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Evaluation of seed filling problems in some hybrids and open-pollinated sun flower (*Helianthus annuus* L) cultivars, as affected by pollination and sowing dates

تقييم مشكلة الحبوب الفارغة وملء الحبوب في اصناف زهرة الشمس أثر الإخصاب ومواعيد الزراعة

A thesis submitted in fulfillment of the requirement for the Degree of (PhD.)
In Agronomy

By

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2018

Dedication

To the Soul of my Father,

To my Mother,

To my Husband and to lovely kids.

Acknowledgement

First of all praise is to ALLA for giving me strength and patience to complete this work successfully.

I would like to express my sincere thanks and profound appreciation to my

Supervisors **Professor Yassin Mohammed Ibrahim Dagash** and **Ahmed Professor Ali Mohammed Othman** for their supervision.

Thanks are extended to my friends and **College** at University of Bahri College of **Agriculture** al Department of Crop Production, also Dr. Baha Eldin Mohamed Edris, Dr. Etahir Omer to their all unlimited help.

I would like to thank my friend Rasha Gassim Gdowra andNahid Abd Alfatah and Dr Amani Hamad for their help scientifically and personally to finch my work.

Thanks are extended to my husband and family for their continuous encouragement, and to Sudan University of Science and Technology, College of Graduate Studies. Thank to those all who helped me in one way or another.

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Abstract

A field experiment was conducted at the College of Agricultural Studies, Sudan University of Science and Technology, Sudan, Khartoum, during summer 2014 and 2015, to study the effects of sowing date, pollinations and cultivars on seed setting and seed filling of sunflower (*Helianthus annuus* L).The cultivars were Hysun33 and local .The experiment was factorial experiment with three factors in a randomized complete block design (RCBD) with four replications. Two cultivars, local (PAN-7351 LC) and hybrid (Hysun-33) were used. Plants were grown in three different sowing dates (March, May, JulyS1 S2 S3)and two type of pollination(open pollination and cover pollination).

Growth parameters studied were Plant height, leaf area, number of seeds setting/head, number of seeds filling/head, hundred seed weight , hundred seeds filling weight, head diameter, dry weight, seeds setting (%),seeds filling %and The efficiency. The results showed that sowing dates were highly significant for most of the parameters in both seasons (leaf area, number of seeds filling per head, head diameter, dry weight).The sowing date revealed highly significant effect in season one, namely in number of seeds setting per head, seeds setting percentage and the efficiency. Significant differences between the two types of pollination were revealed in some characters in first season namely plant height, number of seeds setting per head, , number of seeds filled per head, seeds filling percentage, Seeds setting percentage and the efficiency and highly significant differences on weight of hundred seeds setting. Moreover, analysis of variance indicated highly significant effects of pollination on most characters, number of seeds setting per head, number of seeds filling per head, weight of hundred seeds filling, head diameter, dry weight, seeds setting percentage, seeds filling percentage and the efficiency in second season. Also there were significant differences among sunflower

cultivars in plant height which was highly significant in season two. The analysis of variance indicated highly significant differences among sunflower cultivars in most yield and yield components, namely number of seeds setting per head, , number of seeds filling per head, weight of hundred seeds filled, seeds setting percentage.

المستخلص

أجريت هذه التجربة خلال موسمي 2014 و 2015 بكلية الدراسات الزراعية، جامعة السودان للعلوم والتكنولوجيا. لدراسة تقييم مشكلة الحبوب الفارغة والممتلئة في زهرة الشمس. استخدم صنف بلدي وهجين (هايسن33) بثلاث مواعيد زراعة (مارس، مايو، يوليو) ونوعين من التلقيح مغطاة ومفتوح. صممت التجربة باستخدام القطاعات العشوائية الكاملة واستخدام ثلاثة عوامل وأربعة مكررات وصنفين وثلاثة مواعيد زراعة. مقاييس النمو التي تمت دراستها كانت طول النبات، مساحة الورقة، الوزن الجاف، قطر القرص، وزن المائة حبة ممتلئة ووزن المائة حبة فارغة، عدد البذور الممتلئة بالقرص، عدد البذور الفارغة بالقرص، النسبة المئوية للبذور الممتلئة، النسبة المئوية للبذور الفارغة، الكفاءة والإنتاج. أوضحت النتائج أن ميعاد الزراعة أظهر فروقات معنوية في أغلب الصفات في الموسمين التي تتمثل في مساحة الورقة، عدد البذور الفارغة في القرص، قطر القرص والوزن الجاف. أيضا أعطى ميعاد الزراعة فروقات معنوية في الموسم الأول تمثلت في عدد البذور الممتلئة بالقرص، النسبة المئوية للبذور الممتلئة والكفاءة. أظهر تحليل التباين وجود أثر معنوي للتلقيح على بعض الصفات في الموسم الأول التي تمثلت في طول النبات، عدد البذور الممتلئة بالقرص، عدد البذور الفارغة بالقرص، النسبة المئوية للبذور الفارغة، النسبة المئوية للبذور الممتلئة والكفاءة. أوضح تحليل التباين وجود فروقات معنوية في التلقيح في أغلب الصفات والتي تمثلت في عدد البذور الممتلئة بالقرص، عدد البذور الفارغة بالقرص، قطر القرص، الوزن الجاف، النسبة المئوية للبذور الممتلئة، النسبة المئوية للبذور الفارغة والكفاءة في الموسم الثاني. أيضا أظهر تحليل التباين وجود فروقات معنوية بين أصناف زهرة الشمس في صفة طول النبات في الموسم الثاني. كما أظهر تحليل التباين وجود فروقات معنوية للأصناف في أغلب مكونات الإنتاج والإنتاجية والتي تتمثل في عدد البذور الممتلئة بالقرص، عدد البذور الفارغة بالقرص ووزن المائة حبة الفارغة والنسبة المئوية للبذور الممتلئة.

CHAPTER ONE

INTRODUCTION

Sunflower (*Heliathus annuus* L.) originated in North America . Now days, Sunflower is one of the most important crops in the world grown as edible oil, after soybean ,Rape seed and peanut. Sunflower seed is third largest source of vegetable oil in the world, grown wildly after, soy bean and Palm (Baldini, *et al*, 2000). Sunflower is an annual plant that grows up to about 3 meters long. The large and beautiful flowers are capitulum type with diameter of 35cm .It is being grown in most places around the world.

The seeds are very nutritious with of 24% proteins, 47% oil, 20% hydrocarbons, 8% phosphorus and 9% potassium, in addition to vitamin A and. The oil content is composed of 65% linoleic acid, some phospholipids and vitamin E. For this reason, sunflower seeds are known to be important in lowering blood triglycerides and in regulating blood cholesterol(Khidir, 2007).

The Economical and pharmaceutical importance of the plant is mainly due to the valuable and beneficial oil content and other compounds contained in the seeds. Sunflower is grown in many semi-arid regions of the world from Argentina to Canada and from central Africa to Soviet Union. It is tolerant of both low and high temperatures but more tolerant to low temperatures. Sunflower will grow in a wide range of soil types from sands to clays. The demand of a sunflower crop on soil macro nutrients is not as great as corn, wheat and potato. As with other non-leguminous grain crops, nitrogen is usually the first limiting factor for yield. Sunflower is low in salt tolerance but is somewhat better than field bean or Soy bean in this respect (Dagash, 2003) .Good soil drainage is required for Sunflower production, but this crop does not differ substantially from other field crops in tolerance.

. Seed setting and filling problem is one of the most important constraints in sunflower production and often considered to be a major reason for low productivity (Ram and Davari, 2011). Besides, poor agronomic management, there are several genetic, physiological and environmental factors causing poor seed setting and filling in sunflower. The sporophytic type of self-incompatibility mechanism is one of the genetic reasons for poor seed setting in sunflower.

The term autogamy is used to denote the index of seed set under cover pollination in relation to seed set under open pollination. Autogomous pollination is pollination under just covering the head. Low autogamy is one of the genetic reasons for poor seed setting and filling in sunflower. Therefore, evaluation of hybrids and their parental lines for their autogamy becomes necessary before releasing any genotype or hybrid. in one of the autogamy study in sunflower reported that hybrid produced significantly more autogamous seeds over better parent .Therefore; it suggested that one should grow hybrids for commercial cultivation of sunflower (Rathod *et al* (2002).

In Sudan sunflower demonstrated at first time in the demonstration farm of Eljezra Station in 1932, after that until 1949 experiments showed that it is a summer crop (growing by farmers in Wad Alnow, Gezera scheme). During season 1952/1951 empty seeds percentage was 90% because of low pollination .It was grown commercially at Alsheekh Mustafa Alameen Company during 1985/1986 in an area of 47000 feddan, increased to 269000 feddan 87/1988 and to 366 000 feddan at 1988/1989 in AlDamazIn (73%) and AlGadarf (22%). It grows under irrigation (Aljezera and AlRahed) 80 000 feddan at season of 19 94/1995 and decreased to 20000 feddan in the next season. Average area of 02/2003-06/2007 was92000 feddan, with average production of 02/2003-06/2007 46000ton (Ministry of Agriculture, 2008) Average area of 08/2009 434000feddan. Average area of 2015-

06/2016 was 261000 feddan with average production of 0/2015-06/2016 70000ton (Ministry of Agriculture and Forestry, 2016).

In Sudan, oilseed crops rank second after cereals in area and total production. The country's oilseed production rests mainly on sesame (*Sesamum indicum* L.), groundnut (*Arachis hypogaea* L.), and cotton seed (*Gossypium spp* L.), while sunflower has been introduced recently into the cropping sequence. Sunflower is a promising oilseed in Sudan. The seeds of sunflower have a high oil content (40-50%) and are 30% digestible protein and can thus be used as a source of food for humans or as a poultry feed. Sunflower cake can also be used as animal feed. Sunflower is adaptable to a wide range of climatic conditions and is well suited for Sudanese conditions too. It can be a suitable winter oil crop in irrigated conditions. Sunflower seeds, which are a raw material for the oil industry, can increase the capacity of the local crushers, and the extra raw material can be exported to the Arab countries.

Extensive commercial production of sunflower was initiated in Sudan in the late 1980's and the early 1990's with the introduction of hybrids such as Hysun-33 from Australia and PAN-7351 from South Africa (El Ahamdi, 2003; Nour *et al*., 2005). The production was established mainly in rain fed areas of the country and, to a lesser extent, in irrigated conditions. At about the same time, early maturing accessions of two open-pollinated sunflower varieties, Rodio and Bolereo, were released under the names Damazin-1 and Damazin-2, respectively (Adam and Osman, 1989). In the two decades since then, nevertheless, sunflower has failed to expand significantly in the country in total area and seed production, which could be due to many production constraints that are responsible for the fluctuation in area and productivity. These include frequent dry spells, erratic distribution of rainfall, lack of advanced technologies such as hybrid seeds, poor cultural practices, problems with empty seeds, low use of fertilizers, and faulty policies on funding, processing and marketing. Still, the lack of improved sunflower hybrids developed locally has emerged as the main limiting factor. Sunflower hybrid seeds are introduced from abroad and are bought with hard currency at a price that farmers can hardly afford. There is also the problem of hybrid seeds not being available at optimum planting time.

In Sudan, the value of hybrids and importance of heterosis breeding in sunflower were not sufficiently recognized. Nevertheless, the breeding program is now dealing mainly in the development of new single-cross hybrids characterized by uniform plant height, flowering date and seed quality. Addition, the hybrids are more stable, highly responsive to high-input agriculture, and highly self-fertile, resulting in higher seed set in areas where pollinators are not abundant. Thus, the development of sunflower hybrids for Sudanese conditions is an important step towards narrowing down the gap between supply and demand in the seed market and boosting sunflower production and productivity in the country.

The increase in the productivity of the crop during the last 7-8 years was mainly due to continuous increase in sunflower area in high productive zones in Sudan. The productivity is still low. This is because the crop suffers from several production constraints of different kinds mainly in these traditional areas. Among all the above-mentioned constraints seed setting and filling is the most important constraint generally faced by sunflower growers. Seed setting and filling problem is one of the most important constraints in sunflower production and often considered to be a major reason for low productivity (Ram and Davari, 2011). Besides poor agronomic management, there are several genetic, physiological and environmental factors causing poor seed setting and filling in sunflower. The sporophytic type of self-incompatibility mechanism is one of the genetic reasons for poor seed setting in sunflower.Potential yield of sunflower is highly dependent on environmental conditions during life cycle of the crop. Based on the above mentioned discussion it can be concluded that breeding for the fertile lines, plant physiological manipulations, environmental control and good agronomic management can alleviate up to some extent the problem of seed setting and filling in sunflower.

The objectives of this study are:

a-To select the best sowing date that increase the filling efficiency

b- To increase the autogamy percentage.

c- To select the best cultivars under Sudan conditions.

CHAPTER TWO

LITERATURE REVIEW

Sunflower (*Helianthus annuus* L.) is an important member of the Compositeae family. It is a native to central areas of America continent, and seemingly it is Peruvian or Mexican in origin (Demir, *et al*., 2006); (Salman. 2012). the large and beautiful flowers are capituolum type with a diameter of 35cm. It is being grown in most places around the world. The seeds (nuts) are very nutritious containing 20% proteins, 43% oil, 20% hydrocarbons, 8% phosphorus and 9% potassium, in addition to vitamins A and B (Khajehpur 2008). The oil content is composed of 65% linoleic acid, some phospholipids and vitamin E. For this reason, sunflower seeds are known to be an important food source. The economical and pharmaceutical importance of the plant is mainly due to the valuable and beneficial oil content and other compounds contained within the seeds. These include saturated and unsaturated fatty acids, folic acid, pantothenic acid, vitamin B6, manganese, iron, selenium and copper (Norwood, 2000).

Sunflower seeds contain a high amount of oil (40 to 50%) which is an important source of polyunsaturated fatty acid (linoleic acid) of potential health benefits (Monoti, 2004; Leon *et al*., 2003; Lopez *et al*., 2000).

The economic importance of sunflower cannot be over - emphasized. The fresh green plant can be fed as silage or fodder to livestock. The seed which can be eaten raw or roasted contains 36 to 45 % oil depending on variety and can be used in salads, cooking, margarine, lubricant, paint varnishes and soap production. It is one of the most important oil crop occupying the fourth place in the world (Rodriguez *et al*., 2002). In Romania sunflower is cultivated on 900 000 ha. The process of plant growth is influenced by genetic and environmental factors a (Khalilvand, and . Yarnia, 2007).

The decorticated seed cake is a good source of protein for livestock (35%), especially when made from whole seed. Sunflower has deep tap root system, which develops down to 3m, with a proliferation of surface lateral roots; this makes the crop fairly drought resistant. Although, sunflower is known to be drought resistant, water supply is a critical factor for oil formation. Inadequate water supply with or without the use of fertilizers results in reduced seed yield and oil content .Another factor in the adaptation of a crop to different agro – ecological zones is the growth and yield performance of the crop in the different seasons of sowing, the high adaptation and yield of sunflower in south- western Nigeria (Meinke, *et al*. 1993).

Sunflower is categorized as a low to medium drought sensitive crop (Iqbal , *et al*.2005). All over the world, Sunflower production in the countries which have temperate regions is higher than the tropical. Sunflower can grow on different types of soils but its performance is better in soils best for the growth of maize and wheat. Among the cash crops, sunflower is one of the crops having shortest growing season around the world.

The seeds contain about 40-50 % oil with high polyunsaturated fatty acids and 20 % protein (Joksimovic *et al* 1999). Sunflower is well adapted to water stress condition and can be raised twice a year **(**Salman, 2012). Sunflower is one of the four most important oil crops in the world (Demir *et al*., 2006). Because of its moderate cultivation requirements and high oil quality, its acreage has increased in both developed and developing countries (Skoric, 1992). Sunflower oil is highly demanded not only for human consumption, but also for chemical and cosmetic industries. In respect of total yield produced, water requirements of sunflower are relatively high compared to most crops. Despite its high water use, the crop has the ability to withstand short periods of severe soil water deficit of up to 15 atmosphere tensions. Long periods of severe soil water deficit, particularly at water-sensitive growth stages, cause significant reduction in seed yield (Beyazgul *et al*, 2000) by limiting evapotranspiration (ET) through stomata closure, reduced assimilation of carbon and decreased biomass production (Demir *et al*., 2006). In temperate oilseeds (Putnam *et al*,(1990).regions, sunflower requires approximately 11 days from planting to emergence, 33 days from emergence to visible head, 27 days from head visible to first anther, 8 days from first to last another, and 30 days from last anther to maturity. Cultivar differences in maturity are usually associated with changes in vegetative period before the head is visible. Commercially available sunflower varieties contain from 39 to 49% oil in the seed. In 1985-86, sunflower seed was the third largest source of vegetable oil worldwide, following soybean and palm. Sunflower accounts for about 14% of the world production of seed oils (6.9 million metric tons in 1985-86) and about 7% of the oilcake and meal produced from

The oil accounts for 80% of the value of the sunflower crop, as contrasted with soybean which derives most of its value from the meal. Sunflower oil is generally considered a premium oil because of its light color, high level of unsaturated fatty acids and lack of linolenic acid, bland flavor and high smoke points. The primary fatty acids in the oil are oleic and linoleic (typically 90% unsaturated fatty acids), with the remainder consisting of palmitic and stearic saturated fatty acids. The primary use is as salad and cooking oil or in margarine. In the USA, sunflower oils account for 8% or less of these markets, but in many sunflower-producing countries, sunflower is the preferred and the most commonly used oil. High oleic sunflower oil (over 80% oleic acid) was developed commercially in 1985 and has higher oxidated stability than conventional oil. It has expanded the application of sunflower oils for frying purposes, tends to enhance shelf life of snacks, and could be used as an ingredient of infant formulas requiring stability (Putnam *et al*,(1990).

This will also cut down the time and resources being spent on importations from abroad. Sunflower hybrid seed produced locally is likely to be adopted by the majority of sunflower growers, since the seed source is readily available. On the other hand, in a plant breeding program, potential genotypes are usually evaluated in different environments before selecting desirable ones that show stability across environments. Also, in identifying such genotypes, G × E interactions are of major concern for the breeder, because such interactions confound the selection of superior cultivars by altering their relative productiveness in different environments.

Use of stability is a good technique for measuring the adaptability of different crop varieties to varying environments. The most widely used way to biometrically assess stability is the regression method, which is based on regression of the mean value of each genotype on the environmental index. The technique to measure stability was previously proposed by (Eberhart and Russell 1966). The stability of a variety or sunflower is a promising oilseed in Sudan.

It can be grown in wide range of soil types from sand to clay and better than field been or Soybean in salt tolerance (Dagash, 2003). The demand of the crop of soil macro nutrients is not as great as corn, wheat and potato. Good soil drainage is required for sunflower production, but this crop does not differ substantially from other field crops in flood tolerance, this crop shows adaptability to different regions and sowing dates, due to its high genotype x ambient interactions(Schoeman, 2003).

One of the means to alleviate this problem is to identify the self-fertile lines and thus increase seed set and productivity. The physiological mechanisms that regulate seed setting and filling in sunflower are complex. Studies carried out on source-sink relationship and photoassimilate distribution pattern revealed that the photoassimilate supply in the capitulum largely depends on the phyllotaxy of source leaves and the position of sinks in developing inflorescences (Alkio *et al*., 2003). A higher proportion of empty achenes (up to 60%), especially in the centre of capitulum result from source limitation. During seed filling, maximum import of photoassimilate appeared in intermediate whorls, while central whorls always exhibited the lowest import leading to poor seed filling. The studies carried out on correlation of the metric traits helped in identifying the characters associated with seed setting and filling. The number of filled seeds per head can be increased up to a certain limit by increasing stem girth and head diameter. Good agronomic practices play an important role in production and productivity of any crop. A crop geometry of 60 cm x 20 cm recorded significantly higher values of growth and yield attributes and seed yield compared to 40 cm x 30 cm (Patel and Thakur, 2003). To get synchronized flowering of male and female plants, sowing of male parent seven days early recorded higher seed setting and filling in RSFH-1 sunflower. Water stress caused by deficit irrigation from early flowering to early seed formation leads to reduced leaf area index (LAI) and thus reduces yield attributes. Application of insecticides affects the pollinators visit and pollination thus decreases the seed yield of sunflower (Sumathi *et al*. (2005).

2.1 Variety Selection:

The development of a cytoplasmic male-sterile and restorer system for sunflower has enabled seed companies to produce high-quality hybrid seed. Most of these out yield open-pollinated varieties and are higher in percent oil. Performance of varieties tested over several environments is the best basis for selecting sunflower hybrids. The choice should consider yield, oil percentage, maturity, seed size (for non-oilseed markets), and lodging and disease resistance.

Whether variation in seed size and morphology separately affect population performance under different environmental conditions also remains unknown. Seedling establishment is arguably the most critical period in the life history of a plant. The factors that influence seed and seedling performance determine how many individuals will recruit into the population and ultimately reproduce. In arid environments, seedling establishment in perennial plants is highly variable and episodic (Bowers, *et al* 2004). In spite of the large number of studies, it remains unclear to what extent seed size and seed morphology independently affect ecological characteristics such as germination and seedling performance (Teixeira, *et al*., 2008)size is an important seed quality characteristic affected by variety, environment and management practices .The development of seeds in each whorl of the inflorescence occurs under varying environmental conditions causing variability in seed size and quality(Karadogam, *et al* 2009).

2.2 Temperature:

The weather conditions have evident influence on sunflower inflorescence, visit by honeybees or other pollinators. Total daily visit of the bees depended on weather conditions. The most frequent visits by honeybees were estimated at 20 to 25 degrees centigrade and humidity at 65-75%. Precipitation had negative impact on honeybees visit (Puškadija *et al*. 2007).

Researchers had also mentioned that the seed number in the head depends on power of floret production during primary stages of the production of primordial and their growth which has direct association with the amount of available photosensitive materials in time range of peeping the florets until post-pollination(Patel and Thakur, 2003), (Sumthi, *et al* 2005).

This issue resulted from the seed's number per head, full seed's number per head during stem formation, positive and significant correlation between the seed's operation and the oil operation and also between the seed's number per head and full seed's number per head. Mean while , the fertilization during stem formation would probably bring about on time availability of nutritional sources and suitable growth. (Messetti and Padovani. (2004).

2.3 Sowing date:

Sunflower can be planted at a wide range of dates, as most cultivars are earlier in maturity than the length of growing season in most areas. In areas of the world with no winters, sunflower has been planted at any month of the year to obtain satisfactory yields. In northern regions, highest yields and oil percentages are obtained by planting early - as soon after the spring-sown small grain crops as possible. In the northern mid west and Canada this is often May 1 through 20 and mid-March through early April in the southern USA. Resistance to frost damage decreases as the seedlings develop into the 6leaf stage, so too-early sowings in the northern USA or Canada can be risky.

A later planting date tends to increase the proportion of linoleic acid in sunflower, especially at southern locations. Damage of sunflower heads by insect larvae may be increased by early planting. Test weight tends to decrease with late plantings.

It was noted that there are yield differences between hybrids with regard to sowing time and density. These differences are determined on the one hand by the hybrid characteristics and environmental conditions, and on the other hand, the space of nutrition, soil fertility and soil tillage (Joksimovic *et al.*, 1999; Vega and Hall. 2002).

The results of different research shows the role of sowing time and plant density on increased sunflower production of seeds and oil under different climatic conditions (Vrânceanu, 2000; Barros *et al*., 2004, Ekin *et al*., 2005).

Among several crop production practices, planting date decides the correct expression of a genotype for all morphological characters and physiological processes. Vyakaranahal *et al* .(2002) observed a significant increase in the seed yield due to early planting (July/December) for both the seasons (Kharif/Spring) over late planting (August/January) .The increase in seed yield was due to increased germination percentage and seedling vigor, which subsequently increased the yield and yield components. That sunflower crop sown in the month of December flowered between March-April and since during these months honeybee activity was maximum , which resulted in better pollination and thus good seed setting (Sinha and Atwal (2000).

Relationship among sowing dates, head diameter, seeds/head and total seed weight (TSW) ((Sinha and Atwal (2000),(Ahmad *et al*., 2005). are 22 June, 4July,14July, 30 July, 10 August, 21 August sowing dates respectively).

A significant relationship between sowing dates and seeds per head (Ahmad *et al*.2005).In the early plantation total, number of seeds/head was maximum but total seed weight (TSW) was minimum. The minimum TSW produced by early plantation may be due the fact that plants of this particular sowing produced the plants with larger heads those ultimately encouraged the maximum number of seeds but assimilates were not supplied in enough quantities to fully nourish large number of seeds. Ultimately seeds remained under nourished and less TSW. Seed setting is not only affected by planting time but planting design also. Decline in seed setting as distance from pollen source was increased due to planting design (Yadav *et al*. (2006).

In case of hybrids these differences may be associated besides the other factors of influence with genotypic characters. Previous research showed that they can obtain the production from 1.34 to 3.96 t/ha in Turkey (Ekin *et al*, 2005) or 1.10 to 3.98 tons in Italy (Lauretti *et al*, 2000) in different years. sowing date was the main source of variation for oil content or it was shown that oil content was affected by hybrid and year condition (Vega *et al* ,2002) and(Ekin *et al* (2005).

The problem of non synchrony is generally observed in sunflower hybrids. The male parent flowers later than seed parent. To avoid this problem sowing male parent early to female parent was suggested. Sowing of male parent seven days early resulted in the increase in percent seed set and filling as a result of better synchronization.

There is evidence that sowing time has significant effect on both seed yields, and oil content of sunflower under varying climatic conditions (Larki, 2008). Sowing dates have also been found to greatly influence vegetative (emergence to first flowering time) and reproductive growth stages (flowering to pod maturity time) of crops. When emergence rate for each sowing date was calculated using a common base temperature they were found to be well correlated with rate of change of day length. Time of sowing determines time of flowering and it has great influence on dry matter accumulation, seed set and seed yield (Agele,(2007). To increase yield and its stability, it is necessary to take into consideration determination of the optimum sowing date for achieving higher yield of sunflower.

Results revealed that late sown crop flowered earlier than those of early sown crop which might be due to the fact that higher temperature reduced vegetative growth and enhanced flowering (Nihal, 2010). Similar trend was observed in 50% flowering as well as crop maturity. Late sown crop matured about 7-10 days earlier than that of early sown crop. This was obvious as high temperatures increase rate of plant development (Entz and Fowler, 1991) and reduced length of the reproductive period (Angadi *et al*., 2000). Effect of sowing dates on the vegetative growth, first flowering, seed formation, and number of plants/m^2, Plant height, number of leaves/plant, head diameter, weight of seed per head, thousand seed weight (g) and seed yields (t ha^{-1}) were significantly influenced by sowing dates except leaf area, number of seeds / head and plants/ m^2. It also revealed that the highest plant height (172.13 cm) was found in November 20 sowing while the lowest (166.33 cm) in December 20 sowing. The highest head diameter (18.33 cm) was found in November 20 sowing while the lowest head diameter (13 cm) was in December 20 sowing. However, November 20 sowing showed the maximum number of seed/ head (935.33). The maximum weight of seed was found at November 20 sowing (66 g).The maximum weight of thousand seed was found at November 20 sowing (68 g) but statistically similar with November 30 sowing (64 gm). The maximum seed yield (2.5 t ha^{-1}) was found with November 20 sowing followed by the November 30 sowing (1.83 t ha^{-1}). Seed yield generally decreased with delayed sowing which might be attributed to the decrease in yield components (Siddique *et al.*, 2002). Reproductive development of many crop species may also be damaged by heat stroke imposing plants produce no flowers or set less number of grains with reduced size.

Effect of sowing dates on the yield of sunflower plant height (157 cm) and seed weight per plant (32.33 g) was found with November 20 sowing while the lowest dry matter (0.43 kg), plant height (137.8 cm) and seed weight/ plant (10.63 g) was found with November 10 sowing. There was no significant identical difference in plant height obtained with November 20 and December 20 sowing. Maximum number of unfilled seed (440.0) was received with November 20 sowing and lowest (187.4) with December 20 sowing. The highest thousand seed weight (82.11 g) was recorded in November 10 sowing and lowest (62.27 g) was recorded with December 20 sowing. The highest yield per plot (2.62 kg) and yield (1.16 t ha−1) was reordered in November 20 sowing, whereas the lowest yield (0.51 kg ha−1) was recorded in November 10 sowing.

Planting date exerted highly significant influence ($P \leq 0.01$) on all yield parameters except oil content while cultivar did not during both planting years; with a gross reduction in the second year compared with first year . Heads of those planted late were smaller with tiny seeds. In addition, looking at the heads harvested from those planted late critically, majority of the achiness, towards the centre of the head were hollow, therefore wasted away during winnowing. This explains why the ratio of seed weight to head weight (shelling percent).

2.4 Pollination:

Mating and Breeding System**:** Sunflowers are a member of the aster family. The large flower head is actually an inflorescence, or composite flower, made up of two kinds of tiny florets. The disc florets are located in the center of the composite flower, and the ray florets bear the outer ring of petal-like structures (Müller, *et al*. 2006).

Ray florets are sterile, and disc florets have both male and female structures, including a single ovary that develops into a sunflower seed. A single flower head may have up to two thousand disc florets, each with the potential to develop into a seed. If there are multiple flower heads on the same plant, the number of disc florets per head will be much lower. The disc florets open in sequence, beginning at the periphery of the disc and moving inward. Each floret is first male, with the pollen-bearing anthers extending above the rim of the floret. Later, the style pushes up and the stigmatic lobes spread, opening the receptive surfaces for pollination. If pollinator activity is adequate, the pollen is removed from each floret before the stigma opens, reducing the chances for self-pollination (Greenleaf. 2006).

Pollination, quality and yield numerous experiments have found that a seed set as low as 10-20% results when pollinators are absent and plants self-pollinate, compared to up to 90% seed set in flower heads accessible to pollinators. It should be noted, that different cultivars have different levels of self-fertility, and many modern sunflowers are fully self-fertile. Cross-pollination may still be preferred; however, as it appears to give higher yields and better quality in terms of oil content. Fertility of self-pollen may be greatly reduced at high temperatures, which increases the importance of prompt pollination of self-pollinated varieties during hot weather (Machado, 2006).

Many species of bees will visit sunflowers. Honey bees and bumble bees are known to be effective pollinators of this crop (depending on variety), with bumble bees providing higher yield increases than honey bees.

Certain sunflower varieties can have florets with tubes too deep for honey bees to forage for nectar. Bumble bees and many long-tongued wild bees are able to reach the nectar in the florets of these varieties, and can improve pollination rates. Moreover, research has shown that the interaction with wild bees can enhance honey bee pollination of sunflower, although the reasons for this are not understood (Nderitu, *et al*. 2008).

Sunflower, a cross-pollinated crop, provides an opportunity for developing new and superior hybrids through the use of breeding for heterosis. The practical use of heterosis in sunflower became possible after a source of cytoplasmic male sterility was identified by (Leclercq (1966) in France and fertility restoration was discovered in U.S. (Kinman, 1970). Development of the first sunflower hybrid based on cytoplasmic male sterility in the early 1970’s intensified the interest of farmers in growing this crop (Miller, 1999).

Autogomous pollination is pollination under just covering the head. Low autogamy is one of the genetic reasons for poor seed setting and filling in sunflower. Therefore, evaluation of hybrids and their parental lines for their autogamy becomes necessary before releasing any genotype or hybrid. In one of the autogamy study in sunflower reported that hybrid produced significantly more autogamous seeds over better parent (Rathod *et al*. 2002). Therefore; it suggested that one should grow hybrids for commercial cultivation of sunflower.

The use of insecticides to control pests on agricultural crops is indispensable. Often economically important non target insects such as honeybees are killed in the process of pest control. (Jyothi, 2004) reported that seed yield of sunflower was declined from 764.31g/head to 435.95 g/head after application of insecticide . This decrease in yield of sunflower seeds was due to the decrease in the pollinators visit after insecticide application. Therefore it is suggested that insecticides use should be avoided at blooming stage. If the application of insecticide is so much essential, the hives may be closed for the day and the spray may preferably be taken up during evening hours. Application of insecticides affects the pollinators visit and pollination thus decreases the seed yield of sunflower. Potential yield of sunflower is highly dependent on environmental conditions during life cycle of the crop. Based on the above mentioned discussion it can be concluded that breeding for the fertile lines, plant physiological manipulations, environmental control and good agronomic management can alleviate up to some extent the problem of seed setting and filling in sunflower.

Several possible physiological reasons may be responsible for empty achenes in the capitulum of sunflower. that peripheral seeds were more developmentally mature than intermediary and central seeds. This developmental gradient is due to the poor vascularization of the central flower head. There are no vascular bundles present in the centre of the flower head. Therefore, intermediary and centrally located seeds must receive solutes indirectly by horizontal transport from peripherally located vascular bundles. However, it is interesting to note that centrally located seeds are able to catch up with peripheral seeds during mid-flowering stage. Applied foliar spray of gibberellic acid(GA) and benzyl adenine (BA) for enhancing vascular connections between the outer and inner parts of the capitulum and to increase grain yield by reductions in the percentage of empty achenes in the inner portion of the capitulum (Beltrano *et al*., 1994).

A schematic figure for improving HI in sunflower. In which the possible approaches are reducing thalamus weight, increasing post anthesis biomass production and increased partitioning of biomass to sink by improving sink characters. In sunflower, by anthesis stage, vegetative growth and reproductive structures development is almost completed. Therefore, the dry matter produced after anthesis is probably allocated more towards seed filling process. Thus selecting a genotype for high biomass production during post-anthesis would result in high HI and seed yields. In their experiments with seven genotypes, observed a highly positive significant relationship between seed yield and post anthesis dry matter. This indicates that the maintenance of high leaf area duration LAD during post anthesis period either by decreased leaf senescence or by reduced leaf disease incidence emphasized that the maintenance of high post-anthesis LAD is an important prerequisite to achieve high productivity in sunflower. Tri-iodobenzoic acid (TIBA), an inhibitor of polar transport of auxins, increased the sink capacity of the head and thus movement of metabolites from vegetative organs to the head may be transferred to development of main capitulum. that continuous nipping of auxillary flower buds (from 40 to 68 DAS) significantly increased the capitulum diameter and thus seed yield (Nanja Reddy *et al*. 2003), Vyakaranahal *et al*. 2002).

Physiological effects on the growth and development of plants and draw attention as promising chemicals for practical application in agriculture. Spraying Brassinolide 1 ppm at the ray floret opening stage led to the highest filled seeds percentage and was superior to other seed setting (Chinnamuthu *et al*. 2000).

Productivity of sunflower is often affected by various environmental stresses, of which moisture stress is the most important one. there was maximum decline in LAI and dry matter accumulation in sunflower subjected to moisture stress at flowering stage resulting reduction in yield(Mohan Reddy *et al*. 2003).

Environmental factors make a particular season fit for any crop. studied on seasonal influence on seed set in 13 sunflower genotypes and reported that under open pollination seed set varied from 71.2 to 89.4 % in kharif, 45.4 to 87.2 % in rabi and 60.7 to 91.8 % in spring. The mean seed set under self-pollination was highest in rabi, followed by spring and kharif. Under open pollination, it was highest in kharif followed by spring and rabi. The high percentage of seed filling during kharif under open pollination may possibly be due to the abundance of pollen production and bee activities coupled with high temperature and bright sunshine hours at reproductive phase. Percent seed filling under self and open pollination during kharif, rabi, and spring seasons in sunflower Self pollination Genotype open pollination Kharif Rabi Spring Kharif Rabi Spring(Choudhary and Anand,(1989). In an another experiment, the genotypes, in general, recorded significantly higher seed yield in summer season irrespective of pollination treatment Environmental factors like number of rainy days, rainfall, temperature, relative humidity, longer day lengthn played an important role on final seed yield (Sumangala and Giriraj 2003).

During rainy season, rainfall during peak flowering period brought about poor pollen movement in both exposed and covered heads resulting in poor seed yield. In contrast, the crop raised during summer under irrigation ensured favorable conditions like high temperature, low relative humidity, more sunshine hours and low disease incidence during flowering and seed setting period resulting in increased seed set and seed yield (Sumangala and Giriraj, 2003). The higher yield obtained from the Spring crop confirms the results of who reported that Spring crops have the overall advantage of better plant structure, better environmental condition during crop growth period and maturity over fall crops. Better environmental conditions of spring crop include also the slow and gradual rise in cumulative growing degree days (Aegele, 2007)

Use of borax as filler material helps in uniform spreading of pollen on the stigma and thus increase the seed set and filling in sunflower. Effect of pollen and borax on mean seed number per head and seed filling percentage in sunflower. Most of the pollination gain resulted from the wild bees' presence altering the behavior of foraging honeybees so that they deposited more pollen on female flower parts, leading to greater seed development (Sumathi *et al*. 2005).

Floret number per head was not affected by treatment, but shading reduced grain set significantly ($P<0.05$) in all shading treatments. Florets in the peripheral position on the head showed no change in grain set in response to any shading, grain set of florets in the mid-section of the head radius were affected by immediate post-anthesis shading, and grain set of florets in the central position on the head were affected by most treatments, and particularly so when shading took place immediately after anthesis. Observations of anatomical sections of florets sampled after anthesis from all three positions on the head suggested that fertilization was normal, and that the loss of grain set evoked by shading was due to embryo abortion. There was some evidence of impairment of pollen functionality due to shading, but this involved slower pollen germination and pollen tube growth rather than a complete lack of viability. Shading during the floret growth phase prior to anthesis reduced the unit mass of the resulting grain at physiological maturity. Final unit grain mass was correlated with floret mass at an thesis in both peripheral and mid-section grains. Produced significantly more autogamous seeds over better parent (Rathod *et al*. 2002). Therefore, it suggested that one should grow hybrids for commercial cultivation of sunflower.

Autogamy studies of sunflower genotypes under bagged and open conditions % of filled seed set under bagged condition % seed set under open pollination Self-incompatibility is the inability of fully functional pollen grains to fertilize and seed set on self-pollination. Self-incompatibility of sporophytic nature is reported in sunflower that is major cause for poor seed setting in the crop. Identification of self-fertile lines is one of the means for improving seed setting and productivity in sunflower. Combining ability analysis helps in the identification of suitable parents for further exploitation in breeding programme.) In one of this type of study reported that hybrids are generally more vigorous, uniform, self fertile and resistant to many pests and diseases (Vara Prasad *et al*. 2006). Specific combining ability for seed yield attributes Cross No. of filled seeds 100 seed weight (g) Seed yield per plant (g).

Seed yield is a complex character governed by several contributing characters. Hence, character association study becomes useful to assess the relationship among yield and its components for enhancing the usefulness of selection criterion to be followed while developing varieties. A strong positive association of seed yield with filled seeds/plant, seed set percentage, head diameter and harvest (Ravi *et al*. 2006). After staining with Safranin red/Fast green, the darkened vascular bundles are readily visualized.

The incorporation of these characteristics of interest depends on the existence of genetic variability in germplasm available for the crop breeding programs. From this variability, it is possible to implement the selection process for the most several characteristics, searching the development of lines for hybrids constitution or to obtaining varieties of open pollination ,(Barelli 2004and Amorim *et al*., 2007).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study site:

Two experiments were conducted in the experimental farm of the Department of Agronomy, College of Agricultural Studies, Sudan University of Science and Technology, Shambat, Khartoum, during of 2014/March, May, July and 2o15/, March , May, July seasons to study the evaluation of seed filling problems in some hybrids and open-pollinated sunflower (*Helianthus annuus* L) cultivar effect of pollination and sowing dates.

The area suited in the low land of river Nile, (Latitude 15^{o} 40'N and Longitude 32^{o} 32'E and 375m above sea level. The climate is described as tropical semi-arid .The maximum annual rainfall ranges about 160 mm, occurring during July to September. Relative humidity–ranges between 31-51% during wet season and 12-27% during dry season. Mean maximum and minimum temperature in Khartoum are 41.7^{0} C and 15.3^{0} C respectively. The winter from November to March and is relatively cool and dry. The summer season is hot and dry. The soil is salty clay loam with physical and chemical properties which make it ideal for vegetable and crop production. Pumping water from the river Nile is common, in addition, subsoil water used as supplementary source of irrigation (Hajir. (2012).

3.2 Land preparation sowing and layout of the experiment:

The experimental area was tilled adequately to prepare a suitable seedbed. The implements used were disc plough, disc harrow and leveler to make easy movement and uniform running of irrigation water. The field then was divided to four blocks (replications) each one contained four equal plots of 4x4m size. The seeds of sunflower cultivar local and hybrid were obtained from Alhendy Company (Bahri market) in Khartoum State.

3.3 Experiment Design and Treatments:

The experiment used was a factorial with three factors in a randomized complete block design (RCBD) with four replications. Two cultivars, local (L1) and hybrid (H1)were used. Plants were grown in three different planting dates.

The three sowing date:

1- Sowing in March (S1).

2- Sowing in May (S2).

3- Sowing in July (S3).

Pollinations:

1- Local Cultivar open pollination (Po).

4- Cultivar-local close pollination (Pc, bagged) flower closed before opened.

3=Hysun-33 open pollination (Po).

4-Hysun-33 open pollination (Pc bagged,)flower closed before opened.

3.4 Cultural practices:

Weed control was by hand, one month after sowing and then as needed throughout the growing season. Irrigation was applied at intervals of seven to ten days according to temperature range and soil need.

Data collection:

Three plants were randomly selected from each plot and measured.

3.5 Vegetative growth characters:

3.5.1 Plant height (cm):

The mean plant height was determined after 60days after sowing. The height of the three randomly selected plants was measured from the soil surface to the top of plant.

3.5.2 Leaf area (cm^2):

Three leaves were taken from three plants from each plot to determine leaf area.

3.5.3 Dry weight (g):

This was determined drying the fresh plants(three plant) and then weighted, the weight was stable

3.6 Yield and yield components:

3.6.1 Head diameter (cm):

Measured with aruler across the center of the head and mean head diameter was obtained.

3.6.2 100-seed weight of setting seeds:

Hundred setting seeds weight (g): Hundred-seeds of setting seeds were counted from three heads from each plot weighted and the mean of 100seeds was calculated.

3.6.3 Number of seeds/head:

Total number of seeds per head was calculated**.**

3.6.4 Number of filling seeds/head:

Filling (empty) total number of seeds per head was calculated**.**

3.6.5 100-seed weight of filling seeds:

Hundred setting seeds weight (g): Hundred seeds of filling seeds were counted from three heads from each plot weighed and the mean of 100seed was calculated.

3.6.6 100-seed weight of seeds Setting (g):

Hundred setting seeds weight (g): Hundred Setting seeds of seeds were counted from three heads from each plot weighed and the mean of 100seed was calculated

3.6.7 Setting seeds %:

The percentage seed per head were calculated andx100

$$\textbf{Setting seeds} = \frac{\text{Empty seeds}}{\text{Total}} \times 100$$

3.6.6.2 Filling seeds %:

The percentage (empty) seed per head were calculated.

$$\text{Filling seeds} = \frac{\text{Empty seeds}}{\text{Total}} \times 100$$

3.6.7 The efficiency:

$$\text{Eff} = \frac{O}{\frac{\text{Total}}{(O+E)}} \times 100$$

Where:

O = Open pollination E= Empty seeds

Yield $\boldsymbol{\frac{m2}{1000}\, x\, 10000}$

3.7 Statistical analysis:

The data collected were subjected to analysis of variance (ANOVA) and means were separated for significance by the least significance differences (L.S.D) at P 5% using statistical 8 Version 2.0 (UK).

CHAPTER FOUR

RESULTS

4.1 Plant height (cm):

The highest record of plant height was shown by hybrid the HyS33 in both seasons and the lowest was recorded by local cultivar in two seasons. The analysis of variance showed highly significant differences of cultivar on plant height in the two seasons (Table1, 2).The effect of pollination was significant in season 0ne and not significant in season two local 121cm,hybrid 126cm. The sowing date showed no significant differences in the two seasons (Table1, 2).

There were no significant differences between plant height and interaction in both seasons except between cultivar and sowing date that was significant in season one and highly significant in season two(Table1, 2).

Effect of interaction between cultivars (local cultivar LC, hybrid HyS33) and pollinations (open OP, cover CP) on plant height showed significant differences in season one, hysun33 gave significantly greater plant height than local cultivar, HyS33x OP 134.70 cm and HyS33 x CP 129.41 cm, LC x OP 117.30 cm and LC x CP 113.62 cm. Also in season two hysun33 gave significant differences than local cultivar, HyS33 x OP 132.39 cm and HyS33x CP 128.26 cm, LC x OP 115.1 cm 6and LC x CP 114.31 cm (Table 3).

Effect of interaction of cultivars (local cultivar LC, hybrid HyS33) and sowing dates (March S1, MayS2, JulyS3) on plant height was significant in season one hysun33 greater than local cultivar, HyS33 xS1 131.15cm, HyS33xS2136.55 cm and HyS33xS3 128.46 cm, LC xS1120.63 cm, LC xS2110. 13cm and LC xS3 115.63 cm. Also in season two hysun33 gave significant differences than local cultivar HyS33 xS1 125.50 cm, HyS33x S2135. 84 cm and HyS33 xS3 129.49 cm, LC xS1117.96 cm, LC xS2 109.57 cm and LC xS3 116.66 cm (Table 4).

Effect of interaction between pollinations (open OP, cover CP) and sowing dates (March S1, MayS2, JulyS3)on plant height showed significant differences in season one open pollination was significant, different than cover pollination, OP x S1129.79cm, OP xS2124.71 cm and OP xS3123.50 cm, CP xS1121.29 cm, CP xS2121.96 cm and CP xS3 120.59 cm (Table 7).In the second season no significant differences were observed, OP xS1 121.96 cm, OP xS2 123..54 cm and OP xS3125.83 cm, CP x S1 121.50 cm, CP xS2 121.88 cm and CP xS3 120.33 cm (Table 5).

Effect of interaction between cultivars (local cultivar LC, hybrid HyS33), pollinations (open OP, cover CP) and sowing dates (S1, S2, S3) on plant height gave significant differences in season one HyS33 was significantly higher than local cultivar LC of interaction between cultivars (LC, HyS33 x open and cover pollinations x sowing dates .Also there were significant differences in season two between them and also was significantly higher than local cultivar LC (Table 6).

Table 1: Effect of sowing date and pollination on vegetative parameters of sunflower (cultivar and hybrid) during March, May and July 2014

F Value						
Sources	**Plant height (cm)**	**Leaf area (cm^2)**	**Number of setting seed/head**	**Number of filling seed/head**	**Weightof100 seeds setting(g)**	**Weigh of 100 seeds filling(g)**
Cultivar	50.53^{**}	10.69^{**}	8.09^{**}	10.91^{**}	3.62^{*}	10.04^{**}
Pollination	3.69^{*}	0.49^{NS}	3.14^{*}	5.61^{*}	11.96^{**}	1.75^{NS}
Sowing date	0.94^{NS}	24.21^{**}	34.77^{**}	46.77^{**}	0.32^{NS}	39.59^{**}
1nteraction cxp	0.12^{NS}	0.12^{NS}	0.04^{NS}	1.27^{NS}	0.22^{NS}	13.94^{**}
Interaction cxs	4.51^{*}	0.27^{NS}	1.71^{NS}	2.36^{NS}	1.48^{NS}	4.31^{*}
Interaction pxs	0.50^{NS}	0.88^{*}	1.18^{NS}	1.40^{NS}	5.67^{**}	0.56^{NS}
Interaction cxpxs	0.18^{NS}	2.04^{NS}	1.91^{NS}	2.04^{NS}	0.28^{NS}	2.69^{*}
Error	33	33	33	33	33	33
Total	47	47	47	47	47	47
Ems	65.40	118.96	1194.3	976.9	0.362	0.101
C.V	6.53	10.99	30.01	17.68	13.90	19.80

KEY =C=Cultivar .P= Pollination. S=sowing date. **= (Highly significant) at 5%. * Significant. N.S not significant.

Table 2: Effect of sowing date and pollination on vegetative parameters of sunflower (cultivar and hybrid) during March, May and July 2015

F Value						
Sources	**Plant height (cm)**	**Leaf area (cm^2)**	**Number of setting seed/head**	**Number of filling seed/head**	**Weight of 100 Seeds(g) setting**	**Weight of 100 seeds filling(g)**
Cultivar	76.57^{**}	0.18^{NS}	2.78^{NS}	0.31^{NS}	1.42^{NS}	1.05^{NS}
Pollination	2.05^{NS}	1.41^{NS}	65.33^{**}	33.57^{**}	0.26^{NS}	13.56^{**}
Sowing date	0.20^{NS}	65.54^{**}	2.29^{NS}	7.56^{**}	20.38^{**}	4.13^{*}
1nteraction cxp	0.91^{NS}	0.25^{NS}	1.25^{NS}	0.46^{NS}	1.86^{NS}	1.05^{NS}
Interaction cxs	9.85^{**}	3.99^{*}	0.96^{NS}	1.50^{NS}	0.63NS	0.13^{NS}
Interaction pxs	0.73^{NS}	1.86^{NS}	0.90^{NS}	6.69^{**}	3.13^{*}	$0,38^{NS}$
Interaction cxpxs	0.75^{NS}	0.35^{NS}	0.04^{NS}	0.21^{NS}	1.81^{NS}	0.35^{NS}
Error	33	33	33	33	33	33
Total	47	47	47	47	47	47
Ems	37.85	174.0	3841	8230	0.459	0.079
C.V	5.02	12.42	32.34	31.37	12.41	20.65

KEY =C=Cultivar .P= Pollination. S=sowing date. **= (Highly significant) at 5%. * Significant. N.S not significant

Table 3: Effect of interaction between cultivars and pollinations on plant height (cm) of sunflower (*Helianthus annnus* L) in seasons (2014 and 2015)

Cultivar	Season 1			Season 2		
	Pollinations		Mean	Pollinations		Mean
	OP	CP		OP	CP	
LC	117.30^{B}	113.62 ^{B}	115.46^{A}	115.16 ^{B}	114.31 ^{B}	114.73^{B}
HyS33	134.70 ^{A}	129.41 ^{A}	132.05^{B}	132.39 ^{A}	128.26 ^{A}	130.28^{A}
Mean	126.00^{A}	121.01^{A}		123.77^{A}	121.23^{A}	
SE+3.30						SE+ 2.52
C.V 6.72						C.V 5.11

Means in columns followed by different letters are significantly different at 5 %.
LC=Local Cultivar. HyS33= Hysun33. OP= Open Pollination. CP= Cover Pollination.

Table 4: Effect of interaction between cultivars and sowing dates on plant height(cm) of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015)

Cultivars	Season1			Season2		
	Sowing dates			Sowing dates		
	S1	S2	S3	S1	S2	S3
LC	120.63^{BC}	110.13^{D}	115.63^{CD}	117.96^{C}	109.57^{D}	116.66^{C}
HyS33	131.15^{A}	136.55^{A}	12846^{AB}	125.50^{B}	135.84^{A}	129.49^{B}
Mean	125.89^{A}	123.34^{A}	122.04^{A}	121.73^{A}	122.71^{A}	123.08^{A}
SE+ 4.04						SE+ 3.08
C.V 8.23						C.V6.26

Means in columns followed by different letters are significantly different at 5 %.
LC = local Cultivar. HyS33= Hysun33 Cultivar. S1= Sowing in March. S2= Sowing in May. S3= Sowing in July.

Table 5: Effect of interaction between pollinations and sowing dates on plant height (cm) of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015)

Pollination	Season1			Season2		
	Sowing dates			Sowing dates		
	S1	S2	S3	S1	S2	S3
OP	129.79^{A}	124,71^{AB}	123.50 ^{AB}	121,96 ^{A}	123.54 ^{A}	125.83 ^{A}
CP	121.29 ^{AB}	121.96^{AB}	120.59 ^{B}	121.50 ^{A}	121.88 ^{A}	120.33 ^{A}
SE+ 4.04						SE+ 3.08
C.V 8.20						C.V6.26

Means in columns followed by different letters are significantly different at 5 %.
OP =Open Pollination .CP= Cover pollination. S1= Sowing in March. S2= Sowing in May. S3= Sowing in July.

Table 6: Effect of interaction between cultivars, pollinations and sowing dates on plant height (cm) of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

		Season1			Saeson2		
Cultivar	Pollination	Sowing dates			Sowing dates		
		S1	S2	S3	S1	S2	S3
LC	OP	125.00^{BCD}	111.07^{E}	115.63^{DE}	118.42^{BCD}	109.97^{DE}	117.08^{BCDE}
LC	CP	116.25^{CDE}	109.18^{E}	115.42^{DE}	117.50^{BCDE}	109.17E	116.25^{CDE}
HyS33	OP	134.58^{AB}	138.35^{A}	131.18^{AB}	125.50^{B}	137.10^{A}	134.58^{A}
HyS33	CP	127.73^{ABC}	134.75A^{B}	125.75^{BCD}	125.50^{B}	134.57^{A}	124.40^{BC}
SE+5.72							SE+4.35
C.V 11.64							C.V 8.25

Means in columns followed by different letters are significantly different at 5 %.
LC = Local Cultivar. HyS33= Hysun33.OP=Open pollination. CP= Cover pollination. S1= Sowing in March. S2= Sowing in May. S3= Sowing in July.

4.2 Leaf area:

The highest record of leaf area was shown by local cultivar LC 104.33cm^{2}in the first season and the lowest was recorded by hybrid HyS33 94.35 cm^{2}in second season also. Differences between sunflower cultivar were highly significant in season one and significant in season two. The results of pollination were not significant in the two seasons. There were highly significant differences ($p<0.05$) in sowing date in the two seasons (Table1, 2).

The difference between treatments interaction on leaf area was not significant except for cultivar x pollination sowings date in season one and between cultivar x sowing date in both were significantly different.

Effect of interaction between cultivars (local cultivar LC, hybrid HyS33) and pollinations (open OP, cover CP) on leaf area were significant in season one, local cultivar gave significantly greater leaf area than hysun33, LC x OP 107.79 cm^{2}and LC x CP 104.91 cm^2, HyS33x OP 92.42 cm^2, and HyS33 x CP 195.69 cm^2.There were no significant differences in season two (Table 7).

Effect of interaction cultivars (local cultivar LC, hybrid HyS33) and sowing dates (S1, S2, S3) on leaf area was significant differences in both seasons, season one local cultivar LC xS1106.82 cm^2, LC HyS33xS288.66 cm^2andLCxS3117.56cm^2HyS33xS194.45cm^2,HyS33xS281.59cm^2andHyS33x S3106 cm^2 Season tow local cultivar LC xS1, LC xS2 and LC xS3, HyS33 xS1, HyS33 xS2 and HyS33xS3, (Table 8).

Effect of interaction between pollinations (open OP, cover CP) and sowing dates (S1, S2, S3)on plant height were significant differences in season one open pollination was significant than cover pollination, OP XS196.82 cm^2, OP xS2 81.59 $cm^2$and OP xS3 115.90 cm^2, CP xS1 100.04 cm^2, CP xS288.66 $cm^2$and CP xS3 107.79 cm^2 (Table 6).In the second season no significant differences between them, OP xS1 79.71 cm^2, OP xS2 123.64 cm^2 and OP xS3 108.58 cm^2, CP xS1 73.90 cm^2, CP xS2 134.1 and CP xS3 117.42 cm^2 (Table 9).

Effect of interaction between cultivars (local cultivar LC, hybrid HyS33), pollinations (open OP, cover CP) and sowing dates (S1, S2, S3) on leaf area were significant differences in season one HyS33 was significant than local cultivar LC of interaction between cultivars (LC, HyS33 x open and cover pollinations x sowing dates (Table1,2).Also there were significant differences in season tow between them and HyS33also was significant than local cultivar LC (Table 10).

Table 7: Effect of interaction between cultivars and pollinations on leaf area(cm^2) of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Cultivar	Season 1			Season 2		
	Pollinations		Mean	Pollinations		Mean
	OP	CP		OP	CP	
LC	107.79^{AB}	104.91^{A}	104.33^{A}	104.11^{A}	106.74^{A}	105.84^{A}
HyS33	92.42^{C}	95.69^{BC}	94.35^{B}	103.84^{A}	110.26^{A}	107.05^{A}
Mean	98.10^{A}	100.30^{A}		103.97^{A}	108.50^{A}	
SE+4.45						SE+5.39
C.V9.06						C.V10.96

Means in columns followed by different letters are significantly different at 5 %.

Table 8: Effect of interaction between cultivars and sowing dates on leaf area(cm^2) of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Cultivar	Season1			Season2		
	Sowing dates			Sowing dates		
LC	S1	S2	S3	S1	S2	S3
	106.82^{AB}	88.66^{CD}	117.56^{A}	79.35^{C}	120.50^{B}	116.42^{B}
HyS33	94.45^{C}	81.59^{D}	106.13^{B}	74.26^{C}	137.31^{A}	109.57^{B}
Mean	100.04^{B}	85.13^{C}	111.84^{A}	76.81^{C}	128.00^{A}	113.00^{B}
SE+ 6.51						SE+ 6.60
C.V 11.10						C.V 13.42

Means in columns followed by different letters are significantly different at 5 %.

Table 9: Effect of interaction between pollinations and sowing dates on leaf area (cm^2) of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Pollinations	Season1			Season2		
	Sowing dates			Sowing dates		
	S1	S2	S3	S1	S2	S3
OP	96.82^{BC}	81.59^{A}	115.90^{A}	79.71^{D}	123.64^{AB}	108.58^{C}
CP	104.45^{B}	88.66^{CD}	107.79^{AB}	73.90^{D}	134.17^{A}	. 117.42^{BC}
SE+ 5.45						SE+ 6.51
C.V 11.10						C.V 13.42

Means in columns followed by differ letters are significantly different at 5 %.

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Table 10: Effect of interaction between cultivars, pollinations and sowing dates on leaf area(cm^2) of sunflower (Helianthus annuus L) in seasons (2014 and 2015).

cultivar	Pollination	Season1			Saeson2		
		Sowing dates			Sowing dates		
		S1	S2	S3	S1	S2	S3
LC	OP	107.83^{ABCD}	84.75^{EF}	118.80^{A}	84.92^{D}	116.58^{BC}	110.82^{C}
LC	CP	105.83^{ABCD}	92.58^{DEF}	116.33^{AB}	73.78^{D}	124.42^{BC}	122.02^{BC}
HyS33	OP	85.82^{EF}	78.43^{F}	113.00^{ABC}	74.50^{D}	130.70^{AB}	106.32^{C}
HyS33	CP	103.08^{BCD}	84.75^{EF}	99.25^{CDE}	74.03^{D}	143.93^{A}	112.83^{BC}
SE+ 7.71							SE+ 9.33
C.V 15.69							C.V 18.98

Means in columns followed by different letters are significantly different at 5 %.

4.3 Number of seeds setting/head:

The highest record of number of seeds setting/head was shown by hybrid HyS33 409.04 in the first season and the lowest was recorded by local cultivar LC 319.29 in first season. Statistical analysis indicated that there were highly significant differences in number of seeds setting per head of cultivar in season one but non significant differences in season two (Table1,2). On the other hand, there were significant differences of pollination in the number of seeds setting per head in the first season (Table1,2). However, there was highly significant difference in season two of pollination on number of seeds setting per head. In other hand the effect of sowing date were highly significant differences in season one and non significant differences in season two (Table1, 2).

Treatments interaction showed no significant effect on number of seeds per head in both seasons (Table1, 2).

Effect of interaction between cultivars (local cultivar LC, hybrid HyS33) and pollinations (open OP, cover CP) on number of seeds setting/head were significantly different in season one, hysun33 gave significantly greater than local cultivar, HyS33x OP 440.08 and HyS33x CP 378.00, LC x OP 344.17 and LC x CP 298.42.Also in season two hysun33 gave significant differences than local cultivar, HyS33x OP 770.72 and HyS33x CP 249.84, LC x OP 612.25.and LC x CP 218.62 (Table11).

Effect of interaction of cultivars (local cultivar LC, hybrid HyS33) and sowing dates (S1, S2, S3) on number of seeds setting/head was significantly different in season one hysun33 gave greater number of seeds than local cultivar, HyS33xS1209, HyS33 xS2 358. and HyS33xS3 560.00, LC xS1 186., LC xS2 293and LC xS3 478. Season two hysun33 gave significant differences than local cultivar HyS33 xS1417. HyS33xS2612.and HyS33xS3499, LC xS1337, LC xS2415 and LC xS3493. (Table12).

Effect of interaction between pollinations (open OP, cover CP)and sowing dates (S1, S2, S3)on number of seeds setting/head was significantly different in season one open pollination was significant than cover pollination, OP xS1 212.38., OP xS2382.88and OP xS3 581.13, CP xS1182.87, CP xS2 368.50and CP xS3 457.25 (Table 14).Also in second season open pollination gave highly significant differences than cover pollination, OP xS1 576.26, OP xS2 796.45 and OP xS3 701.80, cover pollination CP xS1 179.42, CP xS2 232.09 and CP xS3 291.18 (Table13).

Effect of interaction between cultivars (local cultivar LC, hybrid HyS33), pollinations (open OP, cover CP) and sowing dates (S1, S2, S3) on number of seeds setting/head there was significantly different in both seasons, interaction between cultivars of open pollination and sowing dates were significant differences than cover pollination (Table 14).

Table 11: Effect of interaction between cultivars and pollinations on number of seed setting of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Cultivar	Season1			Season2		
	Pollinations		Mean	Pollinations		Mean
	OP	CP		OP	CP	
LC	344.17^{B}	294.42^{B}	319.29^{B}	612.25^{A}	218.62^{B}	415.68^{A}
HyS33	44O.08^{A}	378.00^{AB}	409.04^{A}	770.72^{A}	249.84^{B}	510.05^{A}
Mean	392.12^{A}	336.21^{A}		691.51^{A}	234.23^{B}	
SE+44.62						SE+ 80.01
C.V 90.77						C.V 162.78

Means in columns followed by different letters are significantly different at 5 %.

Table 12: Effect of interaction between cultivars and sowing dates on number of seed setting of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Cultivar	Season1			Season2		
	Sowing dates			Sowing dates		
	S1	S2	S3	S1	S2	S3
LC	186.25^{B}	293.25^{B}	478.38^{A}	337.97^{B}	415.79^{AB}	493.29^{AB}
HyS33	209.00^{B}	258.13^{A}	560.00^{A}	417.70^{AB}	612.75^{A}	499.70^{AB}
Mean	197.63^{C}	375.69^{D}	519.19^{A}	377.84^{A}	514.27^{A}	496.49^{A}
SE+ 54.64						SE+97.99
C.V 111.17						C.V 199.37

Means in columns followed by different letters are significantly different at 5 %.

Table 13: Effect of interaction between pollinations and sowing dates on number of seed setting of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Pollination	Season1			Season2		
	Sowing dates			Sowing dates		
	S1	S2	S3	S1	S2	S3
OP	212.38^{C}	382.88^{B}	581.13^{A}	576.26^{B}	796.45^{A}	701.80^{AB}
HyS33	182.87^{C}	368.50^{B}	457.25^{B}	179.42^{C}	232.09^{C}	291.18^{C}
SE+ 54.64						SE+ 97.99
C.V 111.17						C.V 199.37

Means in columns followed by differ letters are significantly different at 5 %.

Table 14: Effect of interaction between cultivars, pollinations and sowing dates on number of seed setting of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

cultivars	Pollination	Season1			Saeson2		
		Sowing dates			Sowing dates		
		S1	S2	S3	S1	S2	S3
LC	OP	218.50^{EF}	253.75^{DEF}	560.25^{AB}	516.10^{BC}	662,07^{BA}	660.08^{AB}
LC	CP	154.00^{F}	332.75^{DE}	396.50^{CD}	159.85^{D}	169.50^{D}	326.50^{CD}
HyS33	OP	206,25^{EF}	512.00^{ABC}	602.00^{A}	636.42^{B}	930.83^{A}	743.55^{AB}
HyS33	CP	211.75^{EF}	404.25^{BCD}	518.00^{ABC}	199.00^{D}	294.68^{CD}	255.85^{CD}
SE+ 77.28							SE+ 138.6
C.V157.22							C.V281.9

Means in columns followed by different letters are significantly different at 5 %.

4.4 Number of seeds filling/head:

The highest record of number of seeds filling/head was shown by hybrid HyS33 191.66in the first season and the lowest was recorded by local cultivar LC 161.86in first season. Statistical analysis showed that there were highly significant differences in number of seeds filling per head of cultivar in season one, and non significant differences in season two (Table1, 2). The effect of pollination was significant in season one and highly significant in season two (Table1, 2). Also effects of sowing dates were highly significant in both seasons (Table1, 2).

Generally, treatment interaction showed that non significant differences on seeds filling number per head, except interaction between pollination x Sowings date in season two (Table1,2).

Effect of interaction between cultivars (local cultivar LC, hybrid HyS33) and pollinations (open OP, cover CP) on number of seeds filling/head were significantly different in season one ,hysun33 gave significantly higher number than local cultivar, HyS33xOP 207.42 and HyS33xCP175.89, LC xOP167.47 and LC xCP156.25. In season two no differences between them, HyS33xOP 214.91 and HyS33xCP 348.83, local cultivar LC x OP 211.68and LC x CP 381.22 (Table15).

Effect of interaction of cultivars (local cultivar LC, hybridHyS33) and sowing dates (S1, S2, S3) on number of seeds filling/head there was not significant differences between them in both seasons. Season one local cultivar LC xS1 228.38, LC xS2 97.79and LC xS3 156.43, HyS33 xS1 235.54, HyS33xS2152.75 and HyS33xS3 186.69. Season two local cultivar LC xS1223.70, LC xS2270.71 and LC xS3394.94 HyS33xS1240.04, HyS33x S2289.38 and HyS33xS3 316.19 (Table16).

Effect of interaction between pollinations (open OP, cover CP) and sowing dates (S1, S2, S3)on number of seeds filling/head was not different in the first season , in contrast in season two cover pollination of hysun33 was significantly higher than open pollination of local cultivar, cover hysun33 CPxS1 261.95,CP xS2 335.57 and CPxS3 497.55, open of local cultivar OP x S1 201.79, OPxS2 224.51andOPxS3 213.58 (Table 17).

Effect of interaction between cultivars (local cultivar LC, hybrid HyS33), pollinations (open OP, cover CP) and sowing dates (S1, S2, S3) on number of seeds filling/head was significantly different of interaction between cultivars x pollinations x sowing dates in the two seasons (Table 18).

Table 15: Effect of interaction between cultivars and pollinations on number of seed filling of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Cultivar	Season1			Season2		
	Pollinations		Mean	Pollinations		Mean
	OP	CP		OP	CP	
LC	167.47^{B}	156.25^{B}	161.86^{B}	211.68 ^{B}	381.22^{A}	296.45^{A}
HyS33	207.42^{A}	175.89^{B}	191.66^{A}	214.91^{B}	348.83^{A}	281.87^{A}
Mean	187.45^{A}	166.07^{B}		213.29^{B}	365.03^{A}	
SE+12.76						SE+37.04
C.V 25.96						C.V 75.35

Means in columns followed by different letters are significantly different at 5 %.

Table 16: Effect of interaction between cultivars and sowing dates on number of seed filling of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Cultivar	Season1			Season2		
	Sowing dates			Sowing dates		
	S1	S2	S3	S1	S2	S3
LC	228.38^{A}.	97.79D	159.43^{BC}	223.70^{C}	270.71^{B}	394.94^{A}
HyS33	235.54^{A}	152.75C	186.69^{B} .	240.04^{BC}	289.38^{BC}	316.19 ^{AB}
Mean	231.96^{A}	125.27^{C}	173.06^{B}	231.87^{B}	280.04^{B}	355.56^{A}
SE+ 15.63						SE+ 45.36
C.V 31.79						C. V 92.29

Means in columns followed by different letters are significantly different at 5 %.

Table 17: Effect of interaction between pollinations and sowing dates on number of seed filling of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Pollination	Sowing date 1			Sowing date 2		
	S1	S2	S3	S1	S2	S3
OP	241.00^{A}	127.66^{C}	193.43^{C}	201.79^{C}	224.51^{C}	213.58^{C}
HyS33	222.91^{AB}	122.88^{C}	152.43^{C}	261.95^{BC}	335.57^{B}	497.55^{A}
SE+15.63						SE+ 45.36
C.V 31.7						C.V 92.29

Means in columns followed by differ letters are significantly different at 5 %.

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Table 18: Effect of interaction between cultivars, pollinations and sowing dates on number of seed filling of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015)

Cultivar		Season1			Saeson2		
	Pollination	Sowing dates			Sowing dates		
		S1	S2	S3	S1	S2	S3
LC	OP	231.10^{AB}	84.93^{F}	186.70^{BC}	176.57^{E}	202.60^{DE}	255.85^{CDE}
LC	CP	225.65^{AB}	110.95^{EF}	132.15^{DF}	270.82^{CDE}	338.83^{BC}	534.02^{A}
HyS33	OP	250.90^{A}	170.70^{CD}	200.68^{BC}	227.00^{CDE}	246.43^{CDE}	171.30^{E}
HyS33	CP	220.18^{AB}	134,80^{DF}	172.70^{CD}	253.07^{CDE}	332.32^{BCD}	461.07^{AB}
SE+22.1							SE+ 64.1
C.V 44.9							C.V 130.9

Means in columns followed by different letters are significantly different at 5 %.

4.5 Hundred Seed weight (g) of seeds setting:

The analysis of variance revealed significant differences (p<o.o5) in 100seed weight due to cultivar in season one and non significant differences in season two (Table1, 2). Pollination showed highly significant differences in season one and non significant in season in season two (Table1,2) . Also differences between the sowing date were statistically not significant in season one, but highly significant in season two (Table1, 2).

The statistical analysis indicated non significant differences of interaction in the two seasons except interaction between pollination X sowing date were highly significantly different in season one (Table1,2).

Effect of interaction between cultivars (local cultivar LC, hybrid HyS33) and pollinations (open OP, cover CP) on hundred seed weight of seeds setting were significantly different in season one, local cultivar were significant than hysun33, HyS33 x OP 3.82 and HyS33xCP 4.50.The local cultivars LC x OP 4.23 and LC x CP 4.75. In season two were not significantly different (Table 19).

Effect of interaction of cultivars (local cultivar LC, hybrid HyS33) and sowing dates (S1, S2, S3) on hundred seed weight significantly different in the two seasons .Season one local cultivar LC xS1 4.64, LC xS2 4.37and LC xS3 4.46, HyS33 xS1 3.89, HyS33 xS2 4.20and HyS33 xS3 4.38. In season two local cultivar LC xS1 5.09, LC xS2 6.14 and LC xS3 4.83, HyS33xS1 5.01, HyS33 xS2 6.56 and HyS33xS3 5.1 (Table20).

Effect of interaction between pollinations (open OP, cover CP)and sowing dates (S1, S2, S3)on hundred seed weight of seeds setting were significant differences in the two seasons. In general, open pollination was significantly higher than cover pollination in season two, open pollination OP x S14.80, OP xS2 6.70and OP xS3 5.50, cover pollination CP xS15.30, CP xS2 6.00and CP xS3 4.95, season one open pollination OP x S1 3.67, OP xS2 4.38, OP xS3 4.02, cover pollination CP xS1 4.86, CP xS2 4.19, CP xS3 4.83 (Table21).

Effect of interaction between cultivars (local cultivar LC, hybrid HyS33), pollinations (open OP, cover CP) and sowing dates (March S1, MayS2, JulyS3) on hundred seed weight of seeds setting\ there were significant differences in the two seasons between them (Table22).

Table 19: Effect of interaction between cultivars and pollinations on weight of100 seed setting of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Cultivar	Season 1			Season 2		
	Pollinations		Mean	Pollinations		Mean
	OP	CP		OP	CP	
LC	4.23^{BC}	4.75^{A}	4.59^{A}	5.53^{A}	5.17^{A}	5.35^{A}
HyS33	3.82^{C}	4.50^{AB}	4.16^{A}	5.50^{A}	5.67^{A}	5.58^{A}
Mean	4.03^{B}	4.63^{A}		5.52^{A}	5.42^{A}	
SE+0 .25						SE+0.28
C.V 0.50						C.V 0 .56

Means in columns followed by different letters are significantly different at 5 %.

Table 20: Effect of interaction between cultivars and sowing dates on weight of 100 seed setting of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Cultivar	Season1			Season2		
	Sowing dates			Sowing dates		
	S1	S2	S3	S1	S2	S3
LC	4.64^{A}	4.37^{AB}	4.46^{AB}	5.09^{B}	6.14^{A}	4.83^{B}
HyS33	3.89^{B}	4.20^{AB}	4.38^{AB}	5.01^{B}	6.56^{A}	5.18^{B}
Mean	4.27^{A}	4.29^{A}	4.42^{A}	5.05^{B}	6.36^{A}	5.00^{B}
SE+ 0.30						SE+0.34
C. V 0.61						C.V0.69

Means in columns followed by different letters are significantly different at 5 %.

Table 21: Effect of interaction between pollinations and sowing dates on weight of 100 seed setting of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015)

Pollination	Sowing date 1			Sowing date 2		
	S1	S2	S3	S1	S2	S3
OP	3.67^{C}	4.38^{AB}	4.02^{BC}	4.80^{C}	6.70^{A}	5.50^{C}
CP	4.86^{A}	4.19^{BC}	4.83^{A}	5.30^{C}	6.00^{B}	4.95^{C}
SE+ 0.30						SE+0.34
C.V 0.61						C.V 0.69

Means in columns followed by differ letters are significantly different at 5 %.

Table 22: Effect of interaction between cultivars, pollinations and sowing dates on weight of 100 seed setting of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Cultivar	Pollination	Season1			Saeson2		
		Sowing dates			Sowing dates		
		S1	S2	S3	S1	S2	S3
LC	OP	4.17^{BC}	4.43^{ABC}	4.10^{BC}	5.18^{CDE}	6.38^{AB}	5.05^{DE}
LC	CP	5.12^{A}	4.31^{ABC}	4.83^{AB}	5.00^{DE}	5.90^{BCD}	4.60^{E}
HyS33	OP	3.18^{D}	4.34^{ABC}	3.94^{CD}	4.43^{E}	7.03^{A}	5.05^{DE}
HyS33	CP	4.61^{ABC}	4.07^{BC}	4.83^{AB}	5.60^{BCD}	6.10^{ABC}	5.30^{CDE}
SE+ 0.43							SE+0.48
C.V 0.98							C.V0.87

Means in columns followed by different letters are significantly different at 5 %.

4.6 Hundred Seeds filling weight (g):

The highest record of hundred Seeds filling weight was shown by hybrid HyS33 1.77gin the first season and the lowest was recorded by local cultivar LC 1.49g in first season. The statistical analysis revealed that cultivar was highly significantly different in season one and non significant in season two(Table1,2). The effect of pollination was not significant in season one, but highly significant in season two (Table1, 2). Sowing date resulted in highly significant differences in season one and significant in season two (Table1, 2).

There was highly significant differences between cultivar X pollination, significant between cultivar X sowing date and, also significant between cultivar X pollination X sowing date, but non significant between pollination X sowing date(Table1,2).

In contrast the analysis of variance resulted in non significant differences in season two between all interactions (Table1, 3).

Effect of interaction between cultivars (local cultivar LC, hybrid HyS33) and pollinations (open OP, cover CP) on hundred seeds filling weight were significantly different in the two seasons, hysun33 gave significantly greater weight than local cultivar in cover pollination of the two seasons, in season one HyS33xOP 1.0and HyS33xCP 1.52., LC x OP 1.35 and LC x CP 1.57. Season two HyS33 x OP 1.60 and HyS33xCP 1.22, local cultivar LC x OP 1.43and LC x CP 1.22 (Table 23).

Effect of interaction cultivars (local cultivar LC, hybrid HyS33) and sowing dates (S1, S2, S3) on hundred seeds filling weight was significantly different, hysun33 gave significantly greater weight than local cultivar in two seasons ,season one HyS33xS1 1.27, HyS33xS22.14and HyS33xS31.83, LC xS1 1.78, LC xS2 1.67and LC xS3 1.92. Season two, HyS33xS1 1.59, HyS33xS2 1.32 and HyS33 xS3 1.33, local cultivar LC xS1 1.48, LC xS2 1.29and LC xS3 123 (Table 24).

Effect of interaction between pollinations (open OP, cover CP)and sowing dates (S1, S2, S3)on hundred seeds filling weight was significantly different open pollination was significant than cover pollination in both seasons. First season open OP x S1 1.23, OP xS2 1.98and OP xS3 1.99, cover CP xS1 1.03, CP xS2 1.84 and CP xS3 1.76. Second season, open OP xS1 1.73, OP xS2 1.45 and OP xS3 1.38, cover CP XS1 1.34, CP xS2 1.15 and CP xS3 1.16 (Table 25).

Effect of interaction between cultivars (local cultivar LC, hybrid HyS33), pollinations (open OP, cover CP) and sowing dates (S1, S2, S3) on hundred seeds filling weight was significantly different in the two seasons. HyS33 was significant than local cultivar LC of interaction between cultivars at open situation in both seasons at three sowing dates (Table26).

Table 23: Effect of interaction between cultivars and pollinations on weight of 100 seed filling of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Cultivar	Season 1			Season 2		
	Pollinations		Mean	Pollinations		Mean
	OP	CP		OP	CP	
LC	1.35^{B}	1.57^{B}	1.49^{B}	1.43^{AB}	1.22^{B}	1.33^{A}
HyS33	1.98^{A}	1.52^{B}	1.75^{A}	1.60^{A}	1.22^{B}	1.41^{A}
Mean	1.66^{A}	1.54^{A}		1.52^{A}	1.22^{B}	
SE+013						SE+0.12
C.V0.26						C.V 0.23

Means in columns followed by different letters are significantly different at 5 %.

Table 24: Effect of interaction between cultivars and sowing dates on weight of 100 seed filling of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Cultivar	Season1			Season2		
	Sowing dates			Sowing dates		
LC	S1	S2	S3	S1	S2	S3
	0.78^{D}	1.67^{B}	1.92^{AB}	1.48^{AB}	1.29^{B}	1.23^{B}
HyS33	1.27^{C}	2.14^{A}	1.83^{AB}	1.59^{A}	1.32^{AB}	1.33^{AB}
Mean	1.03^{B}	1.91^{A}	1.88^{B}	1.53^{A}	1.30^{B}	1.27^{B}
SE+0.16						SE+ 0.14
C.V 0.32						C.V 0.29

Means in columns followed by different letters are significantly different at 5 %.

Table 25: Effect of interaction between pollinations and sowing dates on weight of 100 seed filling of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Pollination	Sowing dates 1			Sowing dates 2		
	S1	S2	S3	S1	S2	S3
OP	1.23^{B}	1.98^{A}	1.99^{A}	1.73^{A}	1.45^{AB}	1.38^{BC}
CP	1.03^{B}	1.84^{A}	1.76^{A}	1.34^{BC}	1.15^{C}	1.16^{C}
SE+ 0.16						SE+ 0.14
C.V 0.32						C.V 0.29

Means in columns followed by differ letters are significantly different at 5 %.

Table 26: Effect of interaction between cultivars, pollinations and sowing dates on weight of 100 seed filling of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Cultivar	Pollination	Season1			Saeson2		
		Sowing dates			Sowing dates		
		S1	S2	S3	S1	S2	S3
LC	OP	0.67^{F}	1.42^{CD}	1.96^{B}	1.68^{AB}	1.38^{ABCD}	1.25^{CD}
LC	CP	0.91^{EF}	1.92^{B}	1.88^{B}	1.28^{BCD}	1.20^{CD}	1.18^{CD}
HyS33	OP	1.38^{CD}	2.53^{A}	2.O3^{B}	1.78^{A}	1.53^{ABC}	1.50^{ABCD}
HyS33	CP	1.16^{DE}	1.76^{BC}	1.64^{BC}	1.40^{ABCD}	1.10^{D}	1.15^{CD}
SE+0.22							SE+ 0.11
C.V 0.46							C.V 0.41

Means in columns followed by different letters are significantly different at 5 %.

4.7 Head diameter (cm):

The highest record of head diameter was shown by hybrid HyS33 10.80 in the second season and the lowest was recorded by local cultivar LC 10.31in the second season .The statistical analysis revealed non significant differences of cultivars in season one, but significant differences in season two(Table27,28). Also non significant differences of pollination in season one, but highly significant in season two (Table2,4). Effect of sowing date was highly significantly different in both seasons (Table27, 28)

Interaction of cultivar X pollination and between pollination X sowing date was highly significant on head diameter, non significant differences on head diameter between cultivar X sowing date and between cultivar X pollination X sowing date in season one(Table27,28). There were significant differences between cultivar X pollination X and between cultivar X pollination X sowing date, highly significant differences between pollination X sowing date and non significant differences between cultivar X sowing date in season two (Table27, 28).

Effect of interaction between cultivars (local cultivar LC, hybrid HyS33) and pollinations (open OP, cover CP) on head diameter was significantly different in the two seasons. Season one Local cultivar LC x OP 9.92 and LC x CP 8.92. HyS33x OP 8.86 and HyS33 x CP 9.31, season two local cultivar LC x OP 10.69and LC x CP 9.93, HyS33 x OP 11.59 and HyS33x CP 10.02 (Table 29).

Effect of interaction cultivars (local cultivar LC, hybrid HyS33) and sowing dates (S1, S2, S3) on head diameter was significantly different in the two seasons Hysun33 gave significantly higher number than local cultivar in second season, HyS33xS1 8.85, HyS33 xS2 12.38and HyS33xS3 11.19, local cultivar LC xS1 8.46, LC xS2 11.48and LC xS3 11.00. Season one HyS33 xS1 8.38, HyS33xS2 9.46 and HyS33xS39.42, local cultivar LC xS1 8.29, LC xS29.92 and LC xS310.04 (Table 30).

Effect of interaction between pollinations (open OP, cover CP)and sowing dates (S1, S2, S3)on head diameter was significantly different in both seasons open pollination was significant than cover pollination, season one open pollination OP x S1 7.88 , OP xS210.46and OP xS3 9.83, cover pollination CP xS1 8.79, CP xS2 8.92and CP xS3 9.63,season two open pollination OP x S1, OP xS2and OP xS3, cover pollination CP xS1 7.40 CP,xS2 11.64.and CP xS3 10.89 (Table31).

Effect of interaction between cultivars (local cultivar LC, hybrid HyS33), pollinations (open OP, cover CP) and sowing dates (S1, S2, S3) on head diameter there was significantly different in both seasons, HyS33 was significant than local cultivar LC of interaction between cultivars (LC, HyS33 x (open and cover) pollinations x sowing dates in both seasons also (Table 32).

Table 27: Effect of sowing date and pollination on vegetative parameters of sunflower (*Helianthus annuus* L) (cultivar and hybrid) during March, May and July 2014

F Value						
Sources	Head diameter (cm)	Dry weight (g)	Setting seed %	Filling seed %	Affiance	Yield 2014
Cultivar	1.75^{NS}	1.13^{NS}	8.09^{**}	0.97^{NS}	1.63^{NS}	4.25^{*}
Pollination	1.21^{NS}	0.06^{NS}	3.14^{*}	3.93^{*}	4.15^{*}	0.07^{NS}
Sowing date	13.24^{**}	11.36^{**}	34.77^{**}	1.05^{NS}	23.80^{**}	41.63^{**}
1interaction cxp	8.18^{**}	3.55^{*}	0.04^{NS}	5.97^{*}	1.50^{NS}	0.38^{NS}
Interaction cxs	0.73^{NS}	2.53^{*}	1.71^{NS}	$0,10^{NS}$	0.13^{NS}	4.33^{*}
Interaction pxs	7.95^{**}	2.54^{*}	1.18^{NS}	3.79^{*}	1.32^{NS}	0.14^{NS}
Interaction cxpxs	0.09^{NS}	1.95^{NS}	1.91^{NS}	0.82^{NS}	0.34^{NS}	2.60^{*}
Error	33	33	33	33	33	33
Total	47	47	47	47	47	47
Ems	0.762	6535.6	1.194	0.442	1.384	138.33
C.V	9.44	19.96	30.01	30.77	19.32	26.86

KEY =C=Cultivar .P= Pollination. S=sowing date. **= (Highly significant) at 5%. * Significant. N.S not significant.

Table 28: Effect of sowing date and pollination on vegetative parameters of sunflower(*Helianthus annuus* L) (cultivar and hybrid) during March, May and July 2015

F Value						
Sources	Head diameter (cm)	Dry weight (g)	Setting seed %	Filling seed %	Affiance	Yield 2015
Cultivar	4.24*	0.84NS	2.78NS	0.32NS	2.72NS	1.64NS
Pollination	23.85**	3.97*	65.29**	33.58**	20.42**	5.99**
Sowing date	67.43**	8.13**	2.29NS	7.57**	0.44NS	2.72**
1interaction cxp	2.92*	0.35NS	1.24NS	0.46NS	0.20NS	0.38NS
Interaction cxs	0.79NS	0.97NS	0.96NS	1.51NS	0.15NS	1.59NS
Interaction pxs	7.97**	1.13NS	0.90NS	6.71**	0.04NS	1.72NS
Interaction cxpxs	3.89*	1.40NS	0.04NS	0.21NS	0.47NS	1.05NS
Error	33	33	33	33	33	33
Total	47	47	47	47	47	47
Ems	0.685	5036.2	3.841	0.822	1.194	1062.1
C.V	7.84	30.52	32.34	31.36	19.134	49.86

KEY =C=Cultivar .P= Pollination. S=sowing date. **= (Highly significant) at 5%. * Significant. N.S not significant

Table 29:Effect of interaction between cultivars and pollinations on head diameter of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Cultivar	Season 1			Season 2		
	Pollinations		Mean	Pollinations		Mean
	OP	CP		OP	CP	
LC	9.92A	8.92B	9.42A	10.69B	9.93C	10.31B
HyS33	8.86 B	9.31AB	9.09A	11.59A	10.02BC	10.80A
Mean	9.39A	9.11A		11.14A	9.98B	
SE+0.36						SE+ 0.34
C. V 0.73						C.V 0.69

Means in columns followed by different letters are significantly different at 5%.

Table 30: Effect of interaction between cultivars and sowing dates on head diameter of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015)

Cultivar	Season1			Season2		
	Sowing dates			Sowing dates		
	S1	S2	S3	S1	S2	S3
LC	8.29B	9.92A	10.04A	8.46C	11.48 B	11.00B
HyS33	8.38B	9.46A	9.42A	8.85C	12.38A	11.19B
Mean	8.33B	9.69A	9.73A	8.66C	11.93A	11.09B
SE+ 0.44						SE+0.41
C.V 0.89						C.V 0.84

Means in columns followed by different letters are significantly different at 5 %.

Table 31: Effect of interaction between pollinations and sowing dates on head diameter of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015

Pollination	Sowing date 1			Sowing date 2		
	S1	S2	S3	S1	S2	S3
OP	7.88^{C}	10.46^{A}	9.83^{A}	9.91^{C}	12.21^{A}	11.30^{B}
CP	8.79^{B}	8.92^{B}	9.63^{AB}	7.40^{D}	11.64^{AB}	10.89^{B}
SE+ 0.62						SE+ 0.41
C.V 0.89						C.V 0.84

Means in columns followed by differ letters are significantly different at 5 %.

Table 32: Effect of interaction between cultivars, pollinations and sowing dates on head diameter of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Cultivar	Pollination	Season1			Saeson2		
		Sowing date			Sowing date		
		S1	S2	S3	S1	S2	S3
LC	OP	8.18^{EF}	11.00^{A}	10.58^{AB}	9.90^{E}	11.60^{BC}	10.58^{CDE}
LC	CP	8.42^{DEF}	8.84^{CDEF}	9.50^{BCD}	7.03^{F}	11.35^{BCD}	11.43^{BCD}
HyS33	OP	7.59^{F}	9.92^{ABC}	9.08^{CDE}	9.93^{E}	12.83^{A}	12.03^{AB}
HyS33	CP	9.17^{CDE}	9.00^{CDE}	9.75^{ABC}	7.78^{F}	11.93^{AB}	10.35^{DE}
SE+ 0.62							SE+ 0.59
C.V 1.26							C.V 1.19

Means in columns followed by different letters are significantly different at 5 %.

4.8 Dry weight (g):

The analysis of variance showed that non significant differences of cultivar on dry weight in both seasons were observed (Table27, 28). Effect of pollination were non significant in season one, but significant in season two (Table27, 28). Effect of sowing date was highly significant differences in both seasons (Table 27, 28).

Effect of interaction were significant between cultivar X pollination, between cultivar X sowing date and between pollination X sowing date in season one and non significant effect of all interaction in season two (Table27,28).

Effect of interaction between cultivars (local cultivar LC, hybrid hysun33C2) and pollinations (open OP, cover CP) on dry weight there was significantly different in the two seasons, local cultivar LC x OP and LC x CP, HyS33 x OP and HyS33 x CP. Season two local cultivar LC x OP and LC x CP, HyS33 x OP and HyS33 x CP (Table33).

Effect of interaction cultivars (local cultivar LC, hybrid HyS33) and sowing dates (S1, S2, S3) on dry weight was significantly different in two seasons. Season one local cultivar LC xS1 366.25 LC, xS2 532.50 and LC xS3 353.75, HyS33 xS1 365.00, HyS33 xS2 435.00and HyS33 xS3 378.13. Season tow local cultivar LC xS1215.00, LC xS2 191.88 and LC xS3 318.75, HyS33 xS1 201.88, HyS33 xS2 205.00 and HyS33 xS3 262.50 (Table 34).

Effect of interaction between pollinations (open OP, cover CP) and sowing dates (S1, S2, S3)on dry weight was significantly different in both seasons. First season open pollination OP x S1 404.75, OP xS2 458.75and OP xS3 361.25, cover pollination CP xS1 327.50, CP xS2 508.75.and CP xS3 370.63 .The second season OP xS1 166.25, OP xS2 188.75 and OP xS3 281.25., CP xS1 250.63 , CP xS2 208.13 and CP xS3 300.00 (Table35).

Effect of interaction between cultivars (local cultivar LC, hybrid HyS33), pollinations (open OP, cover CP) and sowing dates (S1, S2, S3) on dry weight there was significantly different in the two seasons. (Table36).

Table 33: Effect of interaction between cultivars and pollinations on dry weight of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Cultivar	Season one			Season Two		
	Pollinations		Mean	Pollinations		Mean
	OP	CP		OP	CP	
LC	398.33^{AB}	436.67^{A}	417.50^{A}	215.42^{AB}	268.33^{A}	241.88^{A}
HyS33	417.50^{AB}	367.92^{B}	392.71^{A}	208.75^{B}	237.50^{AB}	223.13^{A}
Mean	407.92^{A}	402.29^{A}		212.08^{A}	252.92^{A}	
SE+ 33.00						SE+28.97
C.V 67.15						C.V 58.94

Means in columns followed by different letters are significantly different at 5 %.

Table 34: Effect of interaction between cultivars and sowing dates on dry weight of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Cultivars	Season1			Season2		
	Sowing dates			Sowing dates		
	S1	S2	S3	S1	S2	S3
LC	366.25^{B}	532.50^{A}	353.75^{B}	215.00^{B}	191.88 ^{B}	318.75^{A}
HyS33	365.00^{B}	435.00^{B}	378.13^{B}	201.88 ^{B}	205.00^{B}	262.50^{AB}
Mean	365.63^{B}	483.75^{B}	365.74^{A}	208.44^{B}	198.44^{B}	290.63^{A}
SE+ 40.42						SE+35.48
CV.72.19						C.V82.24

Means in columns followed by different letters are significantly different at 5 %.

Table 35: Effect of interaction between pollinations and sowing dates on dry weight of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Pollination	Sowing date			Sowing date		
	S1	S2	S3	S1	S2	S3
OP	404.75^{BC}	458.75^{AB}	361.25^{C}	166.25^{C}	188.75^{BC}	281.25^{A}
CP	327.50^{C}	508.75^{A}	370.63^{C}	250.63^{AB}	208.13^{BC}	300.00^{A}
SE+ 40.42						SE+35.482
C.V 82.24						C.V 72.19

Means in columns followed by differ letters are significantly different at 5 %.

.

Table 36: Effect of interaction between cultivars, pollinations and sowing dates on dry weight of sunflower (*Helianthus annuus L*) in seasons (2014 and 2015).

Cultivar	Pollination	Season1			Saeson2		
		Sowing dates			Sowing dates		
		S1	S2	S3	S1	S2	S3
LC	OP	407.50^{BC}	455.00^{B}	332.50^{C}	158.75^{D}	200.00^{BCD}	287.50^{AB}
LC	CP	325,00^{C}	610.00^{A}	375.00^{BC}	271.25^{ABC}	183.75^{CD}	350.00^{A}
HyS33	OP	400.00^{BC}	462.50^{B}	390.00^{BC}	173.75^{CD}	177.50^{CD}	275.00^{ABC}
HyS33	CP	330.00^{C}	407.50^{BC}	366.25^{BC}	230.00^{BCD}	232.50^{BCD}	250.00^{ABCD}
SE+57.17							SE+50.18
C.V 116.3							C.V102.1

Means in columns followed by different letters are significantly different at 5 %.

4.9 Seeds Setting (%):

Highest record of Seeds Setting % was shown by hybrid HyS33(4.09)in the first season and the lowest was recorded by 3.1 local cultivar LC 9in first season .Effect of cultivars on seeds setting% were highly significant in season one and non significant in season two(Table27,28). Pollination effected was significant in season one and highly significant in season two (Table27,28). On the other hand sowing date effect was highly significant in season one, and not significant differences in season two (Table27,28). There was no significant effect of treatment interaction on seeds setting percentage in both seasons (Table27, 28).

Effect of interaction between cultivars (local cultivar LC, hybrid HyS33) and pollinations (open OP, cover CP) on seeds setting % was significantly different in both seasons .Hysun33 gave significantly greater percentage than local cultivar in both seasons. In season one HyS33 x OP 4.40 and HyS33 x CP 3.78, local LC x OP 3.44 and LC x CP 2.94.In season two HyS33x OP 7.70 and HyS33x CP 2.50, local cultivar LC x OP 6.13.and LC x CP 2.19 (Table37)

Effect of interaction of cultivars (local cultivar LC, hybrid hysun33C2) and sowing dates (S1, S2, S3) on Seeds setting % was significantly different in both seasons. Hysun33 greater % than local cultivar in both seasons. In season one HyS33xS1 2.09, HyS33xS2 4.58.55and HyS33xS3 5.60, local cultivar LC xS11.86, LC xS2 2.93 and LC xS3 4.78 .In season tow HyS33 xS1 4.18, HyS33 xS2 6.18 and HyS33 xS3 5.00, local cultivar LC xS1 3.38, LC xS2 4.16 and LC xS3 4.93 (Table38).

Effect of interaction between pollinations (open OP, cover CP) and sowing dates (S1, S2, S3) on Seeds setting % there were significant differences in both seasons. Open pollination was better than cover pollination. In season one open pollination OP x S1 2.12, OP xS2 3.82and OP xS3 5.81, cover pollination CP xS1 1.83, CP xS2 3.69 and CP xS3 4.27 .In second season, OP xS1 5.73, OP xS2 7.96 and OP xS3 7.o2, CP xS1 1.80., CP xS2 2.32.88and CP xS3 2.91(Table 39).

Effect of interaction between cultivars (local cultivar C1, hybrid HyS33), pollinations (open P1, coverP2) and sowing dates (S1, S2, S3) on seeds setting % there were significant differences in both seasons. Hysun 33 was significantly greater than local cultivar LC of interaction between cultivars (LC, HyS33 x open and cover pollinations x sowing dates in both seasons (Table 40).

Table 37: Effect of interaction between cultivars and pollinations on seed setting %of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Cultivar	Season 1			Season 2		
	Pollinations		Mean	Pollinations		Mean
	OP	CP		OP	CP	
LC	3.44^{B}	2.94^{B}	3.19^{B}	6.13^{A}	2.19^{B}	4.58^{A}
HyS33	4.40^{A}	3.78^{AB}	4.09^{A}	7.70^{A}	2.50^{B}	5.10^{A}
Mean	3.92^{A}	3.36^{A}		6.91^{A}	2.34^{B}	
SE+0.44						SE+0.80
C.V 0.91						C.V 1.62

Means in columns followed by different letters are significantly different at 5%.

.

Table 38: Effect of interaction between cultivars and sowing dates on seed setting % of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Cultivars	Season1			Season2		
	Sowing dates			Sowing dates		
	S1	S2	S3	S1	S2	S3
LC	1.86^{B}	2.93^{B}	4.78^{A}	3.38^{B}	4.16^{AB}	4.93^{AB}
HyS33	2.09^{B}	4.58^{A}	5.60^{A}	4.18^{AB}	6.18^{A}	5.00^{AB}
Mean	1.98^{C}	3.76^{B}	5.19^{A}	3.78^{A}	5.14^{A}	4.96^{A}
SE+ 0.55						SE+0.98
C.V1.11						C.V 1.99

Means in columns followed by different letters are significantly different at 5 %.

.

Table 39: Effect of interaction between pollinations and sowing dates on seed setting % of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Pollination	Sowing date			Sowing date		
	S1	S2	S3	S1	S2	S3
OP	2.12^{C}	3.82^{B}	5.81^{A}	5.73^{B}	7.96^{A}	7.02^{AB}
CP	1.83^{C}	3.69^{B}	4.57^{B}	1.80^{C}	2.32^{C}	2.91^{C}
SE+ 0.55						SE+ 0.98
C.V 1.11						C.V 1.99

Means in columns followed by differ letters are significantly different at 5 %.

Table 40: Effect of interaction between cultivars, pollinations and sowing dates on seed setting %of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Cultivar	Pollination	Season1			Saeson2		
		Sowing dates			Sowing dates		
		S1	S2	S3	S1	S2	S3
LC	OP	2.19^{EF}	2.54^{DEF}	5.60^{AB}	5.16^{BC}	6.62^{AB}	6.60^{AB}
LC	CP	1.54^{F}	3.33^{DE}	3.97^{CD}	1.60^{D}	1.69^{D}	3.27^{CD}
HyS33	OP	2.06^{EF}	5.12^{ABC}	6.02^{A}	6.37^{B}	9.31^{A}	7.43^{AB}
HyS33	CP	2.12^{EF}	4.04^{BCD}	5.18^{ABC}	1.99^{D}	2.95^{CD}	2.56^{CD}
SE+ 0.77							SE+ 1.39
C.V 1.57							C.V 2.82

Means in columns followed by different letters are significantly different at 5 %.

4.10 Seeds filling %:

The analysis of variance revealed no significant differences of cultivar on filling seeds % in both seasons (Table27, 28). Pollination effect was significant in season one and highly significant in seasons two (Table27, 28). Sowing date effect was not significant differences in season one, but highly significant in season two (Table27, 28).

Interaction effect was significant between Cultivar X pollination and between pollination X sowing date but not significantly different between Cultivar X sowing date and between cultivar X pollination X sowing date in season one , interaction resulted in non significant differences except interaction between pollination X sowing date was highly significant difference seasons two (Table27,28).

Effect of interaction between cultivars (local cultivar LC, hybrid HyS33) and pollinations (open OP, cover CP) on seeds filling % there was significant differences in two seasons. Season one local cultivar LC, x OP 1.64 and LC x CP 2.49 HyS33, x OP 2.30 and HyS33 x CP 2.21. Season two local cultivar LC x OP 2.12and LC x CP 3.81, HyS33 x OP 2.15 and HyS33 x CP 3.49, (Table 41).

Effect of interaction of cultivars (local cultivar LC, hybrid HyS33) and sowing dates (S1, S2, S3) on seeds filling % was significantly different in the two seasons. Season one local cultivar LC xS1 2.28, LC xS2 1.85and LC xS3 2.07,. HyS33 xS1 2.36, HyS33 xS2 2.18and HyS33xS3 2.29,.season tow local cultivar LC xS1 2.24, LC xS2 2.71 and LC xS3 3.95 HyS33xS1 2.40, HyS33xS2 2.89 and HyS33xS3 3.16, (Table42).

Effect of interaction between pollinations (open OP,, cover CP)and sowing dates (S1, S2, S3)on seeds filling % was significantly different in the two seasons. Open pollination was significant than cover pollination in the two seasons. First season OP x S1 2.41, OP xS2 1.43and OP xS3 2.06, CP xS1 2.23, CP xS2 2.53and CP xS3 3.30.In the second season OP xS1 2.02, OPxS2 2.25 and OP xS3 2.14, CP xS1 2.62, CP xS2 3.36and CP xS3 4.98 (Table 43).

Effect of interaction between cultivars (local cultivar LC, hybrid HyS33), pollinations (open OP, cover CP) and sowing dates (S1, S2, S3) on seeds filling % there was significantly different in the two seasons. (Table44).

Table 41: Effect of interaction between cultivars and pollinations on seed filling % of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Cultivar	Season 1			Season 2		
	Pollinations		Mean	Pollinations		Mean
	OP	CP		OP	CP	
LC	1.64^{B}	2.49^{A}	2.07^{A}	2.12^{B}	3.81^{A}	2.97^{A}
HyS33	2.30^{A}	2.21^{A}	2.25^{A}	2.15^{B}	3.49^{A}	2.82^{A}
Mean	1.97^{A}	2.35^{A}		2.13^{B}	3.65^{A}	
SE+0.27						SE+ 0.37
C.V0.55						C.V 0.75

Means in columns followed by different letters are significantly different at 5 %.

Table 42: Effect of interaction between cultivars and sowing dates on seed filling % of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Cultivars	Season1			Season2		
	Sowing dates			Sowing dates		
	S1	S2	S3	S1	S2	S3
LC	2.28^{A}	1.85^{A}	2.07^{A}	2.24^{C}	2.71^{BC}	3.95^{A}
HyS33	2.36^{A}	2.18^{A}	2.29^{A}	2.40^{BC}	2.89^{BC}	3.16^{AB}
Mean	2.32^{A}	1.98^{A}	2.18^{A}	2.32^{B}	2.80^{B}	3.56^{A}
SE+ 0.33						SE+ 0.45
C.V 0.68						C.V 0.92

Means in columns followed by different letters are significantly different at 5 %.

Table 43: Effect of interaction between pollinations and sowing dates on seed filling % of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Pollination	Sowing date			Sowing date		
	S1	S2	S3	S1	S2	S3
OP	2.41^{A}	1.43^{B}	2.06^{AB}	2.02^{C}	2.25^{C}	2.14^{C}
CP	2.23^{A}	2.53^{A}	2.30^{A}	2.62^{BC}	3.36^{B}	4.98^{A}
SE+ 0.33						SE+ 0.45
C.V 0.68						C.V 0.92

Means in columns followed by differ letters are significantly different at 5 %.

Table 44: Effect of interaction between cultivars, pollinations and sowing dates on seed filling %of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Cultivar	Pollination	Season1			Saeson2		
		Sowing dates			Sowing dates		
		S1	S2	S3	S1	S2	S3
LC	OP	2.31^{AB}	1.00^{C}	1.61^{BC}	1.77^{E}	2.03^{DE}	2.56^{CDE}
LC	CP	2.26^{AB}	2.69^{A}	2.53^{AB}	2.71^{CDE}	3.89^{BC}	5.34^{A}
HyS33	OP	2.51^{AB}	1.88 ABC	2.51^{AB}	2.27^{CDE}	2.47^{CDE}	1.71^{E}
HyS33	CP	2.20^{AB}	2.36^{AB}	2.07^{AB}	2.53^{CDE}	3.32^{BCD}	4.61^{AB}
SE+ 0.47							SE+ 0.64
C.V 0.96							C.V1.30

Means in columns followed by different letters are significantly different at 5 %.

4.11 The efficiency:

The statistical analysis revealed non significant differences in both seasons of cultivar, but pollination effect was significant in season one and highly significant in seasons two (Table27, 28). Sowing date effect was highly significantly different in season one, not significant in season two (Table27, 28).

There were no significant effects of treatment interaction on efficiency in both seasons(Table27,28).

Effect of interaction between cultivars (local cultivar LC, hybrid HyS33) and pollinations (open OP, cover CP) on the efficiency was significant in the two seasons. In season one local cultivar LC x OP 6.28 and LC x CP 5.17, HyS33x OP 6.29 and HyS33x CP 6.02 .In season tow local cultivar LC x OP 7.21and LC x CP 3.70, HyS33x OP 7.68 and HyS33 x CP 4.27 (Table45)

Effect of interaction of cultivars (local cultivar LC, hybrid HyS33) and sowing dates (S1, S2, S3) on the efficiency was not significant in the two seasons. Except between LC xS1 4.01, C2xS1 4.60 in season one, local cultivar LC xS14.01, LC xS2 6.24an LC dxS3 6.91, HyS33 xS14.60, HyS33xS2 6.76and HyS33xS3 7.10.In season two, local cultivar LC xS1

5.54, LC xS2 5.51and LC xS3 5.31, HyS33 xS1 5.90 HyS33xS2 6.28 and HyS33xS3 5.75, (Table46).

Effect of interaction between pollination (open OP, cover CP) and sowing dates (S1, S2, S3)on the efficiency was significantly different in the two seasons. Open pollination was significantly greater than cover pollination, first season open pollination OP x S1 4.29, OP xS2 7.15and OP xS37.41, cover pollination CP xS1 4.32, CP xS25.85and CP xS3 6.60 .In the second season, open pollination OP xS1 7.15, OP xS27.68 and OP xS37.51, cover pollination CP xS1 4.29, CP xS2 4.11 and CP xS3 3.55 (Table47).

Effect of interaction between cultivars (local cultivar LC, hybrid HyS33), pollinations (open OP, cover CP) and sowing dates (S1, S2, S3) on the efficiency was significantly different in both seasons (Table48).

Table 45: Effect of interaction between cultivars and pollinations on affiance of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Cultivar	Season 1			Season 2		
	Pollinations		Mean	Pollinations		Mean
	OP	CP		OP	CP	
LC	6.28^{A}	5.17^{B}	5.72^{A}	7.21^{A}	3.70^{B}	5.45^{A}
HyS33	6.29^{A}	6.02^{AB}	6.45^{A}	7.68^{A}	4.27^{B}	5.98^{A}
Mean	6.28^{A}	5.59^{B}		7.45^{A}	3.98^{B}	
SE+4.80						SE+ 4.46
C. V 9.77						C.V 9.08

Means in columns followed by different letters are significantly different at 5 %.

Table 46: Effect of interaction between cultivars and sowing dates on affiance of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015)

Cultivars	Season1			Season2		
	Sowing dates			Sowing dates		
	S1	S2	S3	S1	S2	S3
LC	$.4.01^{B}$	6.24^{A}	6.91^{A}	5.54^{A}	5.51^{A}	5.31^{A}
HyS33	4.60^{B}	6.76^{A}	7.10^{A}	5.90^{A}	6.28^{A}	5.75^{A}
Mean	4.31^{B}	6.50^{A}	7.01^{A}	5.72^{A}	5.89^{A}	5.53^{A}
SE+5.88						SE+5.47
C.V 1.10						C.V1.11

Means in columns followed by different letters are significantly different at 5 %.

Table 47: Effect of interaction between pollinations and sowing dates on affiance of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Pollination	Sowing date			Sowing date		
	S1	S2	S3	S1	S2	S3
OP	4.29^{C}	7.15^{A}	7.41^{A}	7.15^{A}	7.68^{A}	7.51^{A}
CP	4.32^{C}	5.85^{B}	6.60^{AB}	4.29^{B}	4.11^{B}	3.55^{B}
SE+ 5.88						SE+5.47
C.V1.18						C.V 1.14

Means in columns followed by differ letters are significantly different at 5 %.

.

Table 48: Effect of interaction between cultivars, pollinations and sowing dates on affiance of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Cultivar	Pollination	Season1			Saeson2		
		Sowing dates			Sowing dates		
		S1	S2	S3	S1	S2	S3
LC	OP	4.10^{E}	7.00^{AB}	7.73^{A}	7.00^{A}	7.50^{A}	7.12^{A}
LC	CP	3.92^{E}	5.47^{BCDE}	6.10^{ABCD}	4.08^{B}	3.53^{B}	3.50^{B}
HyS33	OP	4.47^{DE}	7.30^{A}	7.10^{AB}	7.30^{A}	7.85^{A}	7.90^{A}
HyS33	CP	4.73^{CDE}	6.22^{ABC}	7.10^{A}	4.50^{B}	4.70^{B}	3.60^{B}
SE+ 8.32							SE+7.73
C.V 1.69							C.V1.57

Means in columns followed by different letters are significantly different at 5 %.

4.12 Yield:

Highest record of yield was shown by hybrid HyS33 47.28in the first season and the lowest was recorded by local cultivar LC 40.28in first season .The analysis of variance revealed significant differences of cultivar in season one and non significant in season two (Table27,28). Pollination shows no significant difference in season one and highly significant difference two seasons (Table27, 28). Sowing date was highly significant in both seasons (Table27, 28).

Interaction of cultivar X sowing date and between cultivar X pollination X sowing date in season one is significant. Other interactions resulted in non significant differences in season one. All interactions were non significant in season two (Table27, 28).

Effect of interaction between cultivars (local cultivar LC, hybrid HyS33) and pollinations (open OP, cover CP) on yield was significantly different in both seasons. , HYsun33 was greater in both seasons than local cultivar, LC x OP 41.78 and LC x CP 38.68, HyS33 x OP 46.68 and HyS33x CP 47.89,.season tow local cultivar LC x OP 91.94and LC x CP 26.72, HyS33x OP 109.80 and HyS33x CP 32.97 (Table 49).

Effect of interaction cultivars (local cultivar LC, hybrid HyS33) and sowing dates (S1, S2, S3) on yield was significantly different in two seasons. Hysun33 greater than local cultivar at sowing dates S2and S3 in the two seasons. In season one HyS33 xS123.77, HyS33 xS2 50.19and HyS33xS367.89, local LC xS1 29.28, LC xS2 31.26and LC xS3 60.30 .In Season two HyS33xS1 54.08, HyS33xS2 98.43 and HyS33xS3 61.65, local cultivar LC xS1 57.33, LC xS2 63.00 and LC xS3 57.66 (Table50).

Effect of interaction between pollinations (open OP, cover CP)and sowing dates (S1, S2, S3)on yield was significantly different in the two seasons. Open pollination was significant higher than cover pollination in second season, open pollination OP xS188.02, OP xS2128.13 and OP xS386.46, cover pollination CP xS123.39, CP xS2 33.30 and CP xS332.85 In the first season no significant differences between them, OP x S1 29.90, OP xS2 39.96and OP xS3 64.83, CP xS1 25.15 CP,xS2 41.49and CP xS3 63.36. (Table51).

Effect of interaction between cultivars (local cultivar LC, hybrid HyS33), pollinations (open OP, cover CP) and sowing dates (March S1, MayS2, JulyS3) on yield there were significant differences in the two seasons, first season LCxP1x(S2,S3 were more significant than HyS33 x OP x(S2,S3) in two seasons. Season second season HyS33 x CP x (S2, S3) were significant than LC x CP x (S2, S3) in season one (Table52).

Table 49: Effect of interaction between cultivars and pollinations on yield of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015)

Cultivar	Season 1			Season 2		
	Pollinations		Mean	Pollinations		Mean
	OP	CP		OP	CP	
LC	41.78^A	38.68^A	40.28^B	91.94^A	26.72^B	59.33^A
HyS33	46.68^A	47.89^A	47.28^A	109.80^A	32.97^B	71.39^A
Mean	44.23^A	43.33^A		100.87^A	29.85^B	
SE+4.80						SE+13.31
C.V 9.77						C.V 27.07

Means in columns followed by different letters are significantly different at 5 %.

Table 50: Effect of interaction between cultivars and sowing dates on yield of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015)Table4

	Season1			Season2		
Cultivars	Sowing dates			Sowing dates		
	S1	S2	S3	S1	S2	S3
LC	29.28^C	31.26^C	60.30^AB	57.33^B	63.00^B	57.66^B
HyS33	23.77^C	50.19^B	67.89^A	54.08^B	98.43^A	61.65^B
Mean	26.53^C	40.72^B	64.09^A	55.71^B	80.72^A	59.66^AB
SE+ 5.88						SE+ 16.295
C.V11.96						C.V 33.15

Means in columns followed by different letters are significantly different at 5 %

Table 51: Effect of interaction between pollinations and sowing dates on yield of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015)

	Season1			Season2		
Pollination	Sowing dates			Sowing dates		
	S1	S2	S3	S1	S2	S3
OP	29.90^C	39.96^B	64.83^A	88.02^B	128.13^A	86.46^B
CP	25.15^C	41.49^B	63.36^A	23.39^C	33.30^C	32.85^C
SE+ 5.88						SE+16.29
C.V 11.96						C.V 33.15

Means in columns followed by differ letters are significantly different at 5 %.

Table 52: Effect of interaction between cultivars, pollinations and sowing dates on yield of sunflower (*Helianthus annuus* L) in seasons (2014 and 2015).

Season1					Saeson2		
Cultivar	Pollination	Sowing dates			Sowing dates		
LC	OP	S1	S2	S3	S1	S2	S3
		35.64^{CD}	26.2^{8D}	63,42^{AB}	96.36^{B}	102.12^{B}	77.34^{BC}
LC	CP	22.92^{D}	36.24^{CD}	57.18^{AB}	18.30^{D}	23.88^{D}	37.98^{CD}
HyS33	OP	20.16^{D}	53.64^{AB}	66.24^{A}	79.68^{BC}	154.14^{A}	95.58^{B}
HyS33	CP	27.38^{D}	46.74^{BC}	69.54^{A}	28.48^{D}	42.72^{CD}	27.72^{D}
SE+ 23.04							SE+ 8.32
C.V16.92							C.V 46.88

Means in columns followed by different letters are significantly different at 5 %.

Table 53: Effect of interaction between cultivar and pollination on efficiency of sunflower along with their significance ranking in seasons of 2014 and2015

Treatment	Efficiency	
	Season1	Sason2
LC OP	6.26^{A}	7.21^{A}
LC CP	5.17^{B}	3.70^{B}
HyS33 OP	6.29^{A}	7.68^{A}
HyS33 CP	6.02^{AB}	4.27^{B}
SE+	4.804	4.462
LSD	9.774	9.079
C.V	2.035	2.035

Mean within column followed by the same letter(S) were note significant different according to test at 5% level.
LC = local cultivar. HyS33= Hysun33. OP =Open pollination. CP =cover pollination.

Table 54: Effect of interaction between cultivar and sowing date on efficiency of sunflower along with their significance ranking in seasons of 2014-2015

Treatment	Efficiency	
	Season1	Sason2
LC S1	4.01[B]	5.54[A]
LC S2	6.24[A]	5.51[A]
LC S3	6.91[A]	5.31[A]
HyS33 S1	4.60[B]	5.90[A]
HyS33 S2	6.76[A]	6.28[A]
HyS33 S3	7.10[A]	5.75[A]
SE+	5.884	5.465
LSD	1.197	1.111
C.V	2.035	2.035

Mean within column followed by the same letter(S) were not significant according to test at 5% level

LC = local cultivar. HyS33=hybrid. S1= .Sowing date at March. S2= Sowing date at May. S3= Sowing date at July.

Table 55: Effect of interaction between pollination and sowing date on efficiency of sunflower along with their significance ranking in seasons of 2014-2015

Treatment	Efficiency	
	Season1	Sason2
OP S1	4.29[C]	7.15[A]
OP S2	7.15[A]	7.68[A]
OP S3	7.41[A]	7.51[A]
CP S1	4.32[C]	4.29[B]
CP S2	5.85[B]	4.11[B]
CP S3	6.60A[B]	4,55[B]
SE+	0.40	5.465
LSD	0.9077	1.111
C.V	2.035	2.035

Mean within column followed by the same letter(S) were not significant according to test at 5% level

OP = Open pollination. CP =Cover pollination. S1= .Sowing date at March. S2= Sowing date at May. S3= Sowing date at July.

Table 56: Effect of interaction between cultivar pollination and sowing date on efficiency of sunflower along with their significance ranking in seasons of 2014-2015

Treatment	Setting seeds%		Filling seeds%	
	First season	Sec season	First season	Sec season
LC OP S1	2.185^{EF}	5.163^{BC}	2.313^{AB}	1.765^{E}
LC OP S2	2.537^{DEF}	6.620^{AB}	1.000^{C}	2.028^{DE}
LC OP S3	5.603^{AB}	6.600^{AB}	1.610^{BC}	2.560^{CDE}
LC CP S2	1.54^{F}	1.600^{D}	2.255^{AB}	2.708^{CDE}
LC CP S2	3.328^{DE}	1.695^{D}	2.690^{A}	3.388^{BC}
LC CP S3	3.965^{CD}	3.265^{CD}	2.525^{AB}	5.343^{A}
HyS33 OP S1	2.063^{EF}	6.365^{B}	2.508^{AB}	2.270^{CDE}
HyS33 OP S2	5.120^{ABC}	9.308^{A}	1.875^{ABC}	2.465^{CDE}
HyS33 OP S3	6.020^{A}	7.433^{AB}	2.513^{AB}	1.710^{E}
HyS33 CP S1	2.118^{EF}	1.990^{D}	2.203^{AB}	2.530^{CDE}
HyS33 CP S2	4.043^{BCD}	2.948^{CD}	2.360^{AB}	3.323^{BCD}
HyS33 CP S3	5.180^{ABC}	2.560^{CD}	2.068^{AB}	4.610^{AB}
SE+	0.77	0.4700	1.3859	0.6412
LSD	1.5722	0.9562	2.8196	1.3046
C.V	2.035	2.035	2.035	2,035

Mean within column followed by the same letter(S) were note significant different according to test at 5% level.

Effect of interaction between cultivars (local cultivar LC, hybrid Hysun33) and pollinations (open OP, cover CP) on efficiency was significantly different in the two seasons. no significant between Local cultivar and Hybrid Hysun33 at open pollination in the two seasons LC x OP 6.26 LC x OP 7.21,HyS33 xOP 6.29 7,68 respectively. (Table52).

Effect of interaction cultivars (local cultivar LC, hybrid HySun33) and sowing dates (March S1, MayS2, JulyS3) on The efficiency Local cultivar was significantly different in season one than HySun33in season two (Table53).

Effect of interaction between pollinations (open P1, coverP2)and sowing dates (March S1, MayS2, JulyS3)on the efficiency in season two was significant higher than season one. Cover pollination in the first season was significant higher than the second season(Table54).

Interaction between cultivar open pollination and sowing dates in season two was significantly higher than season one (two, one) LCOPS1 5.16, 2.19, LCOPS2 6.62, 2.54and C1P0S3 6.60, 5.60 respectively. No significant between cover pollination in two seasons(season one, two) LCCPS1 1,54, 1.60 , and LCCPS3 3.97,3.27,except between LCCS2 3.33, 1.70 .Also HyS33 season two was significant(two, one) C2P0S1 6.37, 2.06 HyS33OP9.31, 5.12, and HyS33OP S3 7.43, 6.02,cover pollination was significant in season one than season two(one, two) HyS33CP S12.12, 1.99 , S2 HyS33CP 4.04, 2.95and HyS33CPS3 5.18, 2.56 respectively. Open pollination of HyS33 was significant than open pollination of cultivar in the two seasons (Table55).

Interaction between cultivar open pollination and sowing dates open pollination of local cultivar on filling seed was significant (Table55).

CHAPTER FIVE

DISCUSSION

Effect of sowing date on plant height and weight of 100 seed setting was not significant to varying climatic conditions. Similar results were reported by Larki,(2008)). Sowing dates have also been found to greatly influence vegetative and reproductive growth stages of crops .When emergence rate for each sowing date was calculated using a common base temperature they were found to be well correlated with rate of change of day length. Time of sowing determines time of flowering and it has great influence on dry matter accumulation, seed set and seed yield. Similar result were obtained by Agele,(2007) and Alkio *et al* (2002).

The highly significant differences in sowing dates in season one and the non significant difference in pollination may be due to the relation between leaf area and pollination and the effect of the environmental condition prevailing in the area.

Number of seeds filling had highly significant differences of sowing date in both seasons and pollination was highly in season two. Cultivars had highly significant differences in season one and non significant differences in season two which may be due to difference in irrigation between the two seasons. It was a major cause for empty achiness in sunflower plants grown under non-stress conditions which agreed with (Luis *et al*. (2003), Dadnia,(2006) and Yawson,*et al* (2011).

The dry matter showed non significant differences in both seasons which may be due to genotype. Highly positive significant relationship between seed yield and post anthesis dry matter was related. This indicates that the maintenance of high leaf area duration during post an thesis period either by decreased leaf senescence or by reduced leaf disease incidence. When emergence rate for each sowing date was calculated using a common base temperature they were found to be well correlated with rate of change of day length. Similar results were shown by Nanja Reddy *et al*. (2003) and Agele,(2007))

Head diameter had non significant difference in season one which may be referred to differences in the amount of water applied in the two seasons. Continuous nipping of auxillary flower buds significantly increased the capitulum diameter and thus seed yield .Similar results were obtained by Vyakaranahal *et al*. (2002) and Amorim *et al*. (2007), Coimbra *et al*. (2009 and Vogt *et al*. (2010). A significant relationship between sowing dates and seeds per head was observed which was similar to (Ahmad et *al*.2005).

Weight of hundred seeds setting was highly sowing date in season two and pollination in season one. Cultivars had significant differences in season one and non significant difference of sowing date in season one which might be due to the fact that higher temperature reduced vegetative growth and enhanced flowering. Trend was observed in 50% flowering as well as crop maturity. This was obvious as high temperatures increase rate of plant development and reduced length of the reproductive period. Similar results were obtained by Ekin,(2005) ,Angadi *et al*., 2000) and Nihal 2010). Non significant differences of pollination in season two might be affected by weather (Machado, 2006).

Weight of hundred seeds filling with sowing date had highly significant differences in season one and significant differences in season two. Cultivars had highly significant differences in season one, no significant difference in season two. Pollination had non significant differences in season one which might be due to environmental effect, for example temperature. Sowing of male parent seven days earlier resulted in the increase of percent seed set and filling as a result of better synchronization in parental lines. The highly significant differences in season two were similar to the results obtained by Umesh *et al*., (2007), Backes *et al* (2008), Balbinotjr, *et al* (2009) and Embara (2011).

Leaf area and plant height were not affected by pollination in season two which may be due to temperature. Cultivars had no significant effect in season two on leaf area, number of seeds setting, number of seeds filling, weight of hundred seed setting, weight of hundred seed filling, seeds setting percentage, seeds filling percentage, dry matter, and efficiency. This might be due to water deficit because the crop experienced water deficit in reproductive stags in season two. The flowering period is the most sensitive to water deficits which cause considerable yield decrease since only fewer flowers come to full development .Seed formation is the next most sensitive period to water deficit, causing severe reduction in both yield and oil content. Minimization of water loss in response to water deficit is a major aspect of drought tolerance and can be achieved through the lowering of either leaf area expansion rate or transpiration per unit leaf area (stomatal conductance). Similar results were shown by Beyazgul *et al*., (2000), Allam,(2003)) and Casadebaig *et al*., (2008).

The sporophytic type of self incompatibility mechanism is one of the genetic reasons for poor seed setting in sunflower. One of the means to alleviate this problem is to identify the self-fertile lines and thus increase seed set and productivity. The physiological mechanisms that regulate seed setting and filling in sunflower are complex. Studies carried out on source-sink relationship and photoassimilate distribution pattern revealed that the photoassimilate supply in the capitulum largely depends on the phyllotaxy of source leaves and the position of sinks in developing inflorescences. A higher proportion of empty achenes (up to 60%), especially in the centre of capitulum resulted from source limitation. During seed filling, maximum import of photoassimilate appeared in intermediate whorls, while central whorls always exhibited the lowest import, leading to poor seed filling, which is similar to Patel and Thakur, (2003) findings.

Sowing date had no significant differences on plant height and number of seed setting which may be due to the differences in the Photoassimilate transport along the stem from source leaves to the capitulum in sunflower during anthesis and seed filling and a single floret is typically connected with the leaves of three neighboring in sunflower capitulum (During early and late stages of anthesis). Strong sinks were staminate florets and young achiness, respectively Alkio *et al*. 2002). During seed filling, an import maximum and minimum photosgnthate appeared in the intermediate and central whorls, respectively. Sowing date in season two had non significant affects on seed setting which may be due to the fact that assimilates were not supplied with enough quantities to fully nourish large number of seeds as stated by Yadav *et al*. (2006) and Laki, (2008).

The efficiency:

The result of this study indicated a highly significant effect of pollination in season two and significant effect in season one. It should be noted, that different cultivars have different levels of self-fertility, and many modern sunflowers are fully self-fertile. Cross-pollination may still be preferred. However, as it appears to give higher yield fertility of self-pollen may be greatly reduced at high temperatures, which increases the importance of prompt pollination of self-pollinated varieties during hot weather as indicated by Sumangala and Giriraj (2003) and Machado, (2006).

The result of this study indicated highly significant difference (sowing date) effect on efficiency in season one and non significant difference in season two which may be affected by environmental factors . Cultivars had non significant difference in both seasons, which may be due to environment and genetic effect.

There is no significant differences in cultivars in the second season in yield due to less amount of water applied in this season. The non significant difference in pollination may be due to abundance of pollen and bee activities cong led with high temperature and bright sunshine at the reproductive stage. The environmental factors affected sowing dates and the longer day length played an important role in the final seed yield. This was supported by Sumangala and Giriraj 2003.

CONCLUSIONS AND RECOMMENDATION

1. The sowing date was highly significant for most of the parameters in both seasons (leaf area, number of seeds filling per head, head diameter, dry weight and yield).
2. Number of seeds setting per head, seeds setting percentage and the efficiency were highly significant in first season. Seed filling percentage and weight of hundred seeds setting were highly significant in second season.
3. Pollinations was significant in the first season on plant height, number of seeds setting per head, number of seeds filling per head, Seeds filling percentage, Seeds setting percentage and the efficiency and highly significant on weight of hundred seeds setting
4. Pollination had highly significant effects in second season on most characters (number of seeds setting per head, number of seeds filling per head, weight of hundred seeds filling, head diameter, dry weight, setting percentage, seeds filling percentage and the efficiency).
5. Cultivars had significant effects on weight of hundred seeds setting and highly significant effects in second season on plant height, number of seeds setting per head, , number of seeds filling per head, weight of hundred seeds filling, seeds setting percentage. In season two cultivars effects were only on plant height.

   6. More studies are needed to study setting seed in sunflowers.

The study concludes with the following:

a) Sowing in June is better than Marsh and May.
b) The open pollination is better than close pollination.
c) The cultivar hysun 33 performed better in most characters studied and productivity.
d) Improving seed setting efficiency can increase seed setting.

e) New varieties that avoid or resist the birds are needed as it s the major factor effected Sunflower production.

CHAPTER SIX

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APPENDICES

Meteorological data for the seasons 2014-2015

SHAMBAT MONTHLY (2014-2015)

	MAX	MAX
month	2014	2015
1	31.5	30.4
2	32.5	35.6
3	37.6	38.4
4	40.8	38.3
5	41.8	42.8
6	42.3	42.6
7	38.0	41.9
8	34.8	38.7
9	37.6	40.6
10	37.8	40.0
11	34.8	35.2
12	34.1	28.7

	MIN	MIN
month	2014	2015
1	14.9	12.7
2	16.2	18.0
3	19.7	20.6
4	22.2	22.7
5	25.3	25.9
6	27.7	26.9
7	26.6	27.0
8	25.5	25.8
9	25.5	26.4
10	23.5	26.4
11	19.3	20.5
12	16.8	14.1

	R-F	R-F
month	2014	2015
1	0.0	0.0
2	0.0	0.0
3	0.3	0.0
4	0.0	0.0
5	0.0	6.1
6	0.0	0.0
7	136.5	0.0
8	65.0	40.1
9	38.0	18.2
10	3.0	9.2
11	0.0	0.0
12	0.0	0.0

	R-H	R-H
month	2014	2015
1	35	32
2	27	26
3	23	22
4	21	15
5	22	20
6	25	25
7	47	30
8	59	45
9	51	40
10	38	34
11	30	27
12	35	31

Source: Meteorological station at the Airport