrigation of bearing palm trees is 7 – 14 days in summer and every 20 – 30 days in winter. However, reduction in water amounts during harvesting period is advisable, (Nixon, 1951, Jagirdar, 1980, Arar, 1980, Al-Bakr, 1972).

After planting small offshoots of date palm, the volume of soil from which they can absorb water is very small. Sufficient water must be applied, to these planted offshoots for optimum growth. It is thus necessary to ensure that enough water reaches the area where the roots are to be formed and to grow thereafter. Irrigation must preferably be done by basin, micro or drip irrigation, due to the shallow root depth at this stage. Date palm tree is usually irrigated by basin method, delivering an abundant amount of water based primarily on a farmer's experience.

The annual water requirements for a mature date palm range between 115 and 306 cubic meters (1.15 - 3.06 m/ha) (AI-Baker, 1972). The estimate of palm tree water use could also be made from data of other areas of similar climate, such as AI-Hassa (eastern region of Saudi Arabia), (Hussein, 1986, Hila! *et aI.*, 1986), Southern California (Furr, 1975), Egypt (Hussein and Hussein, 1982), and Iran, (Furr, 1975).

Studies on irrigation frequencies have shown that, for palm trees, low frequency and large volume of water per irrigation were more favorable (Hilal *et aI.*, 1986). As a result of a study on 'Sakkoti' date palm cultivar at Aswan, it was suggested that an irrigation interval of four weeks applying 71 mm per irrigation is the most suitable (Hussein and Hussein, 1982, Reuveni , 1971- 1974) studied the effect of trickle as compared to sprinkler irrigation on growth and yield of date palms. He concluded that trickle irrigation has definite advantages over sprinkler irrigation as the trickle irrigated tree could be grown with limited wetted volume of soil. Experiments have shown

significant increase in leaf, flower and fruit production in trickle irrigated palm as compared to sprinkler. The yield of drip irrigated palm trees was significantly higher than those irrigated by sprinklers.

A comparison between trickle and bubbler irrigation systems has shown that salt accumulation may be higher in the surface layer for trickle as compared to bubbler, (Nimah, 1985). Most of date palms farmers in the Arab countries, where there are about 75% of the total Date palm of the world do not care much about irrigation. They believe that Date palm trees can grow and bear fruits under drought and do not require much irrigation. But on the contrary all the experiments and studies show that Date farming and development depend on irrigating the trees with enough water to fulfill their water requirement (Ibrahim, 2009).

In spite of that, Date palm trees can tolerate drought more than most of fruit trees. The date palm like any other fruit tree requires enough water to compensate the losses due to the soil surface evaporation and the transpiration from the leaves, as well as the amount that is needed during its growth stage and fruiting (Gasium and Hameed 2003 and Hussein *et al.*, 1983). It is a fact that date palm grow under desert climatic conditions and are drought resistant and salt tolerant as compared to other crops. However, it is equally important to irrigate the tree with sufficient amount of water of good quality in order to produce acceptable yield and better fruit quality, (Ibrahim, 2009 and Al Amoud *et al*., 1999).

Date palm growth and yield are affected by both the magnitude of water deficit and the stage of growth subject to deficit. Insufficient water supply caused by prolongs irrigation intervals, and or decreasing the available moisture in the soil, clearly inhibit plant growth, (Scatter and Habib ,2007, Nimir, 1986) studied the effect of three irrigation intervals (10, 15 and 20 days) in combination with three irrigation water amounts (60, 75 and 90 mm

per irrigation). He reported that plant height increased with both frequent and heavier irrigation. (Makki and Mohamed, 2005) cited that plant heights under 10 days interval were higher than those under 15 days interval.

2.12 Fertilization

Fertilization has generally been found necessary to maintain the quantity and quality of production. Animal manures were widely used in the better date palm gardens of the old world (Nixon, 1951). The type of fertilizer seems to increase the vigour and rate of growth of young plants and the fruit bearing capacity of the adult trees (Nixon, 1951, Hayet, 1980, Al-Bakr, 1972 and Abbas, 2003).

Manuring is usually carried out in winter unless a winter cover crop is grown, in which case it is usually applied in the spring after the cover crop has been turned under (Hayet, 1980, Ahmed and Farooqi, 1972). The recommended rate of manure application was suggested as 5 – 10 tons per acre or 55 – 75 kg/tree.

Inorganic nitrogen in various forms is also often used in date palm gardens. The amount applied should be determined on the basis of weather conditions. It is used alone or in combination with manure or cover crops (Nixon, 1951, Hayet, 1980). The total application of 0.5 – 1kg of actual nitrogen per palm tree from any sources is adequate amount on most soils. It is desirable to divide the nitrogen into 2-3 applications during the growing season (Hayet, 1980). Fertilization is necessary as a nutrient supplementation of natural supply of the nutrients and replacement of nutrients removed by plants. Therefore efficient and balanced use of fertilizers and manures, which are essential for obtaining maximum potential yield and success flowering based on modern technology, should be developed. Two years trials on the effect of nitrogen at 60, 120, or 180 kg/ha and P2O2 at 60, 120, or 180 kg/ha in all possible combination revealed that the best results in terms of flower yield

and quality of china aster were obtained with highest rates of both elements (Reddy, 1978). In Egypt, the total amount of garbage collected from cities and villages reaches nearly 15

million tons per year and the proportion of domestic refuse is estimated to be about 68% (Hassanein and Kandil, 2007). This could be a source of organic fertilization, after suitable composting in fruit orchards. Moreover, few studies have evaluated the effects of organic and mineral fertilizers on the quality characteristics of date fruits as well as the yield (Shahein *et al*., 2003, Al-Kharusi *et al*., 2009).

2.13. Date Culture in Sudan:

Date growing areas in Sudan are almost confined to the northern region which extends from latitude 22^0 N to the north to latitude 15.5^0 N to the south. South of Khartoum, the rainy season becomes the major limiting factor for the production of date palm. A small number of date palms are also grown in Khartoum State, Northern Darfur and Red sea States, (Nixon, 1969, Osman, 1979, Mohamed, 1984, Mohamed, *et al*., 2006 and Dawod, 1997). The population of date palm trees in Sudan was estimated to be 5 million in 1982 and about 8 million in 2006.

About 75% of date palms produced are dry date mainly because of the climatic conditions. The average production per palm is 18-25 kg which is very low, compared to trees grown under good management condition which could produce up to 100kg (Osman, 1977, Mohamed, 1985 and Mohamed, *et al*., 2006). However, the dry climate with negligible rainfall and hot summers and the availability of irrigation water from the Nile and the underground water offers a good potentially for production of the date palm in Sudan. The varieties of date palm grown in Sudan were uncountable. However, about 10 varieties are widely grown within which dry date

cultivars constitute the major part of the good keeping quality that renders them handled and marketed with less damage (Nixon, 1969, Osman, 1979, Mohamed, 1984 and Bashsb, 1997).

The most popular dry date cultivars include Barakawi, Gondeila, Bentamoda, Kulma, Gorgoda, Asada, Abed El Rahim, Deglet Noor and Kursha. Soft date cultivars on the other hand, include Mishrig Wad Khatib, Mishrig Wad Lagai and Madeena. Recently new varieties are introduced, these include Barhee, Khalas, Majhool , etc. Some of the commercial cultivars have been described by (Nixon, 1969) as follows:

-"Barakawi" is the most popular dry cultivar and constitutes about 40% of the total population of date in the Sudan, (Nixon, 1969, Osman, 1979, Mohamed, 1984), and 70% in the Northern State (Mohamed, *et al*., 2006). It has a good keeping quality but lacks uniformity in size, shape, colour and other characteristics. The palm trees produce 10-15 off-shoots which are difficult to root.

- Gondeila: constitutes about 5% of the total production. It is preferred over Barakawi and sold at high prices in the market. It produces 3-7 off-shoots which are hard to root.

- Bentamoda: constitutes about 2% of the production, the palm tree produce 6-8 off-shoots which is hard to root. It is the best dates in Sudan.

2.13.1: Cultural Practices in Sudan

2.13.1.1 Propagation:

Off-shoot propagation is used. Proper practice for off-shoot rooting is what is known as "Tasfeeh" (tins filled with moist soil as rooting medium). Although there were no proper research carried out on when to severe off-shoot, August and February were the months during which off- shoot removal was practiced by the famer (August as first choice, February as second choice), (Nixon, 1969, Osman, 1979, Mohamed, 1984). Nevertheless, (Nixon, 1969,

and Bashab, 1997) stated that exact time is less important than the availability of water and proper care. There are three recommendations in propagation from Agricultural Research Corporation (ARC).

1- Time of separation for Mishrig Wad Laggai and Mishrig Wad Khateib.

2- Buried method for small and short.

3- Treatment of root system of the off shoots, (Dawoud, 1997).

2.13.1.2 Spacing:

The recommended spacing is 8x8 m but the farmers prefer closer spacing and leaving several off-shoots on the palm forming a clump of several stems, though it was known that dense population lower productivity, (Nixon, 1969, Osman, 1979, Mohamed, 1984).

2.13.1.3 Irrigation:

Two recommendations:

1- Water interval

2- Comparison between different irrigation methods, (Dawoud, 1995).

The newly planted off-shoots require small amount of water at frequent intervals, soil type determines the desirable interval, (Osman, 1979).

But in the area of production, water was inadequate for irrigation. In this instance, the well established dates were seldom irrigated for themselves, but they benefited from water given to other crops grown in between (Nixon, 1969).

2.13.1.4 Fertilization:

In most instances the growers do not carry any fertilization programmers'. Manure was some times applied, (Nixon, 1969, Osman, 1979, 1982, Bashab, 1997). But after the experiments which were carried out in Dongola,

Merrowi, New Halfa and Khartoum some of growers can do that (Dawoud 1995).

2.13.1.5 Pruning:

Generally, pruning was not practiced in Sudan. The only pruning method practiced was the removal of dead leaves. Leaves stalk bases were often left on the palm trunk. The tree climber uses these stalks for climbing palm without a girdle (Nixon, 1969 and Dawoud, 2003).

2.13.1.6 Pollination:

Under cultivation only few males are left to grow. Pollination is undertaken by man. Pollination was practiced by putting 3-4 strands of the male flowers in the middle of the female flower cluster or sections of strands cut to length of 10-15cm and tied in a little bundle with a piece of fiber from the spathe or leaf-let and the bundle is wedged between the strands of the newly-opened female flower cluster without tying (Nixon, 1969, Osman, 1979, Mohamed, 1984). Also there was recommendation from Agricultural Research Corporation (ARC) (Dawoud, 2003).

2.13.1.7 Thinning:

In Sudan date palms were seldom thinned. Furthermore, no complaint of alternate bearing was recorded. But some farmers used to thin some varieties for personal consumption by delaying pollination for Wad Laggai and Wad Khateib (Nixon, 1969, Osman, 1979, Bashab, 1997, Dawoud, 1995, and Bashab, 1997).

2.13.1.8 Bunch management:

A little or no attention was given to the bunch after pollination (Nixon, 1969).

2.13.1.9 Fruit handling:

Improper harvesting methods resulted in poor state of date. Harvesting was traditionally done by cutting the bunches and dropping them on the ground, then the fruits were bagged in 100 kg jute sacks. The process in addition to being tedious and endangering the harvester, it resulted in soft fruit damage and hence lowering the grade of the crops (Nixon, 1969, Osman, 1977 and Mohamed, 1990). After harvesting dry dates were spread under the sun to dry. In some occasions, dates were left on the tree to dry.

Therefore, the dates fruits were packed in sacks and sent to the market, with very little girding being practiced (Nixon, 1969, Osman, 1979, and Mohamed, 1990). In the Northern State negligible amount of the production was packed or processed at Karima date factory. Some of the growers preserved date in earthen jars, tins and polythene bags (Osman, 1982, Bashab, 1997).

2.13.2. Problems of Date Production in Sudan:

The total production of dates was increasing due to the increase in population, whereas, the average yield per palm was decreasing annually over the last fewyears due to several reasons that include:

a- A limited number of high yielding and good fruit quality varieties being propagated.

b- Dense population that lowered the productivity compared to a single stem rising on recommended spacing.

c- Inefficient cultural practices in terms of inadequate amount of irrigation water, poor fertilization, poor weeding and cultivation.

d- The difficulty of pollination and harvesting methods due to height of producing trees that hampered the processes to be carried out efficiently.

e- Lack of male pollinator selection.

f- Poor postharvest operations e.g. harvesting, collection of dates, packing processing and marketing.

g- Losses of tree population due to Nile Floods of 1946, 1975, 1988, 1994. 1998.

But in the last years the farmers understood the importance of cultural practices of date palm trees through the cooperation between them and the scientists, (Nixon, 1967, Bashab, 1997).

CHAPTER THREE

MATERIALS AND METHODS

The Experimental Site and the Climate 3.1

The experiments were carried out in a farm belonging to a farmer named Mr. Zibair Mohammed Seed Ahmed at Elselaim area in Dongola area, Northern State. The objective of this study is to increase yield and quality of Barakawi cultivar. The study covered sixty three (63) date-palms of "Barakawi" cultivar, 7-8 years of age, grown on sandy soil. The experimental palms were healthy, as they were uniform in growth and vigour. They were randomly selected and divided into three groups (Replicates). The study was conducted in a randomized complete block design (RCBD) during the years (2009/2010) and (2010/2011). The region is generally characterized by long hot and dry summer with low relative humidity which makes the location ideal for date palm production. The diurnal range of temperature is wide all the year, the mean maximum and minimum temperatures are 36.8^{O}C and 19.5^{O}C, respectively. Temperature as high as 49^{O}C is not uncommon in the period extending from April to June. In winter, temperature as low as 1.0^{O}C had been recorded. The climate is hyper arid with a vapor pressure of only 10.8 mb and a relative humidity of less than 20% with a mean bright sun

shine duration of 10.5 hours (at 87% of the possible hours). Clouds are generally rare, solar radiation is as high as 25.88 MJM in May. Rainfall is scarce with a mean annual of 12.3 mm. Wind prevails from the North at a mean speed of 15.7 km/hr (Osman, 2004) (Appendix 8). In general, in Dongola area the soil is divided into two main groups, namely soils of the recent flood plain and soils of the high terrace (Karouri, 1978). Meteorological data collected for the experimental area for 2010 and 2011 were compiled in (Appendix 9).

3.2 Plant Material and Husbandry Practices:

"Barakawi" date palm cultivar of about 7-8 years old was selected from within a collection grown in a farm belonging to Mr. Zibair Mohammed Seed Ahmed at El-Selaim area. The selected trees were of uniform growth pattern and size and received the same treatments. The orchard was prepared adequately with improved physical conditions. The implements used included traditional tools to break and loosen the soil and a leveler to level the experiment orchard for the easy movement and uniform distribution of irrigation water and fertilization, then basins "hods" for all trees, 2m distance surrounding the trunk (width of the basin is 35cm and depth 40cm), were prepared for each palm. The trees were planted at 7x7 meters planting distance. Fertilization programs were adopted in split doses one after harvest and the other one after fruit set. Farmyard manure (FYM) fermented about 45 days was also used, and N_{15} P_{15} K_{15}% (0.25kg and 0.50kg) from the substance balanced 1.66kg and 3.33kg respectively.

3.3. Experimental Design and Layout

Two factors were investigated in this study, namely seven levels compound fertilizer (NPK 15% fertilizers mixed with farm yard manure (FYM) and three levels irrigation intervals (10, 20 and 30 days), both treatments of

irrigation and fertilization were applied to the same trees. The compound treatments are shown below.

Table (5): Irrigation and fertilization program

Irrigation (days)	Fertilizers Manure(kg) +NPK(kg)	Irrigation (days)	Fertilizers Manure(kg) +NPK(kg)	Irrigation (days)	Fertilizers Manure (kg) +NPK(kg)
10	0	20	0	30	0
	30+0.25		30+0.25		30+0.25
	60+0.25		60+0.25		60+0.25
	120+0.25		120+0.25		120+0.25
	30+0.50		30+0.50		30+0.50
	60+0.50		60+0.50		60+0.50
	120+0.50		120+0.50		120+0.50

The experimental design used was randomized complete block design (RCBD) with three replications.

3.4 Physical and Chemical Characteristics of Experimental Area:

3.4.1 Soil Sampling:

Three composition soil samples were taken from Mr. Zibair farm at 0 – 30 cm, 30 – 60 cm and 60 – 90 cm depths. The soil samples were analyzed at the laboratory of Faculty of Agriculture (Shambat), University of Khartoum (table 7).

3.4.2 Analytical Procedures:

3.4.2.1 Mechanical analysis:

Day's (1956) hydrometer method was used. Sodium hexameter phosphate together with adequate amount of sodium carbonate was used to keep pH at 8.3.

3.4.2.2 Soil reaction:

This was determined in the soil paste using pH meter (model Knick digital pH meter) with glass electrode.

3.4.2.3 Electrical conductivity of the saturation extracts (ECe):

The soil paste was extracted and the electrical conductivity of the soil extract was measured using a Whetstone Bridge method. The values were corrected for temperature at 25° C.

3.4.2.4 Organic carbon:

A method adopted by (F.A.O, 1970) was used to determine the organic carbon percentage in the soil.

3.4.2.5 Organic nitrogen:

It was determined using a macro-Kjeldahl, where the released ammonia was trapped in 2% boric acid and then titrated against 0.1 NHCL.

3.4.2.6 Phosphorous:

Chapman's and Pratt (1961) method for Phosphorous determination using vanadate-molybdate reagent was adopted. The color developed was red in an absorptiometer. The data of the physical and chemical characteristics for the experimental area is shown in table (7).

3.5. Vegetative Growth Characteristics

3.5.1. Stem Height (cm)

The stem (trunk) height was measured from the point of the old leaf to the point of the old root using a tape meter.

3.5.2. Stem Circumference (cm)

Stem circumference of the plants was measured at a point under the first lowest leaf using a measuring tape.

3.5.3. Number of Leaves

Leaves are grouped in 13 nearly vertical columns, spiraling slightly to the left on some palms and to the right on others. Then the number of leaves in one of these columns was counted and multiplied by 13, according to (Nixon

and Carpenter, 1978). Total number of leaves (the old and the new) was recorded.

3.6. Physical Characteristics of the Fruits:

Twenty fruits were randomly selected form each palm to measure the whole fruit weight and the weight of the pulp and seeds, using a sensitive balance (Mettler-Top pan, Model p-1200). A Vernier was used to determine length, width and diameter of fruits and length and width of seeds. Seeds percentage was determined based on weight of whole fruit (pulp/seed ratio %). Also the fruit thickness was determine using Vernier.

3.7. Chemical Characteristics of the Fruits

The flesh of twenty fruits per palm were chopped into small pieces with a clean knife, dried in a forced draft oven at 70° C to a constant weight and ground into a fine powder for chemical analysis. Total soluble solids (TSS) of various treatments were determined by hand refractometer. Total and reducing sugars were determined as percentage of fresh weight according to (A.O.A.C. 1995). Non-reducing sugars were calculated by the difference between total sugars and reducing sugars. Fruit moisture contents was determined, fruits washed with tap water, rinsed twice in distilled water and were cut into small pieces with a clean knife, then an amount of the fresh sample was weighed (fresh weight) and dried to a constant weight (g) in air drying oven at 70° C, then weighed (dry weight).

Fruit moisture was calculated as follows:

Fruit moisture content (%) = (fresh weight − dry weight) / fresh weight × 100.

3.8 Statistical Analysis

The data collected from the different treatments were subjected to analysis of variance (ANOVA) appropriate for randomized complete block design (Gomez and Gomez, 1984). Duncan's Multiple Range Test (DMRT) was applied for the separation of treatment means. All statistical analyses were performed using IRISTAT-4 program computer package.

Plate (1): N $_{15\%}$ P $_{15\%}$ K $_{15\%}$ fertilizer

Table (6): Lay out of the experiment:

R3		R2		R1
AF1		BF6		AF0
CF4		CF0		CF6
AF2		AF1		CF4
CF3		CF2		BF6
BF6		BF4		AF3
AF3		AF3		AF6
CF1		BF2		CF2
BF5		CF4		BF0
AF4		BF0		BF3
BF3		AF5		AF2
AF6		CF6		AF5
CF2		AF0		CF1
BF4		BF1		AF4
CF0		CF1		BF5
BF1		AF2		BF2
BF0		CF3		CF3
AF0		BF3		BF1
CF6		AF4		CF5
BF2		BF5		BF4
AF5		CF5		AF1
CF5		AF6		CF0

Plate (2): Method of adding fertilizers.

Plate (3): Method of adding irrigation.

Table No. (7) Some chemical properties of the experimental soil after treatment (2010/11) season.

Depths	Parameters								
	PH (paste)	ECe (ds/m)	Na (meq/L)	Ca+Mg (meq/L)	SAR (meq/L)	O.C%	N%	Pppm	K ppm
30cm	7.41	1.25	1.03	11.49	0.81	0.64	0.03	4.15	282.2
60cm	7.35	1.41	1.11	12.95	0.57	0.47	0.03	2.78	187.4
90cm	7.4	0.82	1.32	8.05	0.79	0.59	0.03	2.65	189.3
Mean	7.39	1.16	1.15	10.83	0.72	0.57	0.03	3.19	219.6

Soil samples were taken at 0-30 Cm, 30-60 Cm, and 60-90 Cm from soil surface of Barakawi orchard for chemical analysis at the end of experiments.

Table (8): Analysis of farmyard manure (on dry weight basis)

Fe	Zn	Mn	Cu	N	P	K	Ca	Mg	Na	Moisture
Ppm				%						%
53	70	72	14	1.98	0.76	1.09	1.76	0.86	0.31	16.72

Plate (4): Fermentation of farmyard manure.

CHAPTER FOUR

RESULTS

4.1. Effect of Treatments on Yield Components of Date Palm Trees:

4.1.1. Fruits Weight (kg):

The results indicated that there were high significant differences (P=0.01) due to irrigation intervals on fruit weight in both seasons (Tables 9 and 10).The comparison between the irrigation intervals in both seasons showed that the interval of 10 days gave significantly greater fruit weight over the control (32.2% and 27.1%) respectively in both seasons (figure 1). On the other hand, there was low significant difference between irrigation intervals 20 and 30 days in the first season, (Figure 1). This is may refer to the effects of the environmental conditions. But there were significant differences between them in the second season. There were high significant differences (P=0.01) between fertilizers doses in both seasons as shown in (Tables 9 and 10) on fruit weight. The comparison between the fertilizers doses in the first season showed that the application of (30kg organic + 0.25kg NPK 15%), (60kg organic + 0.25kg NPK 15%), (120 organic + 0.25 NPK 15%), and (30kg organic + 0.50 NPK 15%) were significantly greater than the other doses and the control. In the second season no significant difference between (30kg organic + 0.25kg NPK 15%) and (60kg organic + 0.25kg NPK 15%), also no significant difference between (120 organic + 0.25 NPK 15%), and (30kg organic + 0.50 NPK 15%). All treatments were better than the control. This may be due to the effects of the fertilizers doses.

The dose (30kg organic + 0.25kg NPK 15%) increased fruit weight over control by 48.2% and 38.4% respectively in both seasons (tables 11).

The interaction (irrigation intervals x fertilizers doses) was significant (P=0.05) in both seasons (Tables 9 and 10). In both seasons the greatest effects of irrigation and fertilizers obtained from the dose (10 day irrigation + 30kg organic + 0.50kg NPK 15%) which increased the weight by 52% and 41.6% over control respectively (table 12). In the first season no significant difference between these doses (10 day irrigation + 30kg organic + 0.50kg NPK 15%),(10 day irrigation + 60kg organic + 0.25kg NPK 15%), (10 day irrigation + 120kg organic + 0.25kg NPK 15%) and (20 day irrigation + 30kg organic + 0.25kg NPK 15%) on fruit weight, but in the second season there were highly significant difference in fruit weight between the dose(10 day irrigation + 30kg organic + 0.50kg NPK 15%) and the other doses, this may refer to the residual effect of the fertilizers from the first season.

Table (9): Effect of treatments and their interactions on yield components in season (2009/2010).

Parameters	Irrigation	Fertilization	Irrigation X Fertilization
fruit weight (g)	16.04**	9.06**	1.39*
pulp weight or flesh (g)	17.74**	6.16**	1.9 2**
pulp/ seed ratio%	793.74**	314.30*	376.16 N.S
yield/palm (kg)	4634.72**	1658**	963.10**

** = significant at 1% level (highly significant)

* = significant at 5% level (significant)

N.S = not significant.

Table (10): Effect of treatments and their interactions on yield components in season (2010/2011)

Parameters	Irrigation	Fertilization	Irrigation X Fertilization
Fruit weight (g)	28.82**	16.17**	3.25*

Pulp weight or flesh(g)	23.90**	13.04**	3.53**
Pulp/ seed ratio%	42.03 *	960.78 **	33.95 N.S
Yield/palm (kg)	25675.3**	7295.75**	1671.46**

** = significant at 1% level (highly significant)

* = significant at 5% level (significant)

N.S = not significant.

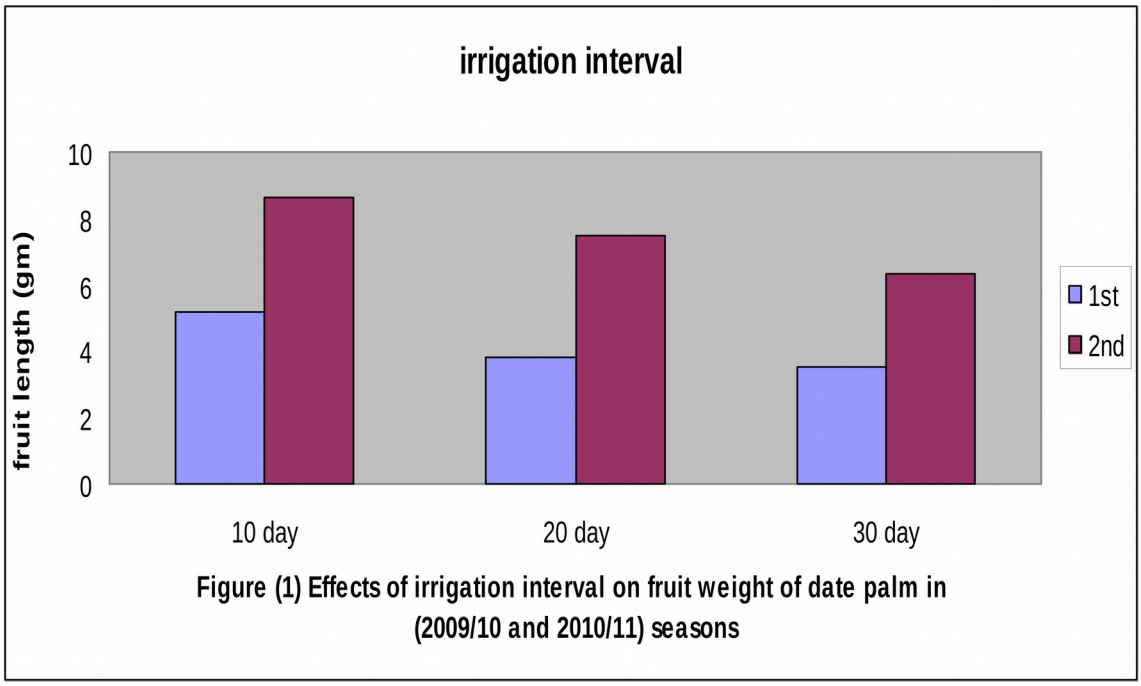

Figure (1) Effects of irrigation interval on fruit weight of date palm in (2009/10 and 2010/11) seasons

Table (11) Effect of fertilization doses on fruit weight of date palm .trees in both seasons (2009/10 and 2010/11)

Treatments	fruit weight (g)	
Fertilization doses	1st	2nd
F0	2.71 c	5.52 d
F1	5.23 a	8.96 a
F2	5.04 a	8.52 ab
F3	4.72 a	8.20 b

F4	4.63 [a]	8.24 [b]
F5	3.76 [b]	7.07 [c]
F6	3.01 [c]	5.93 [d]
Means	4.16	7.49
SE ±	0.25	0.21
LSD	0.73	0.61
C.V%	18.3	8.5

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P> 0.05

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

Table (12) Effect of interaction of irrigation and fertilization on fruit .weight of date palm trees in both seasons (2009/10 and 2010/11)

Treatments	Fruit weight (g)	
Interaction	1st	2nd
AF0	[fghij] 3.35	[ghi] 6.60
AF1	[bcde] 5.20	[de] 8.33
AF2	[abc] 6.08	[cd] 8.83
AF3	[ab] 6.23	[bc] 9.83
AF4	[a] 6.98	[a] 11.30
AF5	[defg] 4.62	[bcd] 8.93
AF6	[fghij] 3.55	[fgh] 6.77
BF0	[j] 2.42	[hij] 5.72
BF1	[abcd] 5.68	[b] 10.00
BF2	[defg] 4.59	[de] 8.53
BF3	[efghi] 3.97	[def] 7.90
BF4	[fghij] 3.70	[efg] 7.43
BF5	[fghij] 3.60	[fgh] 6.73
BF6	[ij] 2.85	[hi] 6.20

CF0	j 2.37	k 4.23
CF1	cdef 4.80	de 8.53
CF2	defgh 4.43	de 8.20
CF3	efghi 3.95	fgh 6.87
CF4	ghij 3.22	hi 6.00
CF5	hij 3.05	ij 5.53
CF6	ij 2.62	jk 4.83
± SE	0.44	b 85.44
LSD	1.26	0.37
%C.V	18.3	1.06

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P>0.05.

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

A= 10 day of irrigation intervals / B= 20 day of irrigation intervals / C= 30 day of irrigation intervals.

4.1.2. Pulp Weight (kg):

There were high significant differences (P=0.01) of irrigation intervals on pulp weight in both seasons (Tables 9 and 10). The comparison between the irrigation intervals in both seasons showed that the 10 day interval gave significantly greater pulp weight (40.7% and 28.1%) over the 20 day and the 30 day irrigation intervals in both seasons (Table 13). The fertilizer dose (30kg organic + o.25kg NPK 15%) increased the pulp by 39.6% and 36.4% over the control respectively, in both seasons (Figure 2). In the first season the doses (30kg organic + o.25kg NPK 15%) and (60kg organic + 0.25kg NPK 15%) showed greater value of pulp. In the second season, application of (30kg organic + o.25kg NPK 15%) gave greater value followed by (60kg organic + o.250kg NPK 15%), (120kg organic + o.25kg NPK 15%) and (30kg organic + o.50kg NPK 15%)

(Figure 2). The interaction (irrigation intervals x fertilizer doses) was significantly different (P=0.05), the treatment (10 day irrigation + 30kg organic + 0.50kg NPK 15%) increased the pulp weight 46.9% and 44.9% respectively in both seasons over the control (Table 14).In the first season no differences between (10 day irrigation + 30kg organic + 0.50kg NPK 15%) and (10 day irrigation + 120kg organic + 0.25kg NPK 15%) also no significant difference between (10 day irrigation + 120kg organic + 0.25kg NPK 15%) and (10 day irrigation + 60kg organic + 0.25kg NPK 15%). In the second season there was difference between (10 day irrigation + 30kg organic + 0.50kg NPK 15%) and other treatments (table 14).

Table (13) Effect of irrigation intervals on pulp weight of date palm .trees in both seasons (2009/10 and 2010/11)

Treatments	pulp weight (g)	
irrigation intervals	1st season	2nd season
day 10	[a] 4.28	[a] 7.59
day 20	[b] 2.88	[b] 6.55
day 30	[b] 2.54	[c] 5.46
Means	3.23	6.53
± SE	0.16	0.12
LSD	0.46	0.35
%C.V	22.8	8.5

Means with the same letters in same column are not significantly .different according to Duncan Multiple Range Test P> 0.05

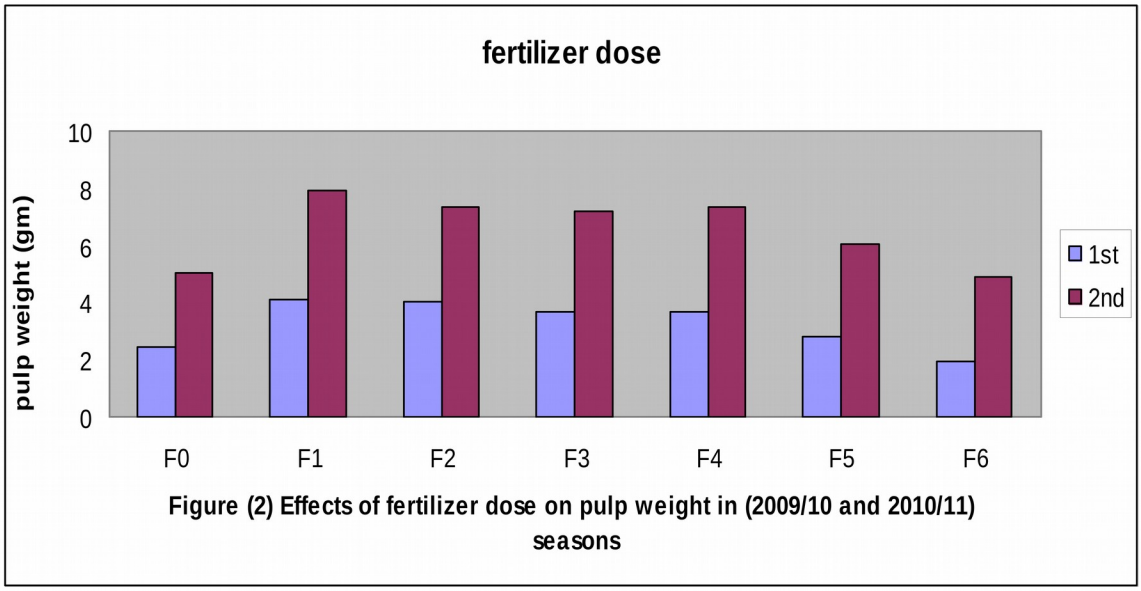

Figure (2) Effects of fertilizer dose on pulp weight in (2009/10 and 2010/11) seasons

Table (14) Effect of interaction on pulp weight of date palm trees in both seasons (2009/10 and 2010/11)

Treatments	*Pulp weight (g)*	
interaction	1st season	*2nd season*
AF0	3.17 efghi	*5.80 gh*
AF1	3.26 defg	7.20 de
AF2	5.03 abc	7.53 d
AF3	5.23 ab	8.70 bc
AF4	5.97 a	10.53 a
AF5	4.30 bcde	7.87 cd
AF6	2.17 hijk	5.50 ghi
BF0	2.60 fghijk	5.23 hi
BF1	4.77 abcd	8.93 b
BF2	3.56 defgh	7.50 d
BF3	3.07 efghij	6.90 def
BF4	2.70 fghijk	6.40 efg
BF5	1.98 ijk	5.67 gh
BF6	1.52 k	5.23 hi
CF0	1.62 k	4.03 j
CF1	3.87 cdef	7.53 d
CF2	3.50 defgh	6.90 def
CF3	2.62 fghijk	5.93 fgh
CF4	2.28 ghijk	5.17 hi
CF5	2.18 hijk	4.63 ij
CF6	1.72 jk	4.00 j

SE ±	0.42	0.32
LSD	1.21	0.92
C.V%	22.8	8.5

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P>0.05.
F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).
A= 10 day of irrigation intervals / B= 20 day of irrigation intervals / C= 30 day of irrigation intervals.

4.1.3. Pulp / Seed Ratio %:

There were highly significant differences (P=0.01) of irrigation intervals on Pulp / seed ratio % in both seasons (Tables 9 and 10). The comparison between the irrigation intervals showed that the interval of 10 days resulted in an increase of 89% and 92.01% over the control, there was significant differences between 20 and 30 day in both seasons respectively (table 15). The comparison between the fertilization doses showed that there were highly significant differences (p= 0.01) over the control in both seasons (Tables 9 and 10). Applications of (30kg organic + 0.25kg NPK 15%) increased the pulp by 79.85% and 87.15% over the control in both seasons respectively (table 16).

In the first season no significant difference between (30kg organic + 0.25kg NPK 15%) and (60kg organic + 0.25kg NPK 15%) and between (120kg organic + 0.25kg NPK 15%) and (30kg organic + 0.50kg NPK 15%). But there were significant differences between (60kg organic + 0.25kg NPK 15%), (120kg organic + 0.25kg NPK 15%), (30kg organic + 0.50kg NPK 15%) and (60kg organic + 0.50kg NPK 15%) (Table16). In

the second season no significant difference between (30kg organic + 0.25kg NPK 15%) , (60kg organic + 0.25kg NPK 15%) , (120kg organic + 0.25kg NPK 15%) and (30kg organic + 0.50kg NPK 15%) then control was in the lowest value(table 16).

The interaction (irrigation intervals x fertilization doses) was significant (P=0.05) in both seasons over control (Tables 9 and 10). In both seasons the greatest effects of irrigation and fertilization doses obtained from (10 day irrigation + 30kg organic + 0.50kg NPK 15%) which gave an increase of 73.18% and 86.12% respectively (Figure 3).

In the first season there were no significant differences between (10 day irrigation + 30kg organic + 0.50kg NPK 15%), (10 day irrigation + 60kg organic + 0.50kg NPK 15%) and (10 day irrigation + 120kg organic + 0.50kg NPK 15%). But in the second season (10 day irrigation + 30kg organic + 0.50kg NPK 15%) was the greatest for all treatments (Figure3).

Table (15) Effect of irrigation intervals on pulp /seed ratio of date .palm fruit in both seasons (2009/10 and 2010/11)

Treatments	pulp /seed ratio	
irrigation intervals	1st season	2nd season
day 10	a 77.64	a 85.41
day 20	b 70.95	b 82.03
day 30	c 69.08	c 78.59
Means	72.56	82.01
± SE	0.84	0.36
LSD	2.40	1.02
%C.V	5.30	2.00

Means with the same letters in same column are not significantly .different according to Duncan Multiple Range Test P> 0.05

Table (16) Effect of fertilization doses on pulp/ seed ratio of date .palm fruit in both seasons (2009/10 and 2010/11)

Treatments	pulp/ seed ratio%	
fertilization doses	1st season	2nd season
F0	62.55 d	77.79 c
F1	78.33 a	83.52 a
F2	75.20 ab	84.42 a
F3	75.70 ab	83.95 a
F4	75.98 ab	84.81 a
F5	72.37 b	82.94 b
F6	67.78 c	81.62 b
Means	72.56	82.72
SE ±	1.28	0.54
LSD	3.66	1.56
C.V%	5.30	2.00

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P> 0.05

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

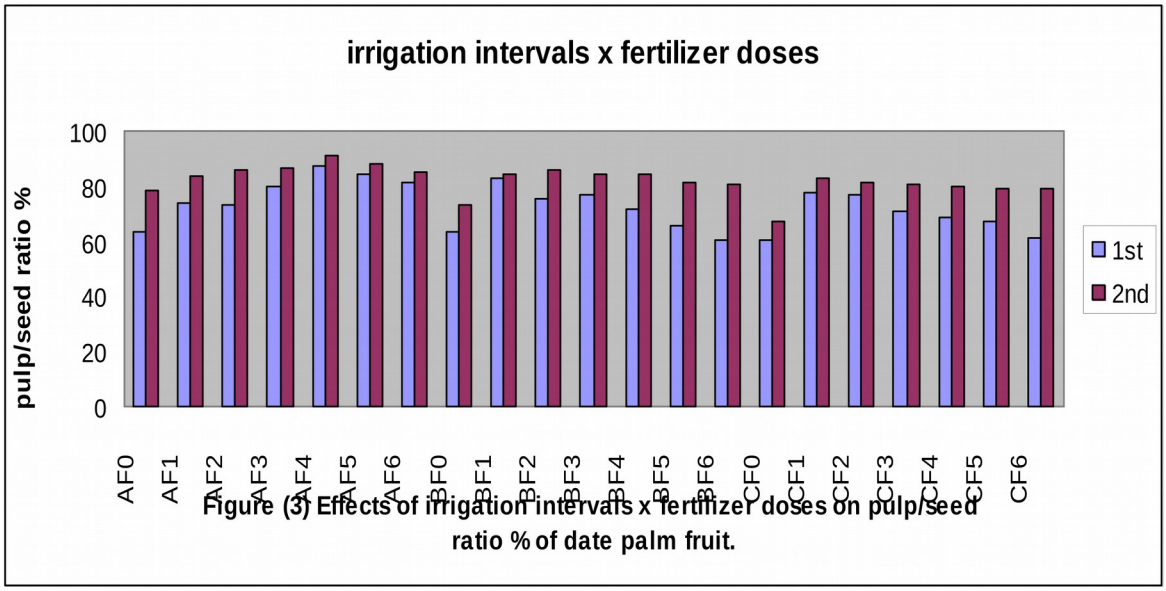

Figure (3) Effects of irrigation intervals x fertilizer doses on pulp/seed ratio % of date palm fruit.

4.1.4. Yield per Palm (kg):

As shown in (Tables 9 and 10), there were highly significant differences (P=0.01) due to irrigation intervals in both seasons. The comparison between the applications of irrigation intervals showed that every 10 day interval gave an increase of 47.5% and 54.6% over the control in both seasons respectively, also there were significant differences between 20 and 30 days intervals respectively (Figure 4). Generally, fertilization had significant effect in both seasons (Tables 9 and 10). The comparison between the fertilization doses in the first season showed that the dose (30kg organic + 0.50kg NPK 15%) increased the yield by 46.8% over the control, no significance difference between(30kg organic + 0.25kg NPK 15%),(60kg organic + 0.25kg NPK 15%) and (30kg organic + 0.50kg NPK 15%) and the control. Also no significant difference between (30kg organic + 0.25kg NPK 15%),(60kg organic + 0.25kg NPK 15%) and (120kg organic + 0.25kg NPK 15%), but there was a significant difference between (30kg organic + 0.50kg NPK 15%) and (120kg organic + 0.25kg NPK 15%), and no significant difference between (120kg organic + 0.25kg NPK 15%) and (60kg organic + 0.50kg NPK 15%) and between (60kg organic + 0.50kg NPK 15%) and the control,

and between (120kg organic + 0.50kg NPK 15%) and the control (table 17). In the second season the dose (30kg organic + 0.25kg NPK 15%) increased yield by 61.5% over the control. (30kg organic + 0.25kg NPK 15%), (60kg organic + 0.25kg NPK 15%), (120kg organic + 0.25kg NPK 15%) and (30kg organic + 0.50kg NPK 15%) gave the highest results, followed by (60kg organic + 0.50kg NPK 15%) then (120kg organic + 0.50kg NPK 15%) over the control(table 17). The differences due to interaction were highly significant (P=0.01) in both seasons (Tables 9 and 10). The results showed that (10 day irrigation + 30kg organic + 0.50kg NPK 15%) increased the yield by 68% and 74.3% over the control in both seasons respectively (Figure 6). In both seasons the treatment (10 day irrigation + 30kg organic + 0.50kg NPK 15%) gave greater increase over other doses and control (Figure 5).

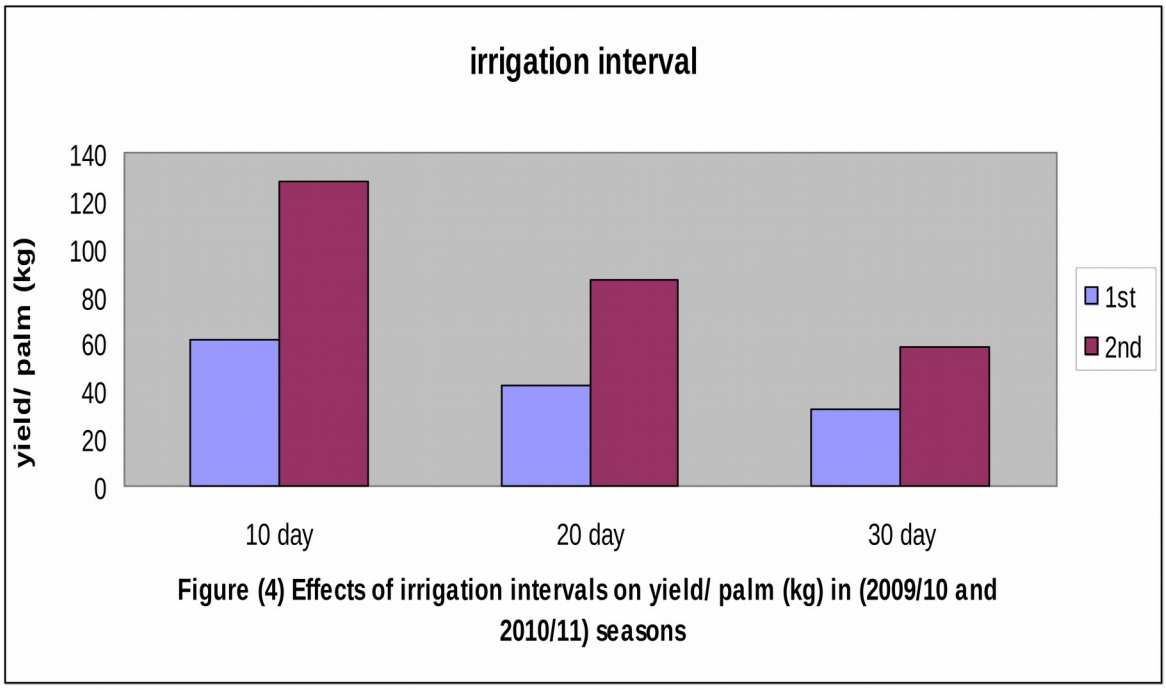

Figure (4) Effects of irrigation intervals on yield/ palm (kg) in (2009/10 and 2010/11) seasons

Table (17) Effect of fertilization doses on yield/palm of date palm trees in both seasons (2009/10 and 2010/11).

Treatments fertilization doses	Yield/palm (kg) 1st season	2nd season
F0	32.13 de	44.84 d
F1	58.84 ab	116.4 a
F2	54.31 ab	113.7 a
F3	48.56 bc	106.7 a
F4	60.42 a	111.1 a
F5	38.70 cd	78.44 b
F6	25.68 e	63.29 c
Means	45.52	90.64
SE ±	3.49	4.64
LSD	9.96	13.26
C.V%	23	15.4

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P> 0.05.

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

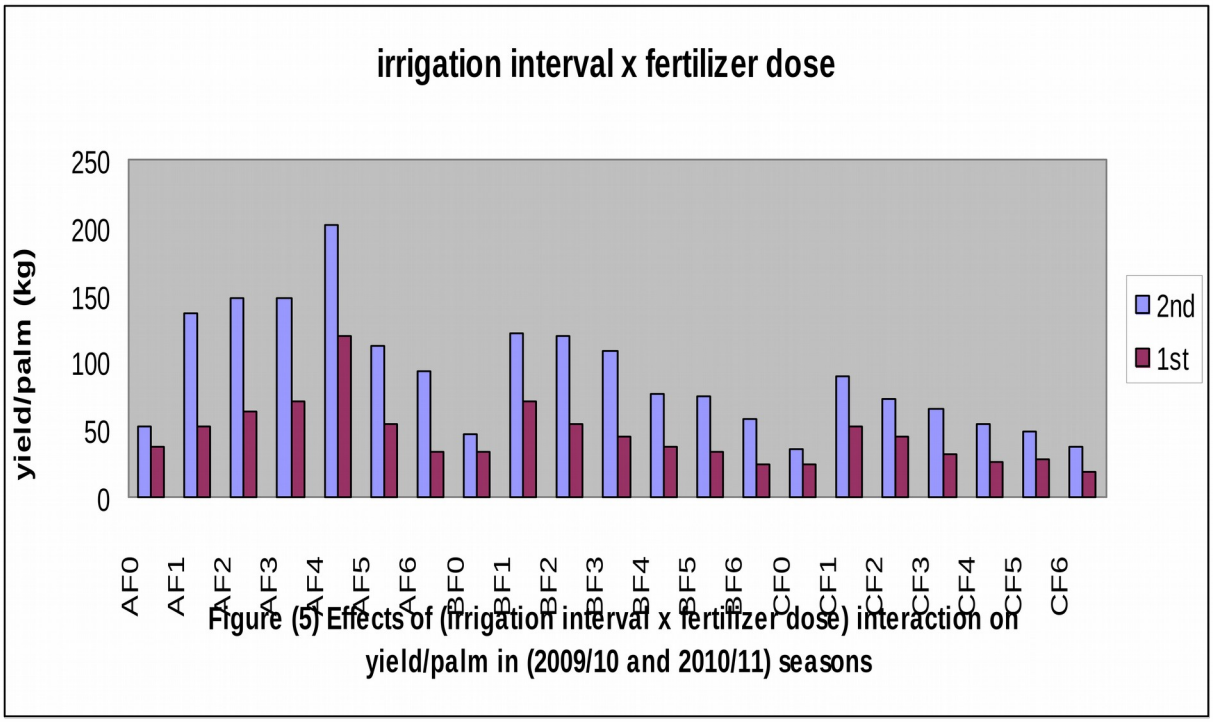

Figure (5) Effects of (irrigation interval x fertilizer dose) interaction on yield/palm in (2009/10 and 2010/11) seasons

4.2. Effects of Treatments on Fruit Physical Characteristics of Dates:

4.2.1. Fruits Length (cm)

(Tables 18 and 19) indicate that there were highly significant differences (P=0.01) in fruit length between the irrigation intervals in both seasons. The comparison between the irrigation intervals in both seasons showed that the application of 10 day interval increased fruit length significantly, 22% and 18.7% over the control respectively, followed by 20 day and 30 day intervals respectively, in both seasons (Figure 6). On the other hand, there was highly significant difference (P=0.01) in fruit length between the applications of fertilization doses in both seasons (Tables 18 and 19). In the first season there were no significant differences due to the treatments (30kg organic + 0.25kg NPK 15%), (60kg organic + 0.25kg NPK 15%), (120kg organic + 0.25kg NPK 15%) and (30kg organic + 0.50kg NPK 15%). The greater value (30kg organic + 0.25kg NPK 15%) gave greater fruit length, 28.9% over the control (Table 20). No

significant difference between (60kg organic + 0.50kg NPK 15%) and (120kg organic + 0.50kg NPK 15%). Also no significant difference between (120kg organic + 0.50kg NPK 15%) and the control, but there was significant difference between (60kg organic + 0.50kg NPK 15%) and the control. In the second season the greater significant difference was due to the treatment (30kg organic + 0.50kg NPK 15%) which increased fruit length by 35.4% over the control, There was no significant difference between (30kg organic + 0.25kg NPK 15%), (60kg organic + 0.25kg NPK 15%), (120kg organic + 0.25kg NPK 15%) and (30kg organic + 0.50kg NPK 15%). No significant difference between (120kg organic + 0.25kg NPK 15%),(60kg organic + 0.50kg NPK 15%) and (120kg organic + 0.50kg NPK 15%) but there were significant differences between (30kg organic + 0.25kg NPK 15%) , (60kg organic + 0.25kg NPK 15%),(30kg organic + 0.50kg NPK 15%) and between (60kg organic + 0.50kg NPK 15%) and (120kg organic + 0.50kg NPK 15%). There were no significant differences between (120kg organic + 0.50kg NPK 15%) and the control, but there were significant differences between (60kg organic + 0.50kg NPK 15%) and the control (table 20).

There were highly significant differences (P=0.01) in fruit length between the interaction (irrigation intervals X fertilization doses) in both seasons (Tables 18 and 19). The comparison between the interactions in both seasons showed that the treatments (10 day irrigation + 30kg organic + 0.50kg NPK 15%) increased fruit length by 43% and 46.3% respectively over the control. In both seasons (10 day irrigation + 30kg organic + 0.50kg NPK 15%) the increase in was highly significant over other doses and control (Figure 7).

Table (18): Effect of treatments and their interactions on fruit physical characteristics in season (2009/2010).

Parameters	Irrigation	Fertilization	Irrigation X Fertilization
Fruit length (cm)	4.88**	2.27**	0.81**
Fruit diameter (cm)	0.18**	0.15**	0.02*
Flesh thickness (cm)	0.054**	0.013**	0.006*

** = significant at 1% level (highly significant)

* = significant at 5% level (significant)

N.S = not significant.

Table (19): Effect of treatments and their interactions on fruit physical characteristics in season (2010/2011).

Parameters	Irrigation	Fertilization	Irrigation X Fertilization
Fruit length (cm)	5.32**	4.06**	1.11**
Fruit diameter (cm)	0.34**	0.18**	0.03**
Flesh thickness (cm)	0.129**	0.04**	0.02**

** = significant at 1% level (highly significant)

* = significant at 5% level (significant)

N.S = not significant.

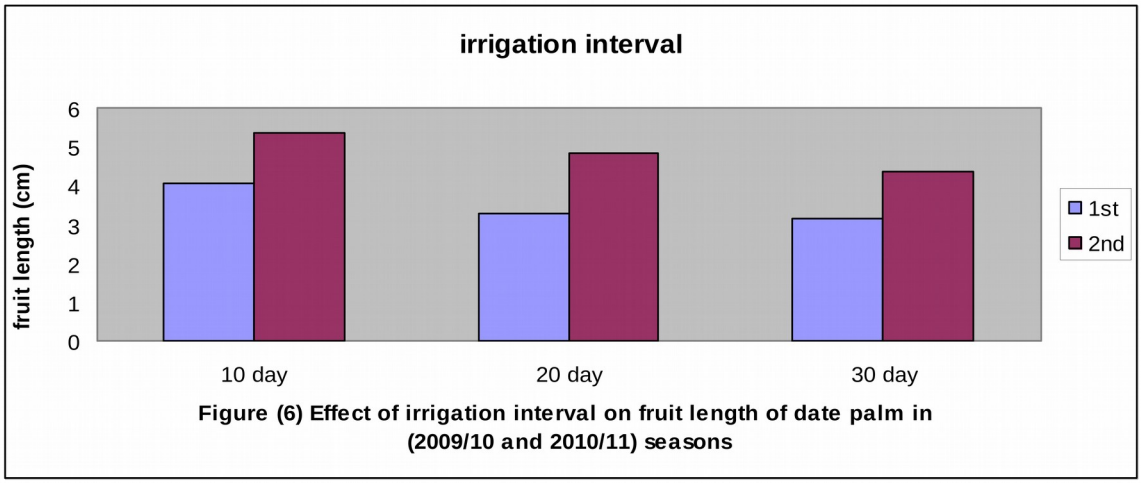

Figure (6) Effect of irrigation interval on fruit length of date palm in (2009/10 and 2010/11) seasons

Table (20) Effect of fertilization doses on fruit length of date palm .trees in both seasons (2009/10 and 2010/11)

Treatments	fruit length (cm)	
fertilization doses	1st season	2nd season
F0	2.83 c	3.66 d
F1	3.98 a	5.27 ab
F2	3.75 a	5.17 ab
F3	3.70 a	5.09 abc
F4	4.07 a	5.67 a
F5	3.21 b	4.65 bc
F6	2.93 bc	4.35 cd
Means	3.50	4.84
SE ±	0.12	0.25
LSD	0.34	0.72
C.V%	10.2	4.9

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

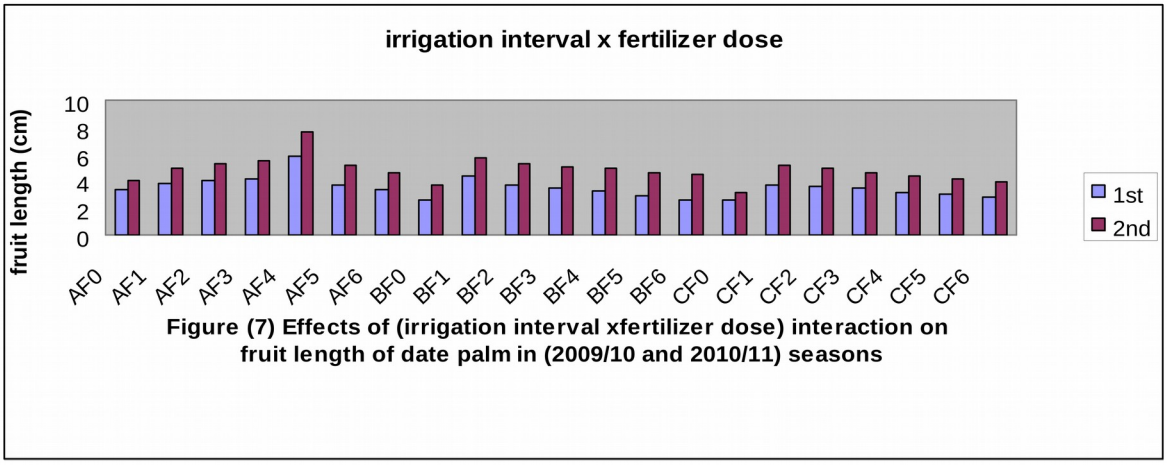

Figure (7) Effects of (irrigation interval xfertilizer dose) interaction on fruit length of date palm in (2009/10 and 2010/11) seasons

4.2.2. Fruit Circumference (cm)

The results presented in (Tables 18 and 19) indicated highly significant difference (P=0.01) in fruit diameter among the different doses of irrigation intervals in both seasons. The result of the first season showed that irrigation every 10 day interval gave significantly higher fruit diameter, 10.3%, over the control, and no significant difference between the 20 day and the control. In the second season also every 10 days interval increased fruit diameter by 12.7% over the control, followed by 20 and 30 day intervals of irrigation (table 21). The fertilization treatments indicated highly significant difference (P=0.01) in fruit diameter due to different doses of fertilization in both seasons (Tables 18 and 19). The comparison between the fertilization doses in the first season showed that the treatment (30kg organic + 0.25kg NPK 15%) gave significantly greater fruit diameter, 18.7%, over the control, and no significant differences between (30kg organic + 0.25kg NPK 15%), (60kg organic + 0.25kg NPK 15%), (120kg organic + 0.25kg NPK 15%) and (30kg organic + 0.50kg NPK 15%). Also no significant differences between (60kg organic + 0.50kg NPK 15%) and (120kg organic + 0.50kg NPK 15%) and no significant differences between (120kg organic + 0.50kg NPK 15%) and the control,

but there was significant difference between (60kg organic + 0.50kg NPK 15%) and the control. In the second season the treatment (30kg organic + 0.25kg NPK 15%) increased fruit diameter 18.9% over the control, but there were no significant differences between (30kg organic + 0.25kg NPK 15%), (60kg organic + 0.25kg NPK 15%) and (120kg organic + 0.25kg NPK 15%). But there was no significant difference between (30kg organic + 0.50kg NPK 15%) and (60kg organic + 0.25kg NPK 15%) , (120kg organic + 0.25kg NPK 15%), but there was a significant difference between (30kg organic + 0.25kg NPK 15%) and (30kg organic + 0.50kg NPK 15%), all doses gave significantly greater fruit diameter over the control (table 22). The differences between the interaction in fruit diameter were significant (P=0.05) in both seasons (Tables 18 and 19). The results showed that in the first season the application of (10 day irrigation + 30kg organic + 0.50kg NPK 15%) gave greater fruit diameter, 27.5%, over the control and no significant difference between (10 day irrigation + 30kg organic + 0.50kg NPK 15%) and(10 day irrigation + 120kg organic + 0.25kg NPK 15%), also no significant difference between (10 day irrigation + 120kg organic + 0.25kg NPK 15%) and (10 day irrigation + 60kg organic + 0.25kg NPK 15%) but there was significant difference between (10 day irrigation + 30kg organic + 0.50kg NPK 15%) and (10 day irrigation + 60kg organic + 0.25kg NPK 15%). The results also showed that in the second season (10 day irrigation + 120kg organic + 0.25kg NPK 15%) increased fruit diameter by 14.3% over the control, and no significant differences between (10 day irrigation + 120kg organic + 0.25kg NPK 15%) , (10 day irrigation + 30kg organic + 0.50kg NPK 15%) and (20 day irrigation + 30kg organic + 0.25kg NPK 15%).

There were significant differences between (10 day irrigation + 60kg organic + 0.25kg NPK 15%), (10 day irrigation + 60kg organic + 0.50kg

NPK 15%), (20 day irrigation + 60kg organic + 0.25kg NPK 15%) and (30 day irrigation + 30kg organic + 0.25kg NPK 15%) (Table 23).

Table (21) Effect of irrigation intervals on fruit diameter of date palm .trees in both seasons (2009/10 and 2010/11)

Treatments	fruit diameter (cm)	
irrigation intervals	1st season	2nd season
10 day	1.65 a	1.97 a
20 day	1.50 b	1.88 b
30 day	1.48 b	1.72 c
Means	1.54	1.86
SE ±	0.02	0.02
LSD	0.06	0.05
C.V%	6.6	4.2

Means with the same letters in same column are not significantly .different according to Duncan Multiple Range Test P> 0.05

Table (22) Effect of fertilization doses on fruit diameter of date palm trees in both seasons (2009/10 and 2010/11).

Treatments	fruit diameter (cm)	
fertilization doses	1st season	2nd season
F0	1.35 c	1.63 e

F1	1.66 [a]	2.01 [a]
F2	1.63 [a]	1.98 [ab]
F3	1.63 [a]	1.94 [ab]
F4	1.64 [a]	1.92 [b]
F5	1.48 [b]	1.82 [c]
F6	1.40 [bc]	1.71 [d]
Means	1.54	1.86
SE ±	0.03	0.03
LSD	0.10	0.07
C.V%	6.6	4.2

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

Table (23) Effect of interaction on fruit diameter of date palm trees in both seasons (2009/10 and 2010/11).

Treatments	fruit diameter (cm)	
Interaction	1st season	2nd season
AF0	[fghi] 1.40	[defg] 1.80
AF1	[bcd] 1.66	[bcd] 1.90
AF2	[bc] 1.70	[ab] 2.03
AF3	[ab] 1.78	[a] 2.10
AF4	[a] 1.93	[a] 2.14
AF5	[cdef] 1.56	[abc] 2.01
AF6	[cdefgh] 1.51	[defg] 1.82

BF0	ghi 1.35	ghi 1.68
BF1	bc 1.70	a 2.11
BF2	bcde 1.60	abc 2.00
BF3	cdef 1.57	bcd 1.92
BF4	cdefgh 1.52	cde 1.88
BF5	efghi 1.43	def 1.84
BF6	hi 1.33	efg 1.75
CF0	i 1.31	j 1.41
CF1	bcde 1.62	abc 2.01
CF2	bcde 1.60	bcd 1.91
CF3	cdefg 1.54	defg 1.81
CF4	defghi 1.47	fgh 1.73
CF5	efghi 1.44	hi 1.61
CF6	ghi 1.36	i 1.57
± SE	0.06	0.04
LSD	0.17	0.13
%C.V	6.6	4.2

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

A= 10 day of irrigation intervals / B= 20 day of irrigation intervals / C= 30 day of irrigation intervals.

4.2.3. Flesh Thickness (cm)

The results of the experiments indicated a highly significant difference (P=0.01) in flesh thickness among the different irrigation intervals in both seasons (Tables 18 and 19). The results of the first season showed that the application of 10 days of irrigation intervals gave significantly higher flesh thickness, 34.6%, over the control, and no significant difference between the 20 and 30 day (the control) (table 24). Likewise, the results of the second season showed that the application of 10 days of irrigation intervals significantly increased flesh thickness by 32% over the control,

followed by 20 and 30 day of irrigation intervals (table 24). The results indicated highly significant difference (P=0.01) in flesh thickness due to the different doses of fertilization in both seasons (Tables 18 and 19). The comparison between the fertilization doses in the first season showed that the application of (30kg organic + 0.25kg NPK 15%), gave significantly greater flesh thickness, 24%, over the control, but there were no significant differences between (30kg organic + 0.25kg NPK 15%), and (60kg organic + 0.25kg NPK 15%), (120kg organic + 0.25kg NPK 15%) and (30kg organic + 0.50kg NPK 15%), also no significant differences between (60kg organic + 0.50kg NPK 15%) and (120kg organic + 0.50kg NPK 15%) , and the control. Also there were no significant differences between the control and (60kg organic + 0.25kg NPK 15%), (120kg organic + 0.25kg NPK 15%) and (30kg organic + 0.50kg NPK 15%). No significant difference between (60kg organic + 0.50kg NPK 15%) and (120kg organic + 0.50kg NPK 15%) and no significant between (60kg organic + 0.50kg NPK 15%) and control but there was a difference between (120kg organic + 0.50kg NPK 15%) and control (table 25).

In the second season, (30kg organic + 0.50kg NPK 15%), increased flesh thickness by 34% over the control, and no significant difference between (30kg organic + 0.50kg NPK 15%) and (30kg organic + 0.25kg NPK 15%) , (60kg organic + 0.25kg NPK 15%), also no significant difference between (30kg organic + 0.25kg NPK 15%) , (60kg organic + 0.25kg NPK 15%) and (120kg organic + 0.25kg NPK 15%) but there was significant difference between (30kg organic + 0.50kg NPK 15%) and (120kg organic + 0.25kg NPK 15%). No significant difference between the control and (120kg organic + 0.50kg NPK 15%) (Table25). The differences between the treatments interaction in flesh thickness were significant in first season and highly significant (p=0.01) in second

season (tables 18 and 19), the results showed that in the first season the application of (10 day irrigation + 30kg organic + 0.50kg NPK 15%) increased flesh thickness by 33.3% over the control and there were no significant differences between the application of (10 day irrigation + 30kg organic + 0.50kg NPK 15%) and (10 day irrigation + 120kg organic + 0.25kg NPK 15%), and no significant differences between (10 day irrigation + no organic + no NPK 15%), (10 day irrigation + 30kg organic + 0.25kg NPK 15%),(10 day irrigation + 60kg organic + 0.25kg NPK 15%) (Table 26). The results also showed that in the second season the treatment (10 day irrigation + 30kg organic + 0.50kg NPK 15%) gave highly significant difference in flesh thickness, 45.9%, over the control (table 26).

Table (24) Effect of irrigation intervals on flesh thickness of date palm trees in both seasons (2009/10 and 2010/11).

Treatments	flesh thickness (cm)	
irrigation intervals	1st season	2nd season
day 10	a 0.26	a 0.50
day 20	b 0.18	b 0.41
day 30	b 0.17	c 0.34
Means	0.20	0.42
± SE	0.01	0.008
LSD	0.03	0.02
%C.V	23.1	8.7

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P> 0.05

Table (25) Effect of fertilization doses on flesh thickness of date palm trees in both seasons (2009/10 and 2010/11).

Treatments	flesh thickness (cm)	
fertilization doses	1st season	2nd season
F0	bc 0.19	d 0.33
F1	a 0.25	ab 0.47
F2	ab 0.23	ab 0.47
F3	abc 0.22	b 0.44
F4	abc 0.22	a 0.50
F5	cd 0.18	c 0.39
F6	d 0.14	d 0.33
Means	0.20	0.42
± SE	0.01	0.01
LSD	0.04	0.03
%C.V	23.1	8.7

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

Table (26) Effect of interaction on flesh thickness of date palm trees in both seasons (2009/10 and 2010/11).

Treatments	flesh thickness (cm)	
interaction	1st season	2nd season
AF0	0.24 bcdef	0.40 ef
AF1	0.26 bcd	0.42 e
AF2	0.28 bc	0.53 bc
AF3	0.32 ab	0.54 b
AF4	0.36 a	0.74 a
AF5	0.21 cdefgh	0.46 de
AF6	0.16 fghi	0.41 e
BF0	0.18 defghi	0.32 gh
BF1	0.23 cdefg	0.52 bc
BF2	0.20 cdefgh	0.48 cd
BF3	0.18 defghi	0.43 de
BF4	0.13 hi	0.42 e
BF5	0.20 cdefgh	0.41 e

BF6	0.14 hi	0.31 ghi
CF0	0.14 hi	0.28 hi
CF1	0.25 bcde	0.46 de
CF2	0.21 cdefgh	0.40 ef
CF3	0.17 efghi	0.35 fg
CF4	0.15 ghi	0.34 g
CF5	0.13 hi	0.31 ghi
CF6	0.11 i	0.26 i
SE ±	0.03	0.02
LSD	0.07	0.05
C.V%	23.1	8.7

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

A= 10 day of irrigation intervals / B= 20 day of irrigation intervals / C= 30 day of irrigation intervals.

4.3. Effect of Treatments on Seed Physical Characteristics of Date Palm

4.3.1. Seed Length (cm)

The results indicated a highly significant difference (P=0.01) in seed length among the different of irrigation intervals in both seasons (Tables 27 and 28). The results of the first season show that the application of every 10 day gave significantly higher seed length, 13.5%, over the control, and no significant difference between 20 and 30 days of irrigation intervals. Whereas in the second season the application of 10 days interval increased the seed length by 12.2% over control, followed by 20day interval and the control (table 29). As shown in (Tables 27 and 28). The results indicated a highly significant difference (P=0.01) in seed length due to the different doses of fertilization in both seasons. The comparison between the fertilization doses in the first season showed that

(30kg organic + 0.250kg NPK 15%), gave highly significant increased, 17.1%, over the control and no significant difference between (30kg organic + 0.250kg NPK 15%) and (60kg organic + 0.250kg NPK 15%), and also no significant different between (60kg organic + 0.250kg NPK 15%) and (120kg organic + 0.250kg NPK 15%) but there was a difference between (30kg organic + 0.250kg NPK 15%) and (120kg organic + 0.250kg NPK 15%). No difference between (120kg organic + 0.250kg NPK 15%) and (30kg organic + 0. 50kg NPK 15%), but there was a difference between (30kg organic + 0. 50kg NPK 15%) and (60kg organic + 0.250kg NPK 15%) also no difference between (60kg organic + 0. 50kg NPK 15%), (120kg organic + 0. 50kg NPK 15%) and the control, but there was a difference between(30kg organic + 0. 50kg NPK 15%) and (60kg organic + 0.50kg NPK 15%) and the control(Figure23). Whereas, in the second season the treatment (30kg organic + 0.250kg NPK 15%) significantly increased seed length by 26.7% weight over the control, no significant differences between(120kg organic + 0. 25kg NPK 15%), (60kg organic + 0. 50kg NPK 15%) and (120kg organic + 0. 50kg NPK 15%) , also no significant difference between (60kg organic + 0.25kg NPK 15%) and (120kg organic + 0.25 kg NPK 15%). But differences between (60kg organic + 0. 25kg NPK 15%) and (30kg organic + 0. 50kg NPK 15%), (60kg organic + 0. 50kg NPK 15%), over the control were observed (table 30). The differences between the interactions on seed length were not significantly different in both seasons as shown in (Tables 27 and 28) and (table 31).

Table (27): F- value of the measured variables for the treatments and their interactions in season (2009/2010).

parameters	Irrigation	Fertilization	Irrigation X Fertilization

Seed length(cm)	0.66 **	0.32**	0.04 NS
Seed diameter(cm)	0.005**	0.02**	0.0004 NS
Seed weight(g)	0.001 NS	0.014**	0.03**

Table (28): F- value of the measured variables for the treatments and their interactions in season (2010/2011).

parameters	Irrigation	Fertilization	Irrigation X Fertilization
seed length(cm)	0.64 **	0.71**	0.01 NS
seed diameter(cm)	0.02*	0.02**	0.001 NS
seed weight(g)	0.14 **	0.01 NS	0.02*

Table (29) Effect of irrigation intervals on seed length of date palm trees in both seasons (2009/10 and 2010/11).

Treatments	seed length(cm)	
irrigation intervals	1st season	2nd season
10 day	2.44 a	2.88 a
20 day	2.16 b	2.71 b
30 day	2.11 b	2.53 c
Means	2.24	2.71
SE ±	0.04	0.03
LSD	0.11	0.09
C.V%	7.7	5.6

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P> 0.05

Table (30) Effect of fertilization doses on seed length of date palm trees in both season (2009/10 and 2010/11).

Treatments	seed length(cm)	
fertilization doses	1st season	2nd season
F0	2.09 de	2.25 e
F1	2.52 a	3.07 a
F2	2.40 ab	2.91 b
F3	2.32 bc	2.83 bc
F4	2.21 cd	2.76 c
F5	2.12 de	2.70 c

F6	1.99 [e]	2.44 [d]
Means	2.24	2.71
SE ±	0.06	0.05
LSD	0.17	0.13
C.V%	7.7	5.6

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P> 0.05.
F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

Table (31) Effect of interaction on seed length of date palm trees in both seasons (2009/10 and 2010/11).

Treatments	seed length(cm)	
Interaction	1st season	2nd season
AF0	[a] 2.33	[a] 2.38
AF1	[a] 2.71	[a] 3.20
AF2	[a] 2.59	[a] 3.08
AF3	[a] 2.48	[a] 3.03
AF4	[a] 2.42	[a] 2.96
AF5	[a] 2.38	[a] 2.89
AF6	[a] 2.17	[a] 2.64
BF0	[a] 2.22	[a] 2.24
BF1	[a] 2.15	[a] 3.04
BF2	[a] 2.30	[a] 2.89
BF3	[a] 2.22	[a] 2.82
BF4	[a] 2.11	[a] 2.75
BF5	[a] 1.95	[a] 2.70
BF6	[a] 1.82	[a] 2.53
CF0	[a] 1.74	[a] 2.13
CF1	[a] 2.35	[a] 2.98
CF2	[a] 2.32	[a] 2.76
CF3	[a] 2.25	[a] 2.65
CF4	[a] 2.11	[a] 2.57
CF5	[a] 2.04	[a] 2.50
CF6	[a] 1.98	[a] 2.14

± SE	0.01	0.09
LSD	0.28	0.25
%C.V	7.7	5.6

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P>0.05.

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

A= 10 day of irrigation intervals / B= 20 day of irrigation intervals / C= 30 day of irrigation intervals.

4.3.2. Seed Diameter (cm)

The results indicated highly significant difference (P=0.01) in seed diameter among the different of irrigation intervals in both seasons (Tables 27 and 28).

The results of the first season showed that there was no significant difference between the intervals 10 and 20 day of irrigation in seed diameter, the 10 day interval increased seed diameter by 5.7% over the control (30 days). In the second season the interval 10 day increased seed diameter by 9% over the control and 20 day, no significant difference between the control and 20 day of irrigation intervals on seed diameter (table 32). The results depicted in (Tables 27 and 28). Indicated highly significant difference (P=0.01) in seed diameter among the different doses of fertilization in both seasons. The comparison between the fertilization doses in both seasons showed that (120kg organic + 0.50kg NPK 15%) increased seed diameter 17.6% and 18.3% over the control respectively. Also in both seasons no significant difference between (120kg organic + 0.50kg NPK 15%) and (60kg organic + 0.50kg NPK 15%) over the control was shown (Table 33). The differences between the interactions on seed diameter indicated no significant difference in both

seasons this may be due to genetic factors (Tables 27 and 28) and (Table 34).

Table (32) Effect of irrigation intervals on seed diameter of date palm trees in both seasons (2009/10 and 2010/11).

Treatments	seed diameter(cm)	
irrigation intervals	1st season	2nd season
10 day	0.70 [a]	0.66 [a]
20 day	0.68 [a]	0.61 [b]
30 day	0.66 [b]	0.60 [b]
Means	0.68	0.62
SE ±	0.006	0.01
LSD	0.02	0.03
C.V%	4.1	8.4

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P> 0.05.

Table (33) Effect of fertilization doses on seed diameter of date palm trees in both season (2009/10 and 2010/11).

Treatments	Seed diameter(cm)	
Fertilization doses	1st season	2nd season
F0	0.61 [e]	0.58 [cd]
F1	0.64 [de]	0.57 [d]
F2	0.67 [cd]	0.60 [cd]
F3	0.69 [bc]	0.61 [bcd]
F4	0.70 [bc]	0.63 [bc]
F5	0.71 [ab]	0.66 [ab]
F6	0.74 [a]	0.71 [a]
Means	0.68	0.62
SE ±	0.01	0.02

LSD	0.03	0.05
C.V%	4.1	8.4

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P> 0.05.
F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

Table (34) Effect of interaction on seed diameter of date palm trees in both seasons (2009/10 and 2010/11).

Treatments	seed diameter(cm)	
Interaction	1st season	2nd season
AF0	ª 0.63	ª 0.63
AF1	ª 0.66	ª 0.59
AF2	ª 0.69	ª 0.62
AF3	ª 0.70	ª 0.64
AF4	ª 0.70	ª 0.67
AF5	ª 0.71	ª 0.70
AF6	ª 0.77	ª 0.77
BF0	ª 0.60	ª 0.57
BF1	ª 0.64	ª 0.58
BF2	ª 0.66	ª 0.61
BF3	ª 0.68	ª 0.61
BF4	ª 0.70	ª 0.63
BF5	ª 0.72	ª 0.63
BF6	ª 0.74	ª 0.67
CF0	ª 0.60	ª 0.53
CF1	ª 0.61	ª 0.54
CF2	ª 0.66	ª 0.58
CF3	ª 0.67	ª 0.59
CF4	ª 0.69	ª 0.60
CF5	ª 0.71	ª 0.65
CF6	ª 0.71	ª 0.69
± SE	0.02	0.03
LSD	0.05	0.09
%C.V	4.1	8.4

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P>0.05.
F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).
A= 10 day of irrigation intervals / B= 20 day of irrigation intervals / C= 30 day of irrigation intervals.

4.3. 3. Seed weight (g)

From the results presented in (Tables 27 and 28) it was clear that there were no significant difference in the first season and high significant differences (P=0.01) in the second between the irrigation intervals in both seasons, respectively.

The comparison between the irrigation intervals showed that there were no significant differences in the first season. On the other hand, in the second season there were highly significant differences in the irrigation intervals between 10 day (increased 14.3%) over the control and no significant differences between 10 and 20 day of irrigation intervals (Table 35).

It was clear that there were highly significant differences (P=0.01) due to fertilization and interactions and no significant difference due to irrigation in the first season, but in the second season no difference due to fertilization dose on seed weight but there were significant differences in irrigation and in interaction (Tables 27 and 28). The comparison between the fertilization doses in the first season showed that the treatment (60kg organic +0.50kg NPK 15%) increased seed weight significantly, 6.3%, over the control, and no difference between (30kg organic + 0.25kg NPK 15%), (120kg organic + 0.50kg NPK 15%) and (60kg organic +0.25kg NPK 15%). No significant difference between (60kg organic +0.25kg NPK 15%) and (120kg organic + 0.25kg NPK

15%) but there were differences between (120kg organic + 0.25kg NPK 15%) and (30kg organic + 0.25kg NPK 15%), (60kg organic +0.25kg NPK 15%), (60kg organic +0.50kg NPK 15%), (120kg organic + 0.50kg NPK 15%). Also no significant difference between the control and (60kg organic +0.25kg NPK 15%), (120kg organic + 0.25kg NPK 15%) but there was a difference between the control and (30kg organic + 0.25kg NPK 15%) (Table 36). On the other hand, there was no significant difference in the seed weight in the second season between the applications of all the fertilization doses (Table 36).

It was clear that there were highly significant differences (P=0.01) and significant difference (p= 0.05) due to the interactions between the treatments in both seasons, respectively (Tables 27 and 28). The results also showed that in the first season (10 day irrigation + 120kg organic + 0.50kg NPK 15%) increased the seed weight 10.9% over the control and all interaction treatments over the control (Table 37).

In the second season the application of control (10 day + without organic and NPK 15%) gave high seed weight, compared with) (10 day irrigation+30kg organic + 0.25kg NPK 15%),(10 day irrigation + 60kg organic + 0.25kg NPK 15%), (10 day irrigation + 120kg organic + 0.25kg NPK 15%), (10 day irrigation+60kg organic + 0.50kg NPK 15%), (10 day irrigation+120kg organic + 0.50kg NPK 15%), (20 day irrigation + without organic and NPK 15%), (20 day irrigation+60kg organic + 0.25kg NPK 15%), (20 day irrigation+30kg organic + 0.50kg NPK 15%), (20 day irrigation+60kg organic + 0.50kg NPK 15%) and (20 day irrigation+120kg organic + 0.50kg NPK 15%) (Table 37).

Table (35) Effect of irrigation intervals on seed weight of date palm trees in both seasons (2009/10 and 2010/11).

Treatments	Seed weight(g)	
irrigation intervals	1st season	2nd season
10 day	0.93 a	1.05 a
20 day	0.91 a	1.03 a
30 day	0.92 a	0.90 b
Means	0.92	0.99
SE ±	0.010	0.01
LSD	0.03	0.05
C.V%	4.8	8.3

Means with the same letters in same column are not significantly .different according to Duncan Multiple Range Test P> 0.05

Table (36) Effect of fertilization doses on seed weight of date palm trees in both season (2009/10 and 2010/11).

Treatments	seed weight(g)	
fertilization doses	1st season	2nd season
F0	0.90 c	1.01 a
F1	0.95 ab	1.04 a
F2	0.93 abc	1.03 a
F3	0.92 bc	1.00 a
F4	0.84 d	0.93 a
F5	0.96 a	0.98 a
F6	0.95 ab	0.98 a
Means	0.92	1.00
SE ±	0.01	0.03
LSD	0.03	0.08
C.V%	4.8	8.3

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

Table (37) Effect of interaction on seed weight of date palm trees in both seasons (2009/10 and 2010/11).

Treatments		seed weight(g)
Interaction	1st season	2nd season
AF0	bcd 0.98	a 1.17
AF1	fg 0.88	ab 1.13
AF2	def 0.93	abc 1.07
AF3	efg 0.90	abc 1.07
AF4	h 0.68	de 0.87
AF5	b 1.02	abcd 1.03
AF6	a 1.10	abcd 1.03
BF0	g 0.85	abcd 1.03
BF1	bc 1.00	bcd 1.00
BF2	efg 0.90	abcd 1.03
BF3	efg 0.90	bcd 1.00
BF4	def 0.93	abcd 1.03
BF5	bcd 0.97	abc 1.07
BF6	g 0.85	abc 1.07
CF0	fg 0.87	e 0.83
CF1	bcd 0.97	bcd 1.00
CF2	cde 0.95	bcd 1.00
CF3	cde 0.95	cde 0.93
CF4	def 0.92	de 0.90
CF5	efg 0.90	e 0.83
CF6	efg 0.90	e 0.83
± SE	0.02	0.05
LSD	0.05	0.14
%C.V	4.8	8.3

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P>0.05.

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).
A= 10 day of irrigation intervals / B= 20 day of irrigation intervals / C= 30 day of irrigation intervals.

4.4. Effect of Treatments on Bunch Characteristics:

4.4.1. Number of Bunches per Palm

There were highly significant differences (P=0.01) in the number of bunches per palm due to the irrigation intervals in both seasons (Tables 38 and 39).

The comparison between the irrigation intervals in the first season showed that the application of water every 10 days resulted in increased number of bunches per palm, 9.8%, over the control (30 days), and no significant difference between 10 and 20 days of irrigation intervals (Table 40). Likewise, in the second season, the10 day irrigation intervals gave greater number of bunches per palm, 18.6% over the control, and no significant difference between 20 and 30 days intervals (Table 40). The comparison between the fertilization doses in both seasons showed highly significant difference (p= 0.01) in number of bunches per palm (Tables 38 and 39). The treatment (60kg organic + 0.25kg NPK 15%) gave greater number of bunches per palm, 9.5% and 14.6% over the control in both seasons (Table 41). In the first season no significant differences between (60kg organic + 0.25kg NPK 15%), (30kg organic + 0.25kg NPK 15%), (120kg organic + 0.25kg NPK 15%) and (30kg organic + 0.50kg NPK 15%), but there were differences between (60kg organic + 0.25kg NPK 15%), (30kg organic + 0.25kg NPK 15%), (120kg organic + 0.25kg NPK 15%) and (30kg organic + 0.50kg NPK 15%). Also no significant difference between the control and (30kg organic + 0.50kg NPK 15%), but there were differences between (30kg organic + 0.25kg NPK 15%),

(60kg organic + 0.25kg NPK 15%), (120kg organic + 0.25kg NPK 15%) and control. Also there was no significant difference between (60kg organic + 0.50kg NPK 15%), (30kg organic + 0.50kg NPK 15%) and the control. But there were differences between (60kg organic + 0.50kg NPK 15%) and (30kg organic + 0.25kg NPK 15%),(60kg organic + 0.25kg NPK 15%), (120kg organic + 0.25kg NPK 15%). The control greater than (120kg organic + 0.25kg NPK 15%) (Table 41). The differences between the interaction in number of bunches per palm were highly significant (P=0.01) in both seasons (Tables 38 and 39). The results showed that the greater number of bunches per palm was obtained by (10 day irrigation + 30kg organic + 0.50kg NPK 15%) in both seasons, increased by 25.5% and 36.2% over the control (Table 42).

In the first season no significant difference between (10 day irrigation + 30kg organic + 0.50kg NPK 15%) and (20 day irrigation + 30kg organic + 0.25 kg NPK 15%) (Table 42). In the second season (10 day irrigation + 30kg organic + 0.50kg NPK 15%) gave greater number over all treatments and the control (Table 42).

Table (38): Effect of treatments and their interactions on bunch characteristics in season (2009/2010).

Parameters	Irrigation	Fertilization	Irrigation X Fertilization
number of bunches/palm	8.30**	9.10**	5.34**
number of fruit/bunch	52212.90**	206646**	21014.8*
Weight of fruit/bunch	18.39**	696**	1.83**

** = significant at 1% level (highly significant)

* = significant at 5% level (significant)

N.S = not significant.

Table (39): Effect of treatments and their interactions on bunch characteristics in season (2010/2011).

Parameters	Irrigation	Fertilization	Irrigation X Fertilization
Number of bunches/palm	47.48**	12.88**	9.16**
Number of fruit/bunch	306003 *	198642**	17216.5**
Weight of fruit/bunch	65.35**	17.29**	2.37**

Table (40) Effects of irrigation intervals on number of bunches/palm of date palm trees in both seasons (2009/10 and 2010/11).

Treatments	Number of bunches/palm	
irrigation intervals	1st season	2nd season
day 10	a 12.52	a 15.10
day 20	a 12.10	b 12.76
day 30	b 11.29	b 12.29
Means	11.97	13.38
± SE	0.25	0.35
LSD	0.71	1.01
%C.V	9.5	12.2

Means with the same letters in same column are not significantly .different according to Duncan Multiple Range Test P> 0.05

Table (41) Effects of fertilization doses on number of bunches/palm of date palm trees in both seasons (2009/10 and 2010/11).

Treatments	number of bunches/palm	
fertilization doses	1st season	2nd season
F0	11.67 bc	12.44 cd
F1	12.78 ab	14.33 ab

F2	12.89 [a]	14.56 [a]
F3	12.67 [ab]	13.89 [abc]
F4	12.33 [abc]	14.33 [ab]
F5	11.33 [c]	12.67 [bcd]
F6	10.11 [d]	11.44 [d]
Means	11.97	13.38
SE ±	0.38	0.54
LSD	1.08	1.55
C.V%	9.5	12.2

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P> 0.05.

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

Table (42) Effects of interaction on number of bunches/palm date palm trees in both seasons (2009/10 and 2010/11).

Treatments	number of bunches/palm	
Interaction	1st season	2nd season
AF0	[cde] 11.67	[cdefgh] 12.33
AF1	[cde] 11.33	[cdefgh] 12.67
AF2	[bcd] 13.00	[b] 16.00
AF3	[bc] 13.33	[bcd] 15.00
AF4	[a] 15.67	[a] 19.33
AF5	[cde] 11.67	[bcdefg] 13.67
AF6	[de] 11.00	[bcdefg] 13.67
BF0	[cde] 11.67	[fgh] 11.00

BF1	ab 14.00	bcdefgh 13.00
BF2	bc 13.33	bc 15.33
BF3	bc 13.33	bcde 14.67
BF4	cde 11.67	defgh 12.00
BF5	de 11.00	cdefgh 12.67
BF6	e 9.67	gh 10.67
CF0	cde 11.67	bcdef 14.00
CF1	bcd 13.00	bcde 14.33
CF2	bcd 12.33	cdefgh 12.33
CF3	cde 11.33	defgh 12.00
CF4	e 9.67	efgh 11.67
CF5	cde 11.33	efgh 11.67
CF6	e 9.67	h 10.00
± SE	0.66	0.94
LSD	1.87	0.94
%C.V	9.5	2.69

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

A= 10 day of irrigation intervals / B= 20 day of irrigation intervals / C= 30 day of irrigation intervals.

4.4.2. Number of Fruits per Bunch

The results indicated highly significant difference (P=0.01) in number of fruits per bunch among the different irrigation intervals in both seasons (Tables 38 and 39). The results of the first season showed that the application of 10 day and 20 day of irrigation intervals gave higher number of fruits per bunch; every 10 day interval increased the number by 11.6% over 30 day interval or the control (Table 43). On the other hand, in the second season there was highly significant difference due to

the applications of water every 10 days interval, increased 25% over the control, then followed by 20 day interval (Table 43).

The comparison between the fertilization doses in both seasons showed that there were significantly greater (P=0.01) number of fruits per bunch (Tables 38 and 39). In the first season no significant differences between (30kg organic + 0.25kg NPK 15%),(60kg organic + 0.25kg NPK 15%), (120kg organic + 0.25kg NPK 15%), (30kg organic + 0.50kg NPK 15%) and (60kg organic + 0.50kg NPK 15%), also no significant difference between (60kg organic + 0.50kg NPK 15%) and (120kg organic + 0.50kg NPK 15%), but there were highly significant differences between (120kg organic + 0.50kg NPK 15%) and (30kg organic + 0.25kg NPK 15%), (60kg organic + 0.25kg NPK 15%),(120kg organic + 0.25kg NPK 15%), (30kg organic + 0.50kg NPK 15%). The dose (30kg organic + 0.25kg NPK 15%) increased the number of fruit per bunch by 46.3% over the control (Table 44). The results in the second season showed that no significant differences between (30kg organic + 0.25kg NPK 15%), (60kg organic + 0.25kg NPK 15%),(120kg organic + 0.25kg NPK 15%) and (30kg organic + 0.50kg NPK 15%).

Also no significant differences between (30kg organic + 0.25kg NPK 15%) and (60kg organic + 0.50kg NPK 15%) but there were differences between (60kg organic + 0.50kg NPK 15%) and (60kg organic + 0.25kg NPK 15%),(120kg organic + 0.25kg NPK 15%), (30kg organic + 0.50kg NPK 15%). The dose (60kg organic + 0.25kg NPK 15%) increased the number of fruit per bunch by 42.9% over the control (Table 44). It was clear that there were highly significant differences (P=0.01) in number of fruits per bunch between the interaction (fertilization doses X irrigation intervals) in both seasons (Tables 38 and 39). In the first season(10 day

irrigation+30kg organic + 0.50kg NPK 15%) increased number of fruit per bunch by 53.4% over the control, and no significant difference between (10 day irrigation + 60kg organic + 0.25kg NPK 15%), (10 day irrigation + 120kg organic + 0.25kg NPK 15%), (10 day irrigation + 120kg organic + 0.50kg NPK 15%), (20 day irrigation + 30kg organic + 0.25kg NPK 15%),(20 day irrigation + 60kg organic + 0.25kg NPK 15%),(20 day irrigation + 120kg organic + 0.25kg NPK 15%), (20 day irrigation + 30kg organic + 0.50kg NPK 15%), (30 day irrigation + 30kg organic + 0.25kg NPK 15%), (30 day irrigation + 60kg organic + 0.25kg NPK 15%) and (10 day irrigation+30kg organic + 0.50kg NPK 15%) (table 28). In the second season (10 day irrigation + 30kg organic + 0.50kg NPK 15%) increased the number of fruit per bunch 45.6% over control, and no significant different between (10 day irrigation+30kg organic + 0.50kg NPK 15%) and (10 day irrigation+120kg organic + 0.25kg NPK 15%) (Table 45).

Table (43) Effects of irrigation intervals on number of fruit/bunch in both seasons (2009/10 and 2010/11).

Treatments	number of fruit/bunch	
Irrigation interval	1st season	2nd season
10 day	822.19 [a]	964.10 [a]
20 day	800.81 [a]	847.43 [b]
30 day	727.14 [b]	722.71 [c]
Means	783.38	844.75
SE ±	20.16	17.45
LSD	57.63	49.88
C.V%	11.8	9.5

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P> 0.05.

Table (44) Effects of fertilization doses on number of fruit/bunch in both seasons (2009/10 and 2010/11).

Treatments	number of fruit/bunch	
fertilization doses	1st season	2nd season
F0	462.3 c	537.0 d
F1	861.0 a	904.6 ab
F2	872.7 a	940.4 a
F3	874.2 a	942.4 a
F4	880.1 a	955.1 a
F5	802.2 ab	846.0 bc
F6	731.1 b	787.7 c
Means	783.4	844.74
SE ±	30.8	26.66
LSD	88.04	76.20
C.V%	11.8	9.5

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

Table (45) Effects of interaction on number of fruit/bunch in both seasons (2009/10 and 2010/11).

Treatments	number of fruit/bunch	
Interaction	1st season	2nd season
AF0	468.0 hi	640 ij
AF1	721.3 efg	897 cdef
AF2	918.0 abc	1031 bc
AF3	952.3 abc	1087 ab
AF4	1004.0 a	1176 a
AF5	908.3 abcd	987 bcd
AF6	683.7 cdef	930 cde
BF0	567.0 gh	508.7 jk
BF1	977.3 ab	894 cdef
BF2	850.3 abcdef	942 bcde
BF3	849.0 abcdef	962.7 bcd

BF4	856.3 abcdef	960.7 bcd
BF5	773.0 cdef	863.7 defg
BF6	732.7 defg	800.3 efgh
CF0	352.0 i	462.3 k
CF1	884.3 abcde	922.7 cdef
CF2	849.7 abcdef	848 defg
CF3	821.3 bcdef	777.3 fghi
CF4	780.3 cdef	628.7 ghi
CF5	725.3 efg	687.3 hi
CF6	677.0 fg	632.ij
SE ±	53.35	46.17
LSD	152.5	132
C.V%	11.8	9.5

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

A= 10 day of irrigation intervals / B= 20 day of irrigation intervals / C= 30 day of irrigation intervals.

4.4.3. Weight of Fruits per Bunch (kg)

There were highly significant differences (P=0.01) due to irrigation intervals treatments on weight of fruits per bunch in both seasons (Tables 38 and 39).The comparison between the irrigation intervals in both seasons showed that 10 day interval increased the weight of fruits per bunch by 40 % and 42.2% over the control, respectively, followed by 20 and 30 day intervals in both seasons, respectively (Table 46). On the other hand, there were highly significant differences (P=0.01) in weight of fruits per bunch resulted from the applications of fertilization doses in both seasons (Tables 38 and 39).

The treatment (30kg organic + 0.25kg NPK 15%) gave greater weight of fruits per bunch, 49.1% and 45.9% over the control in both seasons respectively (Table 46). In the first season there were no significant

differences between (60kg organic + 0.25kg NPK 15%), (30kg organic + 0.50kg NPK 15%) and (30kg organic + 0.25kg NPK 15%) , also no significant differences between(60kg organic + 0.25kg NPK 15%), (120kg organic + 0.25kg NPK 15%) and (30kg organic + 0.50kg NPK 15%), but there was a different between (120kg organic + 0.25kg NPK 15%) and (30kg organic + 0.25kg NPK 15%) , also no significant differences between (120kg organic + 0.25kg NPK 15%) and (60kg organic + 0.50kg NPK 15%), but there were significant different between (60kg organic + 0.25kg NPK 15%),(30kg organic + 0.50kg NPK 15%) and (60kg organic + 0.50kg NPK 15%). The lowest weight of fruit per bunch gave by (120kg organic + 0.50kg NPK 15%) and the control (Table 47). In the second season there were no significant differences between (30kg organic + 0.25kg NPK 15%) and (60kg organic + 0.25kg NPK 15%), also no significant differences between (120kg organic + 0.25kg NPK 15%), (30kg organic + 0.50kg NPK 15%)

and (60kg organic + 0.25kg NPK 15%) but there were significant differences between (60kg organic + 0.25kg NPK 15%), (30kg organic + 0.50kg NPK 15%) and(30kg organic + 0.25kg NPK 15%). The lowest weight of fruit per bunch was given by the control (Table 47).

Highly significant differences (P=0.01) in weight of fruits per bunch were observed between the interaction (irrigation intervals X fertilization doses) in both seasons (Tables 38 and 39).

The comparison between the interactions in both seasons showed that the application of (10 day irrigation+30kg organic + 0.50kg NPK 15%) increased the weight of fruits per palm by 54.2% and 48.6% over the control. In the first season there were highly significant differences caused by the treatment (10 day irrigation+30kg organic + 0.50kg NPK 15%) over other the treatments and the control (Table 48). In the second

season there were no significant differences between (10 day irrigation+30kg organic + 0.50kg NPK 15%), (10 day irrigation+120kg organic + 0.25kg NPK 15%) and (20 day irrigation+30kg organic + 0.25kg NPK 15%) (Table 48).

Table (46) Effects of irrigation intervals on weight of fruit/bunch in both seasons (2009/10 and 2010/11).

Treatments	Weight of fruit/bunch (kg)	
Irrigation interval	1st season	2nd season
10 day	4.57 a	8.37 a
20 day	3.33 b	6.66 b
30 day	2.74 c	4.84 c
Means	3.61	6.62
SE ±	0.13	0.14
LSD	0.38	0.40
C.V%	17.4	9.4

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P> 0.05.

Table (47) Effects of fertilization doses on weight of fruit/bunch in both seasons (2009/10 and 2010/11).

Treatments	Weight of fruit/bunch (kg)	
fertilization doses	1st season	2nd season
F0	2.28 d	4.44 e
F1	4.48 a	8.21 a
F2	4.24 ab	7.66 ab
F3	3.77 bc	7.53 b
F4	4.20 ab	7.15 b
F5	3.39 c	6.07 c
F6	2.46 d	5.30 d
Means	3.55	6.62
SE ±	0.21	0.21
LSD	0.59	0.60
C.V%	17.4	9.4

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

Table (48) Effects of interaction on weight of fruit/bunch in both seasons (2009/10 and 2010/11).

Treatments	weight of fruit/bunch (kg)	
Interaction	1st season	2nd season
AF0	3.11 efghi	5.37 ij
AF1	4.26 bcde	8.75 bcd
AF2	5.00 bc	9.26 bc
AF3	5.28 b	9.85 ab
AF4	6.79 a	10.44 a
AF5	4.67 bcd	8.21 cde
AF6	2.88 ghi	6.70 fgh
BF0	2.03 ij	4.29 jk
BF1	5.08 bc	9.57 ab
BF2	4.05 cdefg	7.76 def
BF3	3.33 efgh	7.33 efg
BF4	3.19 efghi	6.44 ghi
BF5	3.01 fghi	5.82 hi
BF6	2.60 hij	5.41 ij
CF0	1.68 j	3.64 k
CF1	4.10 cdef	6.32 ghi
CF2	3.66 defgh	5.97 hi
CF3	2.71 hij	5.40 ij
CF4	2.62 hij	4.57 jk
CF5	2.49 hij	4.18 k
CF6	2.90 ghi	3.80 k
SE ±	0.36	0.36
LSD	1.02	1.03
C.V%	17.4	9.4

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

A= 10 day of irrigation intervals / B= 20 day of irrigation intervals / C= 30 day of irrigation intervals.

4.5. Effects of Treatments on Strands Characteristics:

4.5.1. Number of Strands per Bunch

There were highly significant differences (P=0.01) on number of strands per bunch in both seasons (Tables 49 and 50). The comparison between the irrigation intervals in the first season showed that the treatment 10 day interval gave significantly greater number of strands per bunch, 12%, over the control, followed by 20 day interval (Table 51).

In the second season, the treatment 10 day interval was grater by 10.7% over the control and no significant difference between 20 and 30 day irrigation intervals (Table 51). The comparison between the fertilization doses in both seasons showed that there were highly significant differences (p= 0.01) in the number of strands per bunch (Tables 49 and 50). Application of (30kg organic + 0.25kg NPK 15%) gave greater number of strands per bunch, 27.8% and 40.4%, over the control in both seasons respectively (table 52). In the first season no significant difference between (60kg organic + 0.25kg NPK 15%) ,(30kg organic + 0.50kg NPK 15%) and (30kg organic + 0.25kg NPK 15%), also no significant difference between(60kg organic + 0.25kg NPK 15%) , (120kg organic + 0.25kg NPK 15%) ,(30kg organic + 0.50kg NPK 15%) and (60kg organic + 0.50kg NPK 15%). But there were differences between (120kg organic + 0.25kg NPK 15%),(60kg organic + 0.50kg NPK 15%) and (30kg organic + 0.25kg NPK 15%). Also there were no

significant differences between (120kg organic + 0.25kg NPK 15%), (60kg organic + 0.50kg NPK 15%) and (120kg organic + 0.50kg NPK 15%), also no significant differences between (120kg organic + 0.50kg NPK 15%) and the control.

But there were differences between (120kg organic + 0.25kg NPK 15%), (60kg organic + 0.50kg NPK 15%) and control(Table 52). In the second season there were no significant differences between (60kg organic + 0.25kg NPK 15%), (120kg organic + 0.25kg NPK 15%) and (30kg organic + 0.50kg NPK 15%), and also no significant differences between (60kg organic + 0.50kg NPK 15%) and (120kg organic + 0.50kg NPK 15%). All treatments were better than control (Table 52). The differences between the interactions on number of strands per bunch were not significant in the first season but highly significantly different (p= 0.01) in the second season (Tables 49 and 50). The results showed that the interactions (10 day irrigation+30kg organic + 0.50kg NPK 15%) increased the number of strands by 27.7% and 47% over the control in both seasons.

In the first season no significant difference between (10 day irrigation+30kg organic + 0.25kg NPK 15%), (10 day irrigation + 60kg organic + 0.25kg NPK 15%), (10 day irrigation + 120kg organic + 0.25kg NPK 15%), (10 day irrigation + 60kg organic + 0.50kg NPK 15%), (20 day irrigation+30kg organic + 0.25kg NPK 15%), (30 day irrigation + 30kg organic + 0.25kg NPK 15%) and(10 day irrigation+30kg organic + 0.50kg NPK 15%) (Table 53). Also, in the second season no significant difference between (10 day irrigation + 60kg organic + 0.25kg NPK 15%), (20 day irrigation+30kg organic + 0.25kg NPK 15%) (30 day irrigation + 30kg organic + 0.25kg NPK 15%) and (10 day irrigation+30kg organic + 0.50kg NPK 15%) (Table 53).

Table (49): Effect of treatments and their interactions on strands characteristics in season (2009/2010).

Parameters	Irrigation	Fertilization	Irrigation X Fertilization
number of strand/bunch	220.91*	251.40**	33.40 NS
number of fruit/strand	1.73 NS	17.65**	4.25**
length of strand	13.90**	31.85**	4.55 *

** = significant at 1% level (highly significant)

* = significant at 5% level (significant)

N.S = not significant.

Table (50): Effect of treatments and their interactions on strands characteristics in season (2010/2011).

Parameters	Irrigation	Fertilization	Irrigation X Fertilization
number of strand/bunch	198.68**	636.19**	68.81 **
number of fruit/strand	21.14 **	13.83**	8.07**
length of strand	445.44**	187.92**	80.41 *

** = significant at 1% level (highly significant)

* = significant at 5% level (significant)

N.S = not significant.

Table (51) Effects of irrigation intervals on number of strand/bunch in both seasons (2009/10 and 2010/11).

Treatments	number of strand/bunch	
irrigation intervals	1st season	2nd season
day 10	a 52.76	a 56.57
day 20	b 48.38	b 52.57
day 30	c 46.43	b 50.52
Means	49.19	53.22
± SE	1.13	0.95
LSD	3.22	2.72
%C.V	10.5	8.2

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P> 0.05.

Table (52) Effects of fertilization doses on number of strand/bunch in both seasons (2009/10 and 2010/11).

Treatments	number of strand/bunch	
Fertilization doses	1st season	2nd season
F0	d 40.11	d 37.56
F1	a 55.56	a 63.44
F2	ab 52.44	b 59.22
F3	bc 49.89	b 55.67
F4	ab 53.00	b 56.56
F5	bc 48.44	c 50.78
F6	cd 44.89	c 49.33
Means	49.19	53.22
± SE	1.72	1.46
LSD	4.92	4.16
%C.V	10.5	8.2

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

Table (53) Effects of interaction on number of strand/bunch in both seasons (2009/10 and 2010/11).

Treatments	Number of strand/bunch	
Interaction	1st season	2nd season
AF0	efg 44.33	k 35.67
AF1	abcde 53.33	bcde 59.33
AF2	abc 56.00	abcd 61.33
AF3	abcde 52.67	bcde 59.00
AF4	a 61.33	a 67.33
AF5	abcde 52.00	cdef 57.00
AF6	bcdef 49.67	defg 56.33
BF0	h 35.00	k 36.67
BF1	ab 58.33	abc 65.00
BF2	bcde 51.33	bcde 59.00
BF3	bcdef 50.67	defg 55.67
BF4	bcdef 49.67	defgh 53.00
BF5	cdefg 48.00	fghi 50.00
BF6	defg 45.67	ghi 48.67
CF0	fgh 41.00	jk 40.33
CF1	abcd 55.00	ab 66.00
CF2	bcdef 50.00	cdef 57.33
CF3	cdefg 46.33	efgh 52.33
CF4	cdefg 48.00	fghi 49.33
CF5	defg 45.33	hij 45.33
CF6	gh 39.33	ijk 43.00
± SE	2.98	2.52
LSD	8.52	7.20
%C.V	10.5	8.2

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

A= 10 day of irrigation intervals / B= 20 day of irrigation intervals / C= 30 day of irrigation intervals.

4.5.2. Number of Fruits per Strand

There were no significant differences in number of fruits per strand between the irrigation intervals in the first season, but there were highly significant differences (p =0.01) in the second season (Tables 49 and 50). Results showed that no significant differences of irrigation intervals in the first season on number of fruits per strand (Table 54).

In the second season the 10 days interval increased the number of fruits per strand by 10.7% over the control, followed by 20 and 30 day (the control) respectively (Table 54). Whereas the fertilization treatments showed highly significant differences (p =0.01) in both seasons (Tables 49 and 50). The comparison between the fertilization doses in both seasons showed that the treatment (30kg organic + 0.25kg NPK 15%) increased number of fruits per strand by 22.5% over the control, and the application of (30kg organic + 0.50kg NPK 15%) increased the number of fruit per strand by 20.3% over the control, respectively (table 55). In the first season no significant differences between (30kg organic + 0.25kg NPK 15%),(60kg organic + 0.25kg NPK 15%) and(30kg organic + 0.50kg NPK 15%), and also no significant differences between (60kg organic + 0.25kg NPK 15%), (120kg organic + 0.25kg NPK 15%) and (60kg organic + 0.50kg NPK 15%). But there were significant differences between (120kg organic + 0.25kg NPK 15%), (60kg organic + 0.50kg NPK 15%) and (30kg organic + 0.25kg NPK 15%), (30kg organic + 0.50kg NPK 15%), also no significant differences between (120kg organic + 0.25kg NPK 15%), (60kg organic + 0.50kg NPK 15%) and (120kg organic + 0.50kg NPK 15%), but there were differences between (120kg organic + 0.50kg NPK 15%) and (60kg organic + 0.25kg NPK 15%) over the control (Table 55).

In the second season (30kg organic + 0.50kg NPK 15%) gave greater value over all treatments and control (Table 55). There were highly significant differences (p=0.1) between the interaction in both seasons (Tables 49 and 50). It was clear that the differences between the interactions (fertilization doses x irrigation intervals) showed that (20 day irrigation interval +30kg organic + 0.25kg NPK 15%) increased the number of fruits per strand by 26.6% over the control in the first season, and that (10 day irrigation +30kg organic + 0.50kg NPK 15%) increased the number of fruits per strand 32% over control in the second season (Table 56). In the first season no significant difference between (20 day irrigation +30kg organic + 0.25kg NPK 15%) and (10 day irrigation +30kg organic + 0.50kg NPK 15%), all treatments over control. In the second season (10 day irrigation +30kg organic + 0.50kg NPK 15%) was greater than other treatments and the control (Table 56).

Table (54) Effects of irrigation intervals on number of fruit/strand in both seasons (2009/10 and 2010/11).

Treatments	number of fruit/strand	
Irrigation interval	1st season	2nd season
day 10	a 16.57	a 18.62
day 20	a 16.81	b 17.48
day 30	a 16.24	c 16.62
Means	16.54	17.57
± SE	0.21	0.21
LSD	0.60	0.60
%C.V	5.8	5.4

Means with the same letters in same column are not significantly .different according to Duncan Multiple Range Test P> 0.05

Table (55) Effects of fertilization doses on number of fruit/strand in .both seasons (2009/10 and 2010/11)

Treatments	number of fruit/strand	
	1st season	2nd season
F0	13.78 d	15.67 e
F1	17.78 a	18.00 bc
F2	17.22 ab	18.22 b
F3	16.67 bc	17.11 cd
F4	17.89 a	19.67 a
F5	16.44 bc	17.33 bcd
F6	16.00 c	17.00 d
Means	16.54	17.57
SE ±	0.32	0.32
LSD	0.91	0.91
C.V%	5.8	5.4

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

Table (56) Effects of interaction on number of fruit/strand in both seasons (2009/10 and 2010/11).

Treatments	Number of fruit/strain	
	1st season	2nd season
AF0	gh 14.67	def 16.33
AF1	efgh 15.67	cd 18.00
AF2	cdefg 16.33	cd 18.00

AF3	cdefg 16.33	cde 17.33
AF4	ab 19.33	a 24.00
AF5	cdef 17.00	cd 18.00
AF6	cdef 16.67	c 18.67
BF0	hi 14.00	f 15.33
BF1	a 20.00	cd 18.00
BF2	bc 18.00	b 20.67
BF3	cde 17.33	cde 17.67
BF4	cdef 17.00	cdef 17.00
BF5	defg 16.00	cde 17.33
BF6	fgh 15.33	def 16.33
CF0	i 12.67	f 15.33
CF1	bcd 17.67	cd 18.00
CF2	cde 17.33	ef 16.00
CF3	cdefg 16.33	def 16.33
CF4	cde 17.33	cd 18.00
CF5	cdefg 16.33	def 16.67
CF6	defg 16.00	ef 16.00
± SE	0.55	0.55
LSD	1.58	1.57
%C.V	5.8	5.4

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

A= 10 day of irrigation intervals / B= 20 day of irrigation intervals / C= 30 day of irrigation intervals.

4.5.3. Length of Strand per Bunch (cm):

There were highly significant differences (P=0.01) in length of strands per bunch in both seasons (Tables 49 and 50). The comparison between the irrigation intervals in the first season showed that the application of 10 day irrigation interval significantly increased the number of strands over the control (30 day), also there was significant differences between 20 and 30 day intervals of irrigation (Table 57).

Whereas in the second season the application of 10 day interval showed greater length of strand per bunch, 20.2%, over the control, and no significant difference between 20 day and 30 intervals of irrigation (Table 57). The comparison between the fertilization doses showed that there were highly significant differences (p= 0.01) in length of strands per bunch in both seasons (Tables 49 and 50). The application of (30kg organic + 0.50kg NPK 15%) gave greater length of strand per bunch, 19.7%, over the control and no significant difference between (30kg organic + 0.25kg NPK 15%), (60kg organic + 0.25kg NPK 15%), (120kg organic + 0.25kg NPK 15%) and (30kg organic + 0.50kg NPK 15%). Also no significant differences between (30kg organic + 0.25kg NPK 15%), (60kg organic + 0.25kg NPK 15%), (120kg organic + 0.25kg NPK 15%), (60kg organic + 0.50kg NPK 15%) and (120kg organic + 0.50kg NPK 15%), but there were significant differences between (60kg organic + 0.50kg NPK 15%) and (120kg organic + 0.50kg NPK 15%) and (30kg organic + 0.50kg NPK 15%).The control gave the lowest value (Table 58). Whereas in the second season the high value (30kg organic + 0.50kg NPK 15%) gave 33.7% increase in length of strands per bunch over the control, and no significant difference between the other treatments over the control (Table 58).

The differences between the interaction on length of strands per bunch were significant (p= 0.05) in both seasons (Tables 49 and 50). The results showed that in the first season the application of (10 day irrigation +30kg organic + 0.50kg NPK 15%) increased the length of strands per bunch by 20.7% over the control, and no significant differences between (10 day irrigation +30kg organic + 0.25kg NPK 15%), (10 day irrigation +60kg organic + 0.25kg NPK 15%), (10 day irrigation +120kg organic + 0.25kg NPK 15%), (20 day irrigation +30kg organic + 0.25kg NPK 15%),(30 day irrigation +60kg organic + 0.50kg NPK 15%) and (30 day irrigation

+120kg organic + 0.50kg NPK 15%) and (10 day irrigation +30kg organic + 0.50kg NPK 15%) over the control (Table 59). In the second season the applications of (10 day irrigation +30kg organic + 0.50kg NPK 15%) gave the greater number of strands per bunch, 51.8% over the control, and all treatments were greater over the control (Table 59).

Table (57) Effects of irrigation intervals on length of strand in both seasons (2009/10 and 2010/11).

Treatments	length of strand (cm)	
Irrigation interval	1st season	2nd season
day 10	[a] 32.48	[a] 43.86
day 20	[c] 30.86	[b] 37.24
day 30	[b] 31.52	[b] 35.00
Means	31.62	38.70
± SE	0.33	0.82
LSD	0.95	2.36
%C.V	4.8	9.8

Means with the same letters in same column are not significantly .different according to Duncan Multiple Range Test P> 0.05

Table (58) Effects of fertilization doses on length of strand in both seasons (2009/10 and 2010/11).

Treatments	length of strand (cm)	
	1st season	2nd season
F0	26.67 [c]	30.33 [c]
F1	32.56 [ab]	40.33 [b]
F2	32.56 [ab]	39.78 [b]
F3	32.67 [ab]	38.89 [b]
F4	33.22 [a]	45.78 [a]
F5	31.44 [b]	37.89 [b]
F6	31.22 [b]	37.89 [b]
Means	31.48	38.70
SE ±	0.51	1.26
LSD	1.45	3.60
C.V%	4.8	9.8

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

Table (59) Effects of interaction on length of strand in both seasons (2009/10 and 2010/11).

Treatments	length of strand (cm)	
	1st season	2nd season
AF0	ef 28.00	fg 30.67
AF1	ab 32.67	bcd 42.67
AF2	ab 33.67	bc 43.00
AF3	ab 34.00	b 43.67
AF4	a 35.33	a 63.67
AF5	bc 32.33	bcd 42.67
AF6	bcd 31.33	bcde 40.67
BF0	ef 28.33	fg 30.67
BF1	ab 33.00	bcd 41.33
BF2	bcd 31.67	bcde 41.00
BF3	bc 32.33	bcdef 37.33
BF4	bc 32.00	bcdefg 37.00
BF5	def 29.00	bcdef 37.33
BF6	cde 29.67	cdefg 36.00
CF0	f 26.67	g 29.67
CF1	bc 32.00	bcdefg 37.00
CF2	bc 32.33	defg 35.33

CF3	bcd 31.67	cdefg 35.67
CF4	bc 32.33	bcdefg 36.67
CF5	ab 33.00	efg 33.67
CF6	ab 32.67	bcdefg 37.00
± SE	0.88	2.18
LSD	2.51	6.23
%C.V	4.8	9.8

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

A= 10 day of irrigation intervals / B= 20 day of irrigation intervals / C= 30 day of irrigation intervals.

4.6. Effects of treatments on growth components of date palm trees:

4.6.1. Stem length (cm)

From the statistical analysis it was clear that there were significant differences (P=0.05) and highly significant differences (P=0.01) on stem length between the irrigation intervals in the first season and the second season, respectively (Tables 60 and 61). The comparison between the irrigation intervals in both seasons showed that the greater value was every 10 day irrigation intervals, the increase was 3.6% and 7.1% over the control, respectively. In both seasons no significant difference between 10 and 20 day irrigation intervals (Table 62). There were highly significant differences (p=0.01) between the fertilization doses on stem length in both seasons (Tables 60 and 61). The comparison between the fertilization doses in the first season showed that the application of (60kg organic + 0.25kg NPK 15%) gave greater length on stem 21.4% over the control, and no significant difference between (30kg organic + 0.25kg NPK 15%), (120kg organic + 0.25kg NPK 15%),

(30kg organic + 0.50kg NPK 15%), (60kg organic + 0.50kg NPK 15%) and (60kg organic + 0.25kg NPK 15%). Also no significant difference between (30kg organic + 0.25kg NPK 15%), (120kg organic + 0.25kg NPK 15%), (60kg organic + 0.50kg NPK 15%) and (120kg organic + 0.50kg NPK 15%), but there was significant difference between (60kg organic + 0.25kg NPK 15%), (30kg organic + 0.50kg NPK 15%) and (120kg organic + 0.50kg NPK 15%) (Table 63). Whereas in the second season the fertilization doses showed that the application of (30kg organic + 0.50kg NPK 15%)gave greater stem length 23.2% over the control, and there were no significant difference between applications of (30kg organic + 0.25kg NPK 15%),

(60kg organic + 0.25kg NPK 15%), (120kg organic + 0.25kg NPK 15%) and (30kg organic + 0.50kg NPK 15%) on stem length, also no significant difference between (30kg organic + 0.25kg NPK 15%), (120kg organic + 0.25kg NPK 15%) , (60kg organic + 0.50kg NPK 15%) and (120kg organic + 0.50kg NPK 15%) ,but there was a difference between(60kg organic + 0.25kg NPK 15%), (30kg organic + 0.50kg NPK 15%) and (120kg organic + 0.50kg NPK 15%) (Table 63). From the statistical analysis it was clear that, the differences between the interactions were not significant in the first season and highly significant (p=0.01) in the second season (Tables 60 and 61). In the second season the application of (10 day irrigation +30kg organic + 0.50kg NPK 15%) were greater significant 30.2% over the control on stem length, all treatments had significant effects over the control (Table 64).

Table (60): Effect of treatments and their interactions on growth components in season (2009/2010).

	Irrigation	Fertilization	Irrigation X Fertilization

Parameters			
Stem length	59.54*	416**	20.04 NS
Stem diameter	106.63**	15.10*	17.02 **
number of new leaves	9 *	3.40*	0.89 NS
number of total leaves	211.92 *	446.98 **	62.33 NS

** = significant at 1% level (highly significant)

* = significant at 5% level (significant)

N.S = not significant.

Table (61): Effect of treatments and their interactions on growth components in season (2010/2011).

Parameters	Irrigation	Fertilization	Irrigation X Fertilization
Stem length	271.44**	573.14**	47.56 *
Stem diameter	80.95**	52.10**	24.59 **
number of new leaves	64.87 **	9.29**	4.58 **
number of total leaves	338.62 *	437.66 **	48.77 NS

** = significant at 1% level (highly significant)

* = significant at 5% level (significant)

N.S = not significant.

Table (62) Effects of irrigation intervals on stem length in both seasons (2009/10 and 2010/11).

Treatments	stem length (cm)	
Irrigation interval	1st season	2nd season
10 day	87.67 a	97.14 a
20 day	87.14 a	95.43 a
30 day	84.52 b	90.24 b
Means	86.44	94.27
SE ±	0.87	0.92
LSD	2.50	2.64
C.V%	4.6	4.5

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P> 0.05.

Table (63) Effects of fertilization doses on stem length in both seasons (2009/10 and 2010/11).

Treatments	stem length (cm)	
Fertilization doses	1st season	2nd season
F0	71.56 c	76.78 d
F1	89.89 ab	96.89 abc
F2	91.00 a	99.11 ab
F3	89.11 ab	97.67 abc
F4	90.33 a	100.00 a
F5	87.22 ab	95.44 bc
F6	86.00 b	94.00 c
Means	86.44	94.27
SE ±	1.34	1.41
LSD	3.82	4.04
C.V%	4.6	4.5

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

Table (64) Effects of interaction of irrigation and fertilization on stem length in both seasons (2009/10 and 2010/11).

Treatments	stem length (cm)	
	1st season	2nd season
AF0	73.00 a	77.67 g
AF1	87.33 a	96.00 bcdef
AF2	90.67 a	99.00 bc
AF3	90.00 a	102.00 b
AF4	96.67 a	111.3 a
AF5	88.33 a	97.00 bcdef
AF6	87.67 a	97.00 bcdef
BF0	70.00 a	75.67 g
BF1	92.33 a	99.00 bc
BF2	94.00 a	101.3 b
BF3	90.33 a	98.67 bcd
BF4	89.00 a	88.00 bcde
BF5	88.33 a	99.33 bc
BF6	86.00 a	96.00 bcdef
CF0	71.67 a	77.00 g
CF1	90.00 a	95.67 bcdef
CF2	88.33 a	97.00 bcdef
CF3	87.00 a	92.33 cdef
CF4	85.33 a	90.67 def
CF5	85.00 a	90.00 ef
CF6	84.33 a	89.00 f
SE ±	2.31	2.45
LSD	6.62	6.99
C.V%	4.6	4.5

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg). A= 10 day of irrigation intervals / B= 20 day of irrigation intervals / C= 30 day of irrigation.

4.6.2. Stem diameter (cm):

The analysis of variance indicated highly significant difference (P=0.01) on stem diameter among the different doses of irrigation intervals in both seasons (Tables 60 and 61). The result of the first season shows that the application of every 10 days of irrigation intervals gave significantly higher stem diameter 7% over the control, no significant differences between 20 and 30 days intervals. Whereas the results of the second season showed that the application of 10 days of irrigation intervals gave significantly greater stem diameter, 6.4% over 30 day (control), also there was significant difference of irrigation intervals between 20 and 30 day (Table 65). Analysis of variance indicated highly significant difference (P=0.01) in stem diameter among the different doses of fertilization in both seasons (Tables 60 and 61). The comparison between the fertilization doses in both seasons showed that the application of all doses gave significantly greater stem diameter over the control (Table 66). In the first season no significant difference between all treatments, the application of (30kg organic + 0.25kg NPK 15%) increased stem diameter 4.9% over the control. In the second season all treatments resulted in greater diameter over (120kg organic + 0.50kg NPK 15%) and the control, and (120kg organic + 0.50kg NPK 15%) over the control (Table 66). The differences between the interaction (irrigation intervals x fertilization doses) on stem diameter were highly significant (P=0.01) in both seasons (Tables 60 and 61). The results showed that in the first season the application of (10 day irrigation +120kg organic + 0.50kg NPK 15%) gave greater stem diameter, 8.4% over the control, and no significant differences between (10 day irrigation +30kg organic + 0.25kg NPK 15%), (10 day irrigation +30kg organic + 0.50kg NPK 15%), (10 day irrigation +60kg organic + 0.50kg NPK 15%) and (10 day irrigation +120kg organic + 0.50kg NPK 15%) (Table 67). Also the

results showed that in the second season (10 day irrigation +30kg organic + 0.50kg NPK 15%) gave significantly greater stem diameter, 19.2% over other doses and the control (Table 67).

Table (65) Effects of irrigation intervals on stem diameter in both seasons (2009/10 and 2010/11).

Treatments	stem diameter (cm)	
Irrigation interval	1st season	2nd season
10 day	61.68 [a]	60.47 [a]
20 day	58.41 [b]	57.99 [b]
30 day	57.35 [b]	56.60 [c]
Means	59.15	58.35
SE ±	0.52	0.39
LSD	1.47	1.13
C.V%	4	3.1

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P> 0.05.

Table (66) Effects of fertilization doses on stem diameter in both seasons (2009/10 and 2010/11).

Treatments	stem diameter (cm)	
Fertilization doses	1st season	2nd season
F0	56.26 [b]	53.81 [c]
F1	59.16 [a]	58.90 [a]
F2	59.65 [a]	60.47 [a]
F3	59.53 [a]	59.36 [a]

F4	59.74 [a]	60.36 [a]
F5	59.90 [a]	58.72 [a]
F6	59.78 [a]	56.52 [b]
Means	59.15	58.31
SE ±	0.79	0.60
LSD	2.25	1.72
C.V%	4	3.1

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

Table (67) Effects of interaction on stem diameter in both seasons (2009/10 and 2010/11).

Treatments	stem diameter (cm)	
	1st season	2nd season
AF0	59.60 [bcdef]	54.83 [i]
AF1	63.18 [ab]	58.39 [defgh]
AF2	58.46 [cdefg]	59.92 [cde]
AF3	59.89 [bcde]	61.89 [bc]
AF4	62.18 [abcd]	67.84 [a]
AF5	63.33 [ab]	62.33 [bc]
AF6	65.10 [a]	59.10 [cdefg]
BF0	54.16 [g]	54.90 [hi]
BF1	56.99 [efg]	57.32 [efghi]
BF2	62.90 [abc]	63.90 [b]
BF3	59.78 [bcde]	59.78 [cdef]

BF4	57.93 defg	56.59 efghi
BF5	60.51 bcde	57.51 efghi
BF6	56.59 efg	55.93 ghi
CF0	55.02 fg	51.70 j
CF1	57.32 efg	60.99 bcd
CF2	57.59 defg	57.59 efghi
CF3	58.93 bcdef	57.38 efghi
CF4	59.11 bcdef	56.66 efghi
CF5	55.85 efg	56.32 fghi
CF6	57.66 defg	55.52 hi
SE ±	1.37	1.04
LSD	3.90	2.98
C.V%	4	3.1

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

A= 10 day of irrigation intervals / B= 20 day of irrigation intervals / C= 30 day of irrigation intervals.

4.6.3. Number of New Growing Leaves per Palm

The analysis of variance indicated that there was no significant difference in number of new leaves per palm while there was a significant difference (P=0.05) among irrigation intervals in both seasons, respectively (Tables 60 and 61). The results of the first season showed that the application of 10 day of irrigation intervals gave significantly higher number of new leaves 10.9% over the control, and no significant difference between 10 and 20 day irrigation intervals (Table 68). Whereas in the second season the application of water every 10 days increased the number of new leaves 24.5% over the control, and there was a difference between 10 and 20 day of irrigation intervals (Table 68). Analysis of variance indicated

highly significant difference (P=0.01) in number of new leaves among the different doses of fertilization in both seasons (Tables 60 and 61). The comparison between the fertilization doses in the first season showed that the application of (30kg organic + 0.50 kg NPK 15%) increased the number 16.4% over the control, and there was no significant difference between (30kg organic + 0.25kg NPK 15%), (60kg organic + 0.25kg NPK 15%), (60kg organic + 0.50kg NPK 15%), (120kg organic + 0.50kg NPK 15%) and (30kg organic + 0.50 kg NPK 15%). Also not significant difference between (30kg organic + 0.25kg NPK 15%), (60kg organic + 0.25kg NPK 15%), (60kg organic + 0.50kg NPK 15%), (120kg organic + 0.50kg NPK 15%) , (120kg organic + 0.25kg NPK 15%) and the control. But there was a difference between the control, (30kg organic + 0.25kg NPK 15%) and (30kg organic + 0.50 kg NPK 15%). No significant difference between (120kg organic + 0.25kg NPK 15%) and the control (Table 69). Whereas was a highly significant difference in the second season of fertilization doses (30kg organic + 0.25kg NPK 15%) gave 17.1% over the control, and no significant difference between (60kg organic + 0.25kg NPK 15%),(120kg organic + 0.25kg NPK 15%) , (30kg organic + 0.50 kg NPK 15%) and (30kg organic + 0.25kg NPK 15%). Also no significant difference between (60kg organic + 0.25kg NPK 15%) and (60kg organic + 0.50kg NPK 15%), but there was no significant difference between (60kg organic + 0.50kg NPK 15%) and (30kg organic + 0.25kg NPK 15%), (120kg organic + 0.25kg NPK 15%) , (30kg organic + 0.50kg NPK 15%) , also no significant difference between (60kg organic + 0.50kg NPK 15%) and (120kg organic + 0.50kg NPK 15%), also between the control and (120kg organic + 0.50kg NPK 15%), but there was a different between the control and (60kg organic + 0.50kg NPK 15%) (Table 69). The differences between the interactions (irrigation intervals x fertilization doses) in number of new leaves were

not significant in both seasons (Tables 60 and 61). In the first season there was no significance different in all treatments (Table 70). In the second season (10 day irrigation +120kg organic + 0.25kg NPK 15%) gave greater value, 32% over the control, and no significant difference between (10 day irrigation +120kg organic + 0.25kg NPK 15%) and (10 day irrigation +30kg organic + 0.50kg NPK 15%) (Table 70).

Table (68) Effects of irrigation intervals on number of new growing leaves in both seasons (2009/10 and 2010/11).

Treatments	number of new leaves	
	1st season	2nd season
10 day	11.76 a	13.81 a
20 day	11.33 a	11.29 b
30 day	10.48 b	10.43 c
Means	11.18	11.84
SE ±	0.26	0.22
LSD	0.74	0.62
C.V%	10.6	8.4

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P> 0.05

Table (69) Effects of fertilization doses on number of new growing leaves in both seasons (2009/10 and 2010/11).

Treatments	number of new leaves

	1st season	2nd season
F0	b 10.22	d 10.22
F1	ab 11.22	a 12.33
F2	ab 11.11	ab 12.22
F3	b 10.78	a 13.00
F4	a 12.22	a 12.78
F5	ab 11.33	bc 11.33
F6	ab 11.44	cd 11.00
Means	11.19	11.84
± SE	0.39	0.33
LSD	1.13	0.95
%C.V	10.6	8.4

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

Table (70) Effects of interaction on number of new growing leaves in both seasons (2009/10 and 2010/11).

Treatments	number of new leaves	
	1st season	2nd season
AF0	a 11.00	de 11.33
AF1	a 11.67	bcd 12.67
AF2	a 11.67	b 14.00
AF3	a 11.33	a 16.67
AF4	a 13.33	a 16.67
AF5	a 11.00	bc 13.33
AF6	a 12.33	cde 12.00
BF0	a 10.67	e 10.67
BF1	a 11.67	bcd 12.67
BF2	a 11.33	cde 12.00
BF3	a 10.33	cde 11.67
BF4	a 12.33	de 11.33
BF5	a 12.00	ef 10.33
BF6	a 11.00	ef 10.33

CF0	[a] 9.00	[f] 8.67
CF1	[a] 10.33	[cde] 11.67
CF2	[a] 10.33	[e] 10.67
CF3	[a] 10.67	[e] 10.67
CF4	[a] 11.00	[ef] 10.33
CF5	[a] 11.00	[ef] 10.33
CF6	[a] 11.00	[e] 10.67
± SE	0.68	0.57
LSD	1.95	1.65
%C.V	10.6	8.4

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

A= 10 day of irrigation intervals / B= 20 day of irrigation intervals / C= 30 day of irrigation intervals.

4.6.4. Number of Total Leaves per Palm

The results indicated that there were significant difference (p= 0.05) in number of total leaves due to the doses of irrigation intervals in both seasons (Tables 60 and 61). The results of the first season showed that the application of every 10 day interval gave the greater value, 6.7% over the control, and no significant difference between 10 and 20 day irrigation intervals (Table 71). Then, in the second season every 10 day interval increased the number of leaves by 7.4% over 30 days interval over the control, and no significant difference between 20 and 30 days of irrigation intervals (Table 71). The comparison between the fertilization doses showed that highly significant difference (P=0.01), in number of total leaves in both season respectively (Tables 60 and 61). In both seasons all doses of fertilization gave greater number, 19.5% and 18.5%, over the control respectively (Table 72). The differences between the

interactions on the number of total leaves were not significantly different in both seasons (Tables 60 and 61) and (Table 73).

Table (71) Effects of irrigation intervals on number of total growing leaves in both seasons (2009/10 and 2010/11).

Treatments	number of total leaves	
	1st season	2nd season
10 day	92.67 a	105.29 a
20 day	90.81 a	99.62 b
30 day	86.48 b	97.52 b
Means	89.99	100.81
SE ±	1.81	1.72
LSD	5.17	4.92
C.V%	9.2	7.8

Means with the same letters in same column are not significantly .different according to Duncan Multiple Range Test P> 0.05

Table (72) Effects of fertilization doses on number of total growing leaves in both seasons (2009/10 and 2010/11).

Treatments	number of total leaves	
	1st season	2nd season
F0	74.22 b	85.44 b
F1	92.22 a	104.8 a
F2	92.44 a	104.8 a
F3	91.33 a	101.3 a
F4	91.56 a	100.9 a
F5	93.33 a	104.8 a
F6	94.78 a	103.7 a
Means	89.98	100.82
SE ±	2.76	2.63
LSD	7.89	7.51
C.V%	9.2	7.8

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

Table (73) Effects of interaction on number of total leaves in both seasons (2009/10 and 2010/11).

Treatments	number of total leaves	
	1st season	2nd season
AF0	a 75.00	a 87.33
AF1	a 98.67	a 109.67
AF2	a 96.67	a 110.67
AF3	a 92.00	a 107.00
AF4	a 93.00	a 107.67
AF5	a 93.00	a 107.67
AF6	a 100.33	a 107.00
BF0	a 75.67	a 87.00
BF1	a 93.67	a 103.33
BF2	a 96.67	a 108.67
BF3	a 89.67	a 96.00
BF4	a 97.00	a 99.67
BF5	a 89.33	a 98.67
BF6	a 93.67	a 104.00
CF0	a 72.00	a 82.00
CF1	a 84.33	a 101.33
CF2	a 84.00	a 95.00
CF3	a 92.33	a 101.00
CF4	a 84.67	a 95.33
CF5	a 97.67	a 108.00
CF6	a 90.33	a 100.00

± SE	4.78	4.55
LSD	13.67	13.01
%C.V	9.2	7.8

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

A= 10 day of irrigation intervals / B= 20 day of irrigation intervals / C= 30 day of irrigation intervals.

4.7. Fruit Chemical Compositions:

4.7.1- Moisture Content

There were highly significant differences (P=0.01) due to irrigation intervals in moisture content of date palm fruit (Table 74). The comparison showed that there were highly significant difference among irrigation intervals; the 20 day gave greater moisture content, 4% over 10 day and 1.1% over 30 day. On the other hand 30 day's greater 3% over 10 day, and no significant difference between 20 and 30 day of irrigation intervals (Table 75). The comparison between the fertilization doses showed that highly significant difference (P=0.01) in moisture content of date palm fruit (Table 74). The dose (30 kg organic + 0.50 kg NPK15%) gave greater moisture content 19.3% over the control then followed by (60 kg organic + 0.50 kg NPK15%) which, gave 15.1% over the control. No significant difference between the dose (120 kg organic + 0.25 kg NPK15%), (60 kg organic + 0.25 kg NPK15%) and (120 kg organic + 0.50 kg NPK15%), also no significant between the dose (120 kg organic + 0.50 kg NPK15%) and (30 kg organic + 0.25 kg NPK15%) but there were significant difference between the doses (120 kg organic + 0.25 kg NPK15%), (60 kg organic + 0.25 kg NPK15%) and (30 kg organic + 0.25 kg NPK15%). Also no significant difference between (30 kg organic +

0.25 kg NPK15%) and the control (Table 76). The interaction (irrigation intervals x fertilization doses) was highly significant (P=0.01) in moisture content of date palm fruit (Table 74).

The greatest effects of irrigation intervals and fertilization dose obtained from (10 day irrigation + 30kg organic + 0.50kg NPK 15%) which gave an increase of 34.3% over the control (Table 77).

Table (74): Effect of treatments and their interactions on fruit chemical composition in season (2010/2011).

	Treatments		
parameters	Irrigation	Fertilization	Irrigation X Fertilization
Moisture	2.61 **	15.03 **	20.16**
Total sugar	7.92**	41.10**	40.09**
Sucrose	149.40 **	39.79 **	55.94**
T.S.S	0.11 NS	0.44**	0.83**
Reducing sugar	129.49**	30.26**	41.43**
Acidity	0.13*	0.25 NS	0.77 NS

** = significant at 1% level (highly significant)

* = significant at 5% level (significant)

N.S = not significant.

Table (75) Effects of irrigation intervals on moisture content in season (2010/11).

Treatments	Moisture content %
10 day	16.43 b
20 day	17.11 a
30 day	16.93 b
SE ±	0.15
LSD	0.43
C.V%	4.1

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P> 0.05.

Table (76) Effects of fertilization doses on moisture content in season (2010/11).

Treatments	Moisture content %
F0	15.34 ^{e}
F1	15.73 ^{de}
F2	16.58 ^{c}
F3	16.75 ^{c}
F4	19.00 ^{a}
F5	18.07 ^{b}
F6	16.29 ^{cd}
± SE	0.23
LSD	0.65
%C.V	4.1

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P> 0.05.

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

Table (77) Effects of interaction on moisture content in season (2010/11).

Treatments	Moisture content %
AF0	14.53 ^{h}
AF1	12.00 ^{i}
AF2	14.92 ^{h}
AF3	14.07 ^{h}
AF4	22.10 ^{a}
AF5	19.13 ^{b}
AF6	18.27 ^{bcde}
BF0	14.50 ^{h}
BF1	17.15 ^{efg}
BF2	18.13 ^{bcde}
BF3	18.47 ^{bcd}
BF4	16.20 ^{g}
BF5	17.27 ^{defg}
BF6	18.08 ^{bcde}
CF0	17.00 ^{efg}
CF1	18.05 ^{bcde}
CF2	16.70 ^{fg}
CF3	17.70 ^{cdef}
CF4	18.70 ^{bc}
CF5	17.82 ^{cdef}
CF6	12.52 ^{i}
± SE	0.40
LSD	1.13
%C.V	4.1

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P>0.05.

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

A= 10 day of irrigation intervals / B= 20 day of irrigation intervals / C= 30 day of irrigation intervals.

4.7.2- Total Sugars

(Table 74) indicates that there were highly significant difference (P=0.01) in increase of total sugars between the irrigation intervals of date palm. The comparison between the irrigation intervals showed that the application of 30 day interval increased total sugars significantly, 3.1% over 20 day interval and 1.5% over 10 day interval (Table 78). The comparison between the fertilization doses showed that highly significant difference (P=0.01) in total sugars content of date palm fruit (Table 74). The dose (120 kg organic + 0.25 kg NPK15%) gave greater total sugars 13.8% over (120 kg organic + 0.50 kg NPK15%) then followed by the control. No significant difference between (60 kg organic + 0.25 kg NPK15%) and (30 kg organic + 0.50 kg NPK15%), also no significant difference between (60 kg organic + 0.50 kg NPK15%) and, (120 kg organic + 0.50 kg NPK15%) (Table 79). The comparison between the interactions showed that the treatments (30 day irrigation interval + 120kg organic + 0.25kg NPK 15%) increased total sugars 28.6% over (10 day irrigation interval + 120kg organic + 0.50kg NPK 15%), then followed by (10 day irrigation interval + no fertilizers). No significant difference between (10 day irrigation interval + 60kg organic + 0.25kg NPK 15%), (10 day irrigation interval + 120kg organic + 0.25kg NPK 15%) ,(20 day irrigation interval + 30kg organic + 0.25kg NPK 15%), (20 day irrigation interval + 120kg organic + 0.25kg NPK 15%), (20 day irrigation interval + 30kg organic + 0.50kg NPK 15%) and (30 day irrigation interval + 30kg organic + 0.50kg NPK 15%) (Table 80).

Table (78) Effects of irrigation intervals on total sugar content in season (2010/11).

Treatments	Total sugar content %
10 day	38.95 [b]
20 day	38.31 [c]
30 day	39.53 [a]
SE ±	0.04
LSD	0.11
C.V%	0.5

Table (79) Effects of fertilization doses on total sugar content in season (2010/11).

Treatments	Total sugar content %
F0	40.71 [b]
F1	37.76 [d]
F2	38.77 [c]
F3	42.74 [a]
F4	38.74 [c]
F5	36.94 [e]
F6	36.84 [e]
± SE	0.06
LSD	0.17
%C.V	0.5

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

Table (80) Effect of treatments interaction on total sugar content in season (2010/11).

Treatments	Total sugar content %
AF0	54.40 [b]
AF1	38.67 [e]
AF2	40.63 [d]
AF3	40.52 [d]
AF4	35.20 [h]
AF5	38.63 [e]

AF6	33.63 [k]
BF0	38.20 [f]
BF1	40.63 [d]
BF2	38.63 [e]
BF3	40.63 [d]
BF4	40.63 [d]
BF5	35.13 [h]
BF6	34.30 [i]
CF0	38.53 [e]
CF1	34.00 [j]
CF2	37.07 [g]
CF3	47.07 [a]
CF4	40.40 [d]
CF5	37.07 [g]
CF6	42.60 [c]
± SE	0.10
LSD	0.29
%C.V	0.5

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

A= 10 day of irrigation intervals / B= 20 day of irrigation intervals / C= 30 day of irrigation intervals.

4.7.3- Sucrose

(Table 74) indicate that there were highly significant differences (P=0.01) in sucrose content due to the irrigation intervals of date palm. The comparison between the irrigation intervals showed that the application of 10 day interval increased sucrose significantly, 44.5%, over 20 day interval and 32.9% over 30 day interval (Table 81).

The comparison between the effect of fertilizers doses (120kg organic + o.25kg NPK 15%) showed an increase in sucrose content by 52.5 % over the lowest dose (60kg organic + o.50kg NPK 15%) then followed by doses

(30kg organic + o.25kg NPK 15%), (120kg organic + o.50kg NPK 15%) and the control. No significant difference between the doses (Table 82). The interaction (irrigation intervals x fertilization doses) gave highly significant increase (P=0.01) in sucrose content of date palm (Table 83). The greatest effects of irrigation intervals and fertilization dose obtained from (10 day irrigation interval + 120kg organic + 0.25kg NPK 15%) which gave an increase of 33.2% over the control, then followed by (30 day irrigation interval + 120kg organic + 0.25kg NPK 15%) (Table 83).

Table (81) Effects of irrigation intervals on sucrose content in season (2010/11).

Treatments	Sucrose content %
10 day	11.56 [a]
20 day	6.42 [c]
30 day	7.76 [b]
SE ±	0.07
LSD	0.19
C.V%	3.5

Means with the same letters in same column are not significantly .different according to Duncan Multiple Range Test P> 0.05

Table (82) Effects of fertilization doses on sucrose content in season (2010/11).

Treatments	Sucrose content%
F0	8.64 [b]
F1	8.85 [b]
F2	8.15 [c]
F3	12.64 [a]
F4	6.84 [d]
F5	6.00 [e]
F6	8.93 [b]
± SE	0.10
LSD	0.29
%C.V	3.5

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

Table (83) Effects of treatments interaction on sucrose content in season (2010/11).

Treatments	Sucrose content
AF0	13.10 [c]
AF1	10.62 [d]
AF2	9.62 [e]
AF3	19.62 [a]
AF4	8.41 [f]
AF5	9.92 [e]
AF6	9.62 [e]
BF0	6.30 [g]
BF1	13.31 [g]
BF2	6.33 [g]
BF3	2.17 [ij]

BF4	8.36 f
BF5	1.89 j
BF6	6.56 g
CF0	6.50 g
CF1	2.62 i
CF2	8.49 f
CF3	16.13 b
CF4	3.75 h
CF5	6.20 g
CF6	10.60 d
± SE	0.17
LSD	0.50
%C.V	3.5

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

A= 10 day of irrigation intervals / B= 20 day of irrigation intervals / C= 30 day of irrigation intervals.

4.7.4- Total Soluble Solids

There were no significant differences due to irrigation intervals, but there were highly significant difference (P=0.01) due to fertilization doses and the interaction between them in total soluble solids of date palm fruit (Table 74). The comparison between the irrigation intervals showed that the application of every 30 days interval increased total soluble solids 3.6% over the 10 day interval and 1.8% over 20 day interval and no significant difference between 10 and 20 day and 30 irrigation intervals (Table 84). The comparison between the fertilization doses showed that highly significant difference (p= 0.01) in total soluble solids (Table 74). The treatment (120kg organic + 0.50kg NPK 15%) gave greater total soluble solids, 7.1% over the control, (30kg organic + 0.25kg NPK 15%) and

(60kg organic + 0.25kg NPK 15%). No significant difference between (120kg organic + 0.25kg NPK 15%), (30kg organic + 0.50kg NPK 15%), (60kg organic + 0.50kg NPK 15%) and (120kg organic + 0.50kg NPK 15%) (Table 85). The differences between the interaction (irrigation intervals x fertilization doses) in total soluble solids was highly significant (P=0.01) (Table 74). The results showed that the application of (10 day irrigation +120kg organic + 0.25kg NPK 15%), (10 day irrigation +60kg organic + 0.50kg NPK 15%), (10 day irrigation +120kg organic + 0.50kg NPK 15%), (20 day irrigation +30kg organic + 0.25kg NPK 15%), (20 day irrigation +30kg organic + 0.50kg NPK 15%), (20 day irrigation +60kg organic + 0.50kg NPK 15%), (20 day irrigation +120kg organic + 0.50kg NPK 15%), (30 day irrigation +60kg organic + 0.25kg NPK 15%), (30 day irrigation +120kg organic + 0.25kg NPK 15%) and (30 day irrigation +30kg organic + 0.50kg NPK 15%) increased total soluble solids by 12.5% over (10 day irrigation interval +30kg organic + 0.25kg NPK 15%), (10 day irrigation interval +60kg organic + 0.25kg NPK 15%), (10 day irrigation interval +30kg organic + 0.50kg NPK 15%),(20 day irrigation interval +60kg organic + 0.25kg NPK 15%) , (20 day irrigation interval +120kg organic + 0.25kg NPK 15%) ,(30 day irrigation interval +30kg organic + 0.25kg NPK 15%) and (30 day irrigation interval +60kg organic + 0.50kg NPK 15%) (Table 86).

Table (84) Effects of irrigation intervals on total soluble solids in season (2010/11).

Treatments	Total soluble solids content %
10 day	7.48 [a]
20 day	7.62 [a]
30 day	7.76 [a]
SE ±	0.05
LSD	0.15
C.V%	3.1

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P> 0.05.

Table (85) Effects of fertilization doses on total soluble solids in season (2010/11).

Treatments	Total soluble solids content %
F0	7.33 [b]
F1	[b] 7.33
F2	[b] 7.33
F3	7.67 [a]
F4	[a] 7.67
F5	[a] 7.67
F6	7.89 [a]
± SE	0.08
LSD	0.23
%C.V	3.1

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

Table (86) Effects of interaction on total soluble solids in season (2010/11).

Treatments	Total soluble solids content %
AF0	7.33 [bc]
AF1	7.00 [c]
AF2	7.00 [c]
AF3	8.00 [a]
AF4	7.00 [c]
AF5	[a] 8.00
AF6	[a] 8.00
BF0	[c] 7.00
BF1	[a] 8.00
BF2	[c] 7.00
BF3	[c] 7.00
BF4	8.00 [a]
BF5	8.00 [a]
BF6	8.00 [a]

CF0	7.33 bc
CF1	c 7.00
CF2	a 8.00
CF3	a 8.00
CF4	a 8.00
CF5	c 7.00
CF6	7.67 ab
± SE	0.14
LSD	0.40
%C.V	3.1

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

A= 10 day of irrigation intervals / B= 20 day of irrigation intervals / C= 30 day of irrigation intervals.

4.7.5- Reducing Sugars

(Table 74) indicates that there were highly significant difference, (P=0.01) in reducing sugars between the irrigation intervals of date palm. The comparison between the irrigation intervals showed that the application of 20 day interval increased reducing sugars significantly, 14.1% over 10 day and 1% over 30 day (Table 87). On the other hand, there was highly significant difference (P=0.01) in reducing sugars between the applications of fertilization doses (Table 74). The greater value obtained from the control which increased the content 13.5% over (120kg organic + 0.50kg NPK 15%), then followed by (30kg organic + 0.50kg NPK 15%). (88).The increase due to the interaction (irrigation intervals x fertilization doses) was highly significant (P=0.01) in reducing sugars of date palm fruit (Table 74). The greatest effects of irrigation intervals and fertilization dose were obtained from (20 day irrigation interval + 120kg organic + 0.25kg NPK 15%) which gave an increase of 44.5% over the control and then followed

by (10 day irrigation interval + 120kg organic + 0.25kg NPK 15%), then followed by (30 day irrigation interval + 30kg organic + 0.25kg NPK 15%) (Table 89).

Table (87) Effects of irrigation intervals on reducing sugar content in season (2010/11).

Treatments	Reducing sugar content %
10 day	27.15 [c]
20 day	31.60 [a]
30 day	31.28 [b]
SE ±	0.04
LSD	0.11
C.V%	0.6

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P> 0.05.

Table (88) Effects of fertilization doses on reducing sugar content in season (2010/11).

Treatments	reducing sugar content %
F0	[a] 32.10
F1	[g] 27.25
F2	[d] 30.45
F3	[e] 30.15
F4	[b] 31.54
F5	[c] 30.82
F6	[f] 27.78
± SE	0.06
LSD	0.17
%C.V	0.6

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

Table (89) Effects of interaction on reducing sugar content in season (2010/11).

Treatments	reducing sugar content %
AF0	32.10 d
AF1	27.24 g
AF2	31.00 e
AF3	21.21 j
AF4	26.25 h
AF5	28.24 f
AF6	24.00 i
BF0	32.10 d
BF1	26.25 h
BF2	32.10 d
BF3	38.23 a
BF4	32.10 d
BF5	33.21 c
BF6	27.24 g
CF0	32.10 d
CF1	28.24 f
CF2	28.24 f
CF3	31.00 e
CF4	36.28 b
CF5	31.00 e
CF6	32.10 d
± SE	0.10
LSD	0.29

%C.V	0.6

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

A= 10 day of irrigation intervals / B= 20 day of irrigation intervals / C= 30 day of irrigation intervals.

4.7.6- Acidity

There were highly significant differences (P=0.05) in acidity of date fruits due to irrigation intervals but there were no significant differences due to fertilization doses or to the interaction (Table 74). The comparison between the irrigation intervals showed that the treatment 30 day intervals gave significantly greater amount of acidity, 10.9% over 10 day interval and 2.9% over 20 day interval (Table 90).

The comparison between the fertilization doses showed that the dose (120kg organic + 0.50kg NPK 15%) increased acidity by 7.9% over the control (Table 91). The differences between the interactions on acidity of fruits indicated that (20 day irrigation + 120kg organic + 0.50kg NPK 15%) increased acidity by 45% over (10 day irrigation + 30kg organic + 0.25kg NPK 15%). No significant difference in all treatments except (10 day irrigation + 30kg organic + 0.25kg NPK 15%), (Table 92).

Table (90) Effects of irrigation intervals on amount of acidity in season (2010/11).

Treatments	Amount of acidity content %
10 day	1.23 [a]
20 day	1.34 [a]
30 day	1.38 [a]
SE ±	0.05
LSD	0.13

C.V%	16

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P> 0.05.

Table (91) Effects of fertilization doses on amount of acidity in season (2010/11).

Treatments	Amount of acidity content %
F0	[a] 1.29
F1	[a] 1.26
F2	[a] 1.38
F3	[a] 1.29
F4	[a] 1.29
F5	[a] 1.29
F6	[a] 1.40
± SE	0.07
LSD	0.19
%C.V	16

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).

Table (92) Effects of treatment interaction on amount of acidity content in season (2010/11).

Treatments	Amount of acidity content %
AF0	1.29 ª
AF1	0.88 ᵇ
AF2	1.26 ª
AF3	1.29 ª
AF4	1.29 ª
AF5	ª 1.29
AF6	ª 1.29
BF0	ª 1.29
BF1	ª 1.29
BF2	ª 1.29
BF3	ª 1.29
BF4	ª 1.29
BF5	ª 1.29
BF6	1.60 ª
CF0	1.29 ª
CF1	1.60 ª
CF2	1.60 ª
CF3	ª 1.29
CF4	ª 1.29
CF5	ª 1.29
CF6	ª 1.29
± SE	0.12
LSD	0.33
%C.V	16

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P>0.05.

F0=Control- F1= (30kg+0.25kg) - F2= (60kg+0.25kg) - F3= (120kg+0.25kg) - F4= (30kg+0.50kg) - F5= (60kg+0.50kg) -F6= (120kg+0.50kg).
A= 10 day of irrigation intervals / B= 20 day of irrigation intervals / C= 30 day of irrigation intervals.

CHAPTER FIVE

DISCUSSION

5.1. Yield Components of Date Palm Trees:

Yield components attributes of palm trees which were investigated in this study included fruit weight, pulp weight, pulp/ seed ratio and yield per palm. Generally most of the yield components attributes had been significantly affected by irrigation intervals, fertilization doses and interaction (irrigation intervals x fertilization doses) in both seasons. In this study the general trend was that the application of irrigation intervals in both seasons significantly increased the yield components (fruit weight, pulp weight, pulp/ seed ratio and yield / palm). The highest value was obtained by 10 days of irrigation intervals, whereas the lowest values were recorded under the 30 days of irrigation intervals in both seasons. Superiority of frequent irrigation over the other was reported by Ibrahim (2009 and Al Amoud *et al*. (1999) who found that it is equally important to irrigate the tree with sufficient amount of water of good quality in order to produce acceptable yield and better fruit quality, and mentioned by Hussein and Hussein (1982) as a result of a study on date palm cultivar at Aswan, it was suggested that an irrigation interval of four weeks applying 71 mm per irrigation is the most suitable. The results obtained in this study indicated that there were greater significant differences among fertilization doses in the yield components of date palm in both seasons. The highest value was obtained by (30kg+0.25kg NPK 15%) fertilization dose, whereas the lowest value was recorded by the control in both seasons. This result agreed with reports of Shahein *et al*. (2003) and Al-Kharusi *et al*. (2009). Few studies have evaluated the effects of organic and mineral fertilizers on the quality characteristics of date fruits as well as the yield. Similar findings were reported by Shahein *et al*. (2003) working on Samany date.

Also, Al-Kharusi *et al*. (2009), indicated an enhancement in fruit quality characteristics especially fruit color, weight, size, with the application of organic manures or its supplementation with mineral NPK compared to mineral fertilization alone. The type of fertilizer seems to increase the vigour and rate of growth of young plants and the fruit bearing capacity of the adult trees (Nixon, 1951, Hayet, 1980, Al-Bakr, 1972). In both seasons the effects of interaction (irrigation intervals x fertilization doses) were highly significant in yield components. The treatment (10 days irrigation intervals+ fertilization dose (30k g organic + 0.50kg NPK15%) gave the highest value in the yield components. Similar result was found by (Barreveld, 1993, Osman, 1995 Iqbal *et al*., 2004 and MAF, 2005) who reported that the production of good quality dates however depends on adequate irrigation, fertilization, disease protection, pollination and harvesting as well as post-harvest handling techniques.

5.2. Fruit Physical Characteristics of Date Palm Trees:

Fruit physical characteristics of palm trees which were investigated in this study included fruit length, fruit diameter and flesh thickness. From the statistical analysis it was clear that there were highly significant differences in fruit physical characteristics due to irrigation intervals, fertilization doses and interaction of irrigation intervals x fertilization doses in both seasons. The comparison between the irrigation intervals in both seasons showed that the application of every 10 day increased fruit physical characteristics significantly over control (30 day).This result is supported by the finding of Al – Amoud *et al* (2000) who conducted a field experiment to investigate the response of date palm trees to different water regimes (50, 100 and 150% of pan evaporation rate), using three irrigation systems: basin, bubbler and trickle irrigation systems. The results of the study demonstrated a general trend of yield increase as irrigation water

quantity increases. It is a fact that date palm grow under desert climatic conditions and are drought resistant and salt tolerant as compared to other crops. However, it is equally important to irrigate the tree with sufficient amount of water of good quality in order to produce acceptable yield and better fruit quality.

(Ibrahim, 2009 and Al Amoud *et al*. 1999). From the treatments it was clear that there were highly significant difference in fruit physical characteristics due to fertilization doses in both seasons. The comparison between the fertilization doses in both seasons showed that the application of (30 kg organic + 0.25 kg NPK15%) increased fruit physical characteristics significantly greater than the control. Similar result was found by AL-Baker, (1972) who reported that a five- year experiment in AL-Tanooma, near Basra, showed that the addition of 1.2Kg of nitrogen, 600g of PzOsand 1.2Kg of KzOper to one palm tree increased the yield 2-3 times. Bacha and Abo- Hassan (1982) found that fertilizer treatments consisting of (NPK fertilizers and organic manure) on yield and fruit quality of Khudari date palm variety increased the yield of trees as compared with the organic manure. Similar findings were reported by Shahein *et al.* (2003) and Al-Kharusi *et al*. (2009). Few studies have evaluated the effects of organic and mineral fertilizers on the quality characteristics of date fruits as well as the yield. The above results indicated an enhancement in fruit quality characteristics especially fruit weight, fruit size, dry matter, TSS and total sugars contents with the application of organic manures or its supplementation with mineral NPK

compared to mineral fertilization alone. From the study it was clear that there was a significant increase and a highly significant increase in fruit physical characteristics between the interactions of irrigation intervals x fertilization doses in both seasons respectively. In the first season the increase in thickness of the fruit was significant but in the second season

was highly significant, this may be due to the residual effects of fertilization dose from the previous season.

5.3. Seed Physical Characteristics of Date Palm Trees:

Date palm seeds physical characteristic which were investigated in this study included seed length, seed diameter and weight of the seed. From the result obtained it was clear that there was highly significant difference in most variables of seed physical characteristics in both seasons, except the effect of irrigation intervals in seed weight in the first season, also fertilization in the second season showed no significance difference in seed weight. This may be due to the environmental factors. In both seasons the interaction showed no significance difference in seed length and in the second season on seed diameter this may be due to the cellulose deposit on the inside of the cell walls (Zaid and de- Wet, 1999). The comparison between the irrigation intervals in both seasons showed that the application of every 10 day interval increased all variables of seed physical characteristics, except the seed weight in the first season which showed no significant difference. There was no literature available to compare these results. From the fertilization treatments it was clear that there were highly significant difference in most variables of seed physical characteristics in both seasons. The comparison between the fertilizer doses showed that the highest seed length obtained by the application of (30 kg organic + 0.25 kg NPK 15%)

and highest seed diameter obtained by the application of (120 kg organic + 0.50 kg NPK15%) respectively in both seasons. The highest seed weight obtained by the application of (60 kg organic + 0.50 kg NPK15%), (30 kg organic + 0.25 kg NPK15%) and (60 kg organic + 0.25 kg NPK15%) in first season but there was no significant difference in the second season in all treatments. This may be due to the environmental conditions.

This result agreed with Elfawal (1962 and Khairi *et al* (1983) who reported that the increase in fresh weight was due to increase in pulp weight. Nevertheless, there was no positive correlation between fruit and seed physical characteristics. From these results it was clear that there was no significant difference in physical characteristics of seed of date palm trees in both seasons. There was no any literature available to compare these results.

5.4. Bunch Characteristics of Date Palm Trees:

Bunch characteristics of date palm trees which were investigated in this study included number of bunch /palm, number of fruit/bunch and weight of fruit/bunch. From the results obtained it was clear that there were high significant differences in bunch characteristics of date palm trees due to irrigation intervals, fertilization doses and interaction of irrigation intervals x fertilization doses in both seasons. The comparison between the irrigation intervals in both seasons showed that the application of every 10 day interval increased all variables of bunch characteristics. This result is supported by the finding of (Hussein and Hussein, 1983) who studied the effect of irrigation on the tree growth, fruit yield and quality and time of fruit maturity. They concluded that: The increase of irrigation frequencies increased the size, the weight, the moisture content and the total soluble solid (TSS) of the fruit. However, it is equally important to irrigate the tree

with sufficient amount of water of good quality in order to produce acceptable yield and better fruit quality. The results revealed that there were highly significant differences in bunch characteristics between the fertilization doses in both seasons. The comparison between the fertilization doses in both seasons showed that the application of (30 kg Organic + 0.50 kg NPK15%) increased bunch characteristics significantly

over the control. Similar results were found by (Nixon, 1951, Hayet, 1980 Al-Bakr, 1972). The type of fertilizer seems to increase the vigour and rate of growth of young plants and the fruit bearing capacity of the adult trees. In both seasons the effects of interaction of irrigation intervals x fertilization doses were highly significant on all yield components of bunch characteristics in both seasons. The application of (10 days irrigation intervals+ (30kg Organic + 0.50kg NPK15%) fertilization dose gave the highest value in the yield components, similar results were found by (Barreveld, 1993 Osman, 1995 Iqbal *et al*., 2004 MAF, 2005).They reported that the production of good quality dates however depends on adequate irrigation, fertilization, disease protection, pollination and harvesting as well as post-harvest handling techniques.

5.5. Strands Characteristics of Date Palm Trees:

Strand characteristics attributes of palm trees which were investigated in this study included number of strand/bunch, number of fruit/strand and length of strand. Generally most of the strand characteristics attributes had been significantly affected by irrigation intervals, fertilization doses and interactions of irrigation intervals x fertilization doses in both seasons.

The comparison between the irrigation intervals showed that the highest value obtained by the application of every 10 days interval on all strand characteristics of date palm trees, this result is in agreement with

(Hilal *et aI.,* 1986) who studied irrigation frequencies and showed that low frequency and large volume of water per irrigation were more favorable. From this study it was clear that there was high significant difference on strands characteristic between the fertilizer doses and interaction of irrigation intervals x fertilization doses in both seasons.

5.6. Growth Components of Date Palm Trees:

Growth components attributes of palm trees which were investigated in this study included stem length, stem diameter, number of new growing leaves and number of total leaves per palm. Generally most of the growth components attributes had been significantly affected by irrigation intervals, fertilization doses and interaction of irrigation intervals x fertilization doses in both seasons. In this study the general trend was that the application of irrigation intervals in both seasons significantly increased the growth components (stem length, stem diameter, number of new growing leaves and number of total leaves per palm. The highest value was obtained by 10 days of irrigation intervals, whereas the lowest values were recorded by the control (30 days) in both seasons. These results were in agreement with the findings of Abou-Khalid *et al.* (1982) who reported that poor irrigation and water stress depress vegetative growth and reduce production. The comparison between the fertilizer doses showed that the (30 kg Organic + 0.25 kg NPK15%) gave the highest harvest index on growth components, while the control gave the lowest one. This result is supported by many workers; (Kaur *et al*., 2005 Sarkar *et al*., 2003 Bokhtiar and Sakurai, 2005 Hossain and Ishimine, 2007 and Tirol-Padre *et al*., 2007). In Nigeria, organic manure may be beneficial to date palm cultivation on the long term, their efficiency in enhancing crop growth and yield in the short term have in most cases been enhanced with combination of inorganic fertilizers. Also, (Bamiftah, 2000) recommend 2 to 3 kg of potassium sulfate/palm/year for increasing the vegetative growth. Also Amiri *et at*. (2007). Studied the response of date palm growth under three different irrigation systems basin, their results demonstrated that the mean values of leaf number, leaf size and tree height of date palm were significantly influenced by irrigation system, and the general trend of growth increased as water availability to tree increased.

5.7. Fruit Chemical Compositions:

Fruits chemical compositions attributes of palm trees which were investigated in this study included moisture content, total sugars, sucrose, total soluble solids, reducing sugars and acidity of date palm fruits. Generally most of the fruit chemical compositions attributes had been significantly affected by irrigation intervals, fertilization doses and the interaction of irrigation intervals x fertilization doses.

In this study the general trend was that the application of irrigation significantly increased all parameters of fruit chemical compositions except the total soluble solids which were not significant. The highest value in moisture content was obtained by 20 days of irrigation intervals and no significant difference between 20 and 30 day intervals. Regards' total sugars the highest value was obtained by 30 days interval followed by 10 day interval, whereas the lowest value was recorded by 20 days interval. In case of sucrose the highest value was obtained by 10 days of irrigation intervals, the lowest value was recorded by 20 days interval. For total soluble solids the 30 days interval recorded the highest value but there was no significant difference between 10 and 20 days interval. Regarding reducing sugars, 20 day of irrigation intervals gave the highest value followed by 30 day while 10 day intervals were the lowest.

No significance difference due to all irrigation intervals on acidity in fruit of date palm. Similar result was reported by Ibrahim, (2009 and Al Amoud *et al*. (1999) who found that it was important to irrigate the tree with sufficient amount of water for good and better fruit quality. Also, the result is supported by the finding of Hussein and Hussein (1983) who studied the effect of irrigation on the tree growth, fruit yield and quality and time of fruit maturity. They concluded that the increase of irrigation frequencies increased the moisture content and the total soluble solid (TSS) of the fruit.

In this study the trend was that the application of fertilizer dose significantly increased all parameters of fruit chemical compositions but the total soluble solids were not significant. Regarding moisture content the highest value was obtained by the dose (30kg organic +0.50kg NPK 15%) while the control was the lowest. The highest value in total sugar was obtained by the dose (120kg organic +0.25kg NPK 15%), also sucrose and T.S.S content, whereas regarding reducing sugars the control was the greatest and no significance different in amount of acidity. This result agreed with reports of (Shahein *et al.,* 2003 Al-Kharusi *et al*., 2009). The study was undertaken to investigate the effect of different nutrient sources namely, chicken manure, cow dung, composted domestic refuse and mineral fertilizers, on the yield, fruit quality and nutritional value of the date palm. The results indicated an enhancement in fruit quality characteristics especially dry matter, TSS and total sugars contents with the application of organic manures. Also, Al-Kahtani and Soliman (2012) carried five treatments, agricultural waste + mineral fertilizers, agricultural waste + 5% sheep manure, agricultural waste + 10% sheep manure, agricultural waste + 20% sheep manure and agricultural waste + 40% sheep manure. The results indicated that agricultural waste + 40% sheep manure gave the highest initial fruit set and retained fruit, bunch weight, yield fruit weight, flesh weight, flesh thickness, fruit volume, fruit dimensions, total soluble solids, non- reducing sugars and total sugars. Applying agricultural waste + mineral fertilizers showed highest increase in the total acidity and moisture content percentage than the other treatments in both seasons.

5-8 Effect of Seasons:

Generally the effects of season showed highly differences for all or most of the yield components, fruit physical characteristics, seed physical

characteristics, bunch characteristics, strands characteristics and growth components of date palm trees (Appendix 1, 2 and 3).

This may be due to the residual effects of the fertilizers, sufficient amount of irrigation and suitable temperature during the (2010/2011) season which increased the overall yield and yield components as compared to the (2009/2010) season (Appendix 1, 2 and 3). These results were in agreement with the findings of Nixon, (1951) Hayet (1980) and Al-Bakr (1972), who reported that: the type of fertilizer seems to increase the vigour and rate of growth of young plants and the fruit bearing capacity of the adult trees. Similar results were found by Ibrahim (2009) and Al Amoud *et al.* (1999). It is equally important to irrigate the tree with sufficient amount of water of good quality in order to produce acceptable yield and better fruit quality. Similar results were reported by Osman (1977 and Mohamed (1985). They reported that the dry climate with negligible rainfall and hot summers and the availability of irrigation water from the Nile and the under ground water offers a good potential for production of the date palm in Sudan.

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENDATIONS

The experiments were conducted during the seasons of 2009/2010 and 2010/2011 at the Farm of Mr. Zibair Mohammed Seed Ahmed, at Elselaim- Dongola, Northern State, Sudan, to study the effect of fertilization and irrigation on yield, yield components and fruit quality of date palm (*Phoenix dactylifera* L.) "Barakawi" CV".

In this study the general trend was that the increase in fertilization significantly increased the yield components, fruit physical characteristics, strands characteristics, growth parameters and fruit chemical compositions, but there was no significant difference in seed weight. Also the decrease in irrigation intervals significantly increased the yield components, fruit physical characteristics, seed physical characteristics, bunch characteristics, strands characteristics, growth parameters and fruit chemical compositions. According to the results it was clear that there were highly significant differences in both seasons in all or most parameters of the treatments.

From the study it was clear that the increase in fertilization doses in optimum level and decrease in irrigation interval resulted in highly significant increase yield and fruit quality in both seasons.

In conclusion, fertilizer doses and irrigation intervals significantly affected all parameters measured except seed weight.

From this study, it can be recommended that: The yield significantly increased with decreasing the intervals of irrigation.

There were no significant differences between fertilizer doses (30 kg organic + 0.50 kg NPK 15%) and (30 kg organic + 0.25 kg NPK 15%) on yield of date palm trees in both seasons.

For better yield, good quantity and quality , 10 days irrigation interval , 30 kg organic and 0.50 kg NPK 15% a should be adopted for dates palm trees.

More studies are needed to evaluate the fertilization doses and irrigation intervals under Northern Sudan conditions.

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APPENDICES

Appendix (1) Mean for effect of both seasons on the different characteristics of date palm trees in (2009/10 and 2010/11) seasons

Treatments	Fruit weight (g)	Pulp weight (g)	Pulp/seed %	Yield/palm(kg)	Fruit length (cm)	Fruit diameter (cm)	Flesh thickness (cm)
First season	4.16 [b]	3.23 [b]	72.56 [b]	45.52 [b]	3.49 [b]	1.54 [b]	0.20 [b]
Second season	7.49 [a]	6.53 [a]	82.o1 [a]	90.63 [a]	4.84 [a]	1.86 [a]	0.42 [a]
SE ±	0.09	0.09	0.48	2.20	0.04	0.01	0.06
LSD	0.26	0.24	1.34	6.18	0.11	0.03	0.02
C.V%	12.4	13.8	15	25.7	7.7	5.6	16.2

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P> 0.05

Appendix (2) Mean for effect of both seasons on the different characteristics of date palm trees in (2009/10 and 2010/11) seasons

Treatments	Seed length (cm)	Seed diameter (cm)	Seed weight (g)	No of bunches/palm	No of fruit/ bunches	Weight of fruit/ bunch (kg)
First season	2.24 [b]	0.68 [a]	0.92 [b]	11.97 [b]	783.38 [b]	3.54 [b]
Second season	2.71 [a]	0.62 [b]	1.00 [a]	13.38 [a]	844.75 [a]	6.62 [a]
SE ±	0.02	0.005	0.01	0.18	11.37	0.10
LSD	0.06	0.014	0.03	0.52	31.89	0.27
C.V%	7.2	6.3	8.4	11.6	11.1	15

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P> 0.05

Appendix (3) Mean for effect of both seasons on the different characteristics of date palm trees in (2009/10 and 2010/11) seasons

Treatments	No of strand/bunch	No of fruit/ strand	Length of strand/bunch (cm)	Stem length (cm)	Stem diameter (cm)	No of new leaves	No of total leaves
First season	49.19 [b]	16.54 [b]	31.62 [b]	86.44 [b]	59.15 [a]	11.19 [b]	89.98 [b]
Second season	53.22 [a]	17.57 [a]	38.70 [a]	94.27 [a]	58.35 [a]	11.84 [a]	100.81[a]
SE ±	0.60	0.15	0.51	0.50	0.34	0.18	0.93
LSD	1.69	0.42	1.42	1.41	0.96	0.50	2.62
C.V%	9.3	6.9	11.4	4.4	4.6	12.2	7.8

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P> 0.05

Appendix (4): F- value of the measured variables for the treatments of leaves and their interactions in season (2011).

Treatments parameters	Irrigation	Fertilization	Irrigation X Fertilization
Ash%	7.44**	2.17 **	5.78 **
Ca%	52.00**	50.29**	44.00 **
Mg%	63.43 **	170.29**	217.43**
Na%	25.18 **	5.04**	4.65**
K%	274.90 **	123.42 **	137.10 **
N%	0.87 **	0.15 **	0.70 **
Ppm	0.54 **	0.33 **	0.79 **
O.C%	0.83 **	1.21**	1.59 **

** = significant at 1% level (highly significant)

* = significant at 5% level (significant)

N.S = not significant.

Appendix (5) Effects of irrigation intervals on chemical composition of leaves of date palm in season (2010/11)

Treatments	Ash%	Ca%	Mg%	Na%	K%	N%	Pppm	O.C%
10 day	8.42 [b]	11.14 [a]	33.14 [a]	4.50 [a]	26.69 [a]	0.48 [b]	0.46 [c]	2.70 [c]
20 day	7.59 [c]	9.43 [b]	30.00 [c]	2.32 [c]	23.52 [b]	0.49 [a]	0.50 [b]	3.03 [b]
30 day	8.75 [a]	8.00 [c]	30.29 [b]	3.53 [b]	19.47 [c]	0.49 [a]	0.75 [a]	3.06 [a]
SE ±	0.00	0.00	0.001	0.00	0.00	0.00	0.00	0.00
LSD	0.00	0.00	0.002	0.00	0.00	0.00	0.00	0.00
C.V%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P> 0.05

Appendix (6) Effect of fertilization doses on chemical composition of leaves of date palm in season (2010/11)

Treatments	Ash%	Ca%	Mg%	Na%	K%	N%	Pppm	O.C%
F0	7.55	11.33 [a]	26.67	3.03	25.27	0.52	0.56	3.24
F1	7.62	10.67	30.67	4.66 [a]	22.57	0.55 [a]	0.91 [a]	3.30 [a]
F2	8.63	9.33	34.00	2.79	30.26 [a]	0.49	0.32	3.09
F3	8.67 [a]	7.33	36.67 [a]	2.98	21.25	0.43	0.42	2.28
F4	8.60	7.33	30.67	2.94	19.16	0.48	0.65	2.66
F5	8.57	7.33	34.67	3.41	23.62	0.50	0.64	3.12
F6	8.13	13.33 [a]	24.67	4.35 [a]	20.47	0.45	0.49	2.83
± SE	0.00	0.00	0.001	0.00	0.00	0.00	0.00	0.00
LSD	0.00	0.00	0.003	0.00	0.00	0.00	0.00	0.00
%C.V	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Means with the same letters in same column are not significantly different according to Duncan Multiple Range Test P> 0.05

F0= Control / F1= (30kg+0.25kg) / F2= (60kg+0.25kg) / F3= (120kg+0.25kg) / F4= (30kg+0.50kg) / F5= (60kg+0.50kg) / F6= .(120kg+0.50kg)

Appendix (7) some chemical properties of the experimental soil after treatment in (2010/11) season.

Barakawi date palm									
Para. Depths	pH (paste)	ECe (ds/m)	Na (meq/L)	Ca+ Mg (meq/L)	SAR (meq/L)	O.C %	N %	P Ppm	K Ppm
30cm	7.41	1.25	1.03	11.49	0.81	0.64	0.03	4.15	282.2
60cm	7.35	1.41	1.11	12.95	0.57	0.47	0.03	2.78	187.4
90cm	7.4	0.82	1.32	8.05	0.79	0.59	0.03	2.65	189.3
Mean	7.39	1.16	1.15	10.83	0.72	0.57	0.03	3.19	219.6

Appendix (8): Climate of Dongola [Long. 30°.48 Lat. 19°.16 Alt. 226m]

Month	Maximum Temperature [°C]	Minimum Temperature [°C]	Relative Humidity [%]	Sun shine [h\day]	ETo [mm\day]	Wind speed [km\day]	Precipitation [mm\month]	Solar Radiation [MJ/m^2/day]
January	26.7	8.5	40.25	8.75	5.08	388.80	0.3	17.82
February	29.4	9.8	35.08	9.57	6.05	388.80	0.0	20.88
March	33.8	13.9	26.64	9.35	7.80	388.80	0.0	22.59
April	38.6	18.5	24.16	9.54	9.33	388.80	0.0	24.06
May	41.8	22.3	20.29	10.00	10.67	388.80	0.0	24.98
June	43.4	24.7	18.99	9.94	11.29	388.80	0.5	24.73
July	42.2	25	23.07	9.51	9.76	311.04	0.0	24.06
August	41.8	25.2	23.97	9.70	10.16	345.60	3.2	24.23
September	39.8	24.7	22.54	9.12	10.76	423.36	7.7	22.55
October	38.4	20.4	28.06	9.44	9.34	423.36	0.1	21.30
November	32.1	14.8	35.58	9.42	6.78	388.80	0.5	19.16
December	28.3	10.2	41.1	9.13	5.09	345.60	0.0	17.62

Source: FAO, 2006

Appendix (9): Dongola Temperature data for both seasons, Station: Dongola.

MONTH	1st SEASON (2009/10)		2nd SEASON (2010/11)	
	M.MIN	M.MAX	M.MIN	M.MAX
January	10.8	29.4	12.9	30.9
February	12.0	31.2	14.8	33.0
March	13.6	32.8	17.8	35.1
April	22.6	42.2	21.3	40.0
May	22.8	40.6	23.8	42.8
June	25.6	43.8	27.5	44.9
July	28.0	44.1	29.2	43.0
August	31.5	46.0	30.0	44.4
September	27.2	43.8	27.3	42.7
October	23.4	39.7	26.1	41.8
November	16.6	32.4	20.6	36.1
December	11.5	28.2	13.9	29.6

Source: Ministry of Science and Technology, Metrological Authority Administration of Data

Appendix (10): Dongola climatologically data (1961- 1990) Station: Dongola.

Month	Mean Temp. Max.+ Min. 2	Bright sunshine Duration		Reference Evapotranspiration (ETo)
	OC	Hour	%	mm /day
Jan.	17.6	9.9	91	3.64
Feb.	19.6	10.5	90	4.32
March	23.9	10.3	85	5.79
April	28.5	10.7	85	6.95
May	32.1	10.5	84	7.69
June	34.0	11.3	89	8.29
July	33.6	10.8	81	4.04
August	33.5	10.9	83	7.73
Sept.	32.3	9.6	78	7.25
Oct.	29.4	10.3	88	6.04
Nov.	23.5	10.5	93	
Dec.	19.3	10.1	91	3.47
Year	27.3	10.5	87	-

Source: Sudan Meteorological Department, Khartoum