Date palm (Phoenix dactyliferous L.) Genetic Diversity and Conservation under Climate

Jain, Shri Mohan

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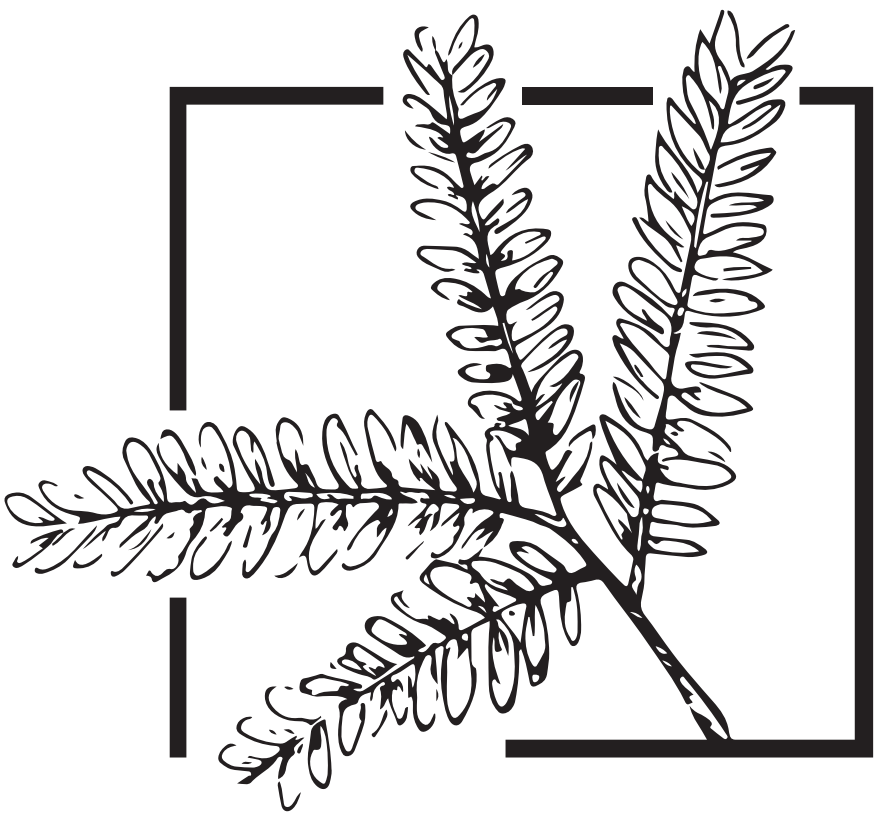
Conference of Agricultural Ministers
of the Word's Date Producing
and Processing Countries
9th March 2019



YEAR OF TOLERANCE

Ceremony honoring the winners
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10th March 2019

Global Food Security Index
Regional Round Table
11th March 2019

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YEAR OF TOLERANCE

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KHALIFA INTERNATIONAL AWARD FOR DATE PALM AND AGRICULTURAL INNOVATION

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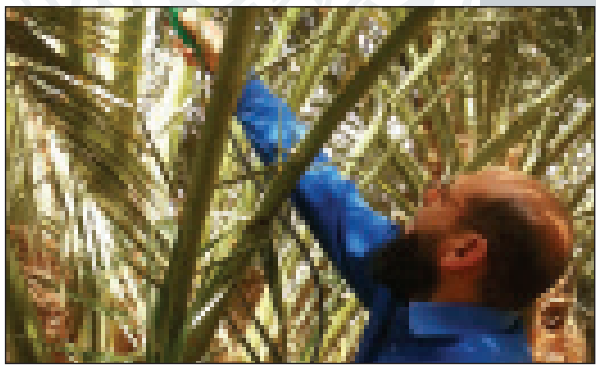

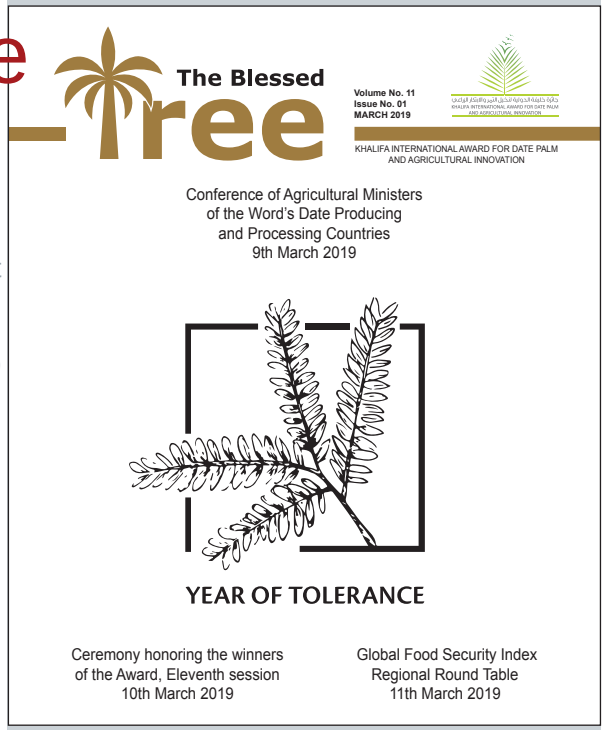

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Date Palm (*Phoenix dactyliferous* L.) Genetic Diversity and Conservation under Climate Change

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Date fruits are highly nutritive, versatile tree byproducts, and diverse medicinal properties.

Photographed By: Kasim Al-Faresi

Abstract

Date palm (*Phoenix dactylifer-ous* L.) is an economically im-portant tree species, grown in the arid and semiarid regions of the Middle East and North Afri-ca. Recently, its cultivation has expanded to Australia, South-ern Africa, South America, Mex-ico and the southwestern USA. Date fruits are highly nutritive, versatile tree byproducts, and diverse medicinal properties. There is an increase in demand of dates worldwide and requires to enhance date production by producing new improved culti-vars, conservation, prevention, and utilization of spontaneous and induced date palm genetic diversity. Induced genetic diver-sity is caused by radiation and chemical mutagens. Climate change is a greater challenge on date production, e.g. water availability, soil quality, insect and pests. Date palm genetic diversity is conserved by cryo-preservation (somatic embry-os, embryogenic cell cultures), cold storage (seed and in vitro shoots) and in vivo (field gene banks), establish germplasm website for exchange and utili-zation. Plant regeneration from somatic embryos and embryo-genic cell suspension is neces-sary for applying cryopreserva-tion by using liquid nitrogen. In cold storage, shoot cultures are

preserved at 4-50C, however subcultures are needed even though their number is reduced. In cryopreservation subculture is not needed and cultures are stored for longer period. Seed banks are commonly used in most of the seed crops. Field gene bank is alternate to in vitro conservation, and is being widely used, however has risk of insect and pest attack. This approach could be best applied under controlled conditions in plastic house. We will discuss the importance of different approaches of date palm gene pool conservation, climate change, and setting up of germplasm pool bank.

Keywords: Genetic diversity, cryopreservation, cold storage, field gene banks, seed bank, climate change

Introduction

In the past, global climate has continuously been changing, seems to continue to change in the coming future. Recently erratic and rapid climate change is being recorded worldwide that has affected food and agriculture especially developing countries have more devastated impact due to poor infrastructure, trained manpower, and economic conditions. Rapidly changing climate and ever-growing human population have caused loss of genetic resources, arable land and water shortage. Any small change in global temperature may develop new pests and disease that may devastate food and agriculture. The availability of sufficient water is another matter of concern to sustainable agriculture.

Genetic diversity is the key for the survival and evolution of species. Genetic variation within a species is important for its ability to adapt to a changing environment (Ahuja, 2017). Species having larger levels of genetic diversity have a better chance of adaptation, survival, and deployment over a wide range of environmental conditions. Appropriate levels of genetic variation should be maintained in the populations of a species for conservation planning. The conservation of genetic resources should be based on the genetic architecture and phenology, and how genetic and phenotypic variation is organized and distributed within and among populations of a species.

Materials And Methods

Date Palm-A Tree of Life

The date palm (*Phoenix dactylifera* L.), a tree of life (Fig.1) - considered one of the most ancient plant cultivated in Mesopotamia some 4,000 years ago.

Fig. 1: Date palm-tree of life, https://commons.wikimedia.org/w/index.php?curid=133553

It belongs to the monocot family Arecaceae; an arborescent, dioecious tall evergreen and highly heterozygous plant providing nutrition, as a staple food, food security, health benefits, shelter, raw material to the food industry, and fuel to the people. Even though date fruits are rich in nutrition, minerals, sugar and phytochemicals and its global market share is extremely low.

There are at least 15 minerals in dates, varies from 0.1 to 916 mg/100g, include boron, potassium, phosphorous, sodium and zinc. The seeds contain aluminum, cadmium, chloride, lead and Sulphur in various proportions. The total date palm production is 350,000 tons/year with an average yield 30-40 kg/tree. It is well distrib-

uted throughout the Middle East, North Africa, South Sahel, East and South Africa, and in certain parts of Europe and USA. This tree is an important economically fruit crop of the date palm growing countries. Date palm trees are high resilience and tolerance to environmental stresses- high temperature and radiation, low soil and atmospheric moisture, extended periods of drought, high salinity levels, and large diurnal and seasonal fluctuations. Date palm plantation creates an equable microclimate within oasis ecosystems and enables agriculture development as well as helpful in the conservation of the fragile environment structure and reduce desertification risks. It is an excellent source of edible sweet fruit in the arid and semi-arid regions worldwide. Date fruit ripening requires hot and dry climate with very low humidity and requires 200-250 mm rainfall. As the climatic conditions are continuously changing, rainfall during flowering and ripening stages may lead to considerable loss of fruit production and quality; lead to considerably economic loses impacting growers and provision of nutrition. Date palm is well known for highly nutritious fruits, versatile tree byproducts, and diverse medicinal properties.

Problems Facing Date Palm Cultivation

The date palm production is faced difficulties in sustainable production and proper utilization of available genetic diversity globally due to biotic and abiotic stresses (Zaid et al. 2002), industrialization, human development, and climatic variation. The loss of date palm plantations due human activities would need to be replaced with new plantations for sustainable production. Rainfall fluctuation has resulted in a gradual decline in ground water table and threatening survivability of communities in several date palm growing countries (Abul-Soad et al. 2017). The availability of water and impact on soil quality would deteriorate by 2100 (Shabani et al 2012). Pests and diseases invade date palm cultivation including Bayoud disease, caused by a fungus *Fusarium oxsysporumf*. sp. albedinis, has destroyed millions of date trees in North African countries Morocco and Algeria (Sedra 2011), however Tunisia has so far been safe from this disease. In addition, fungus *Fusarium solani* attacks date plan in Pakistan (Abul-Soad et al. 2017), and Al-Wijam disease caused by phytoplasma in Saudi Arabia (Alhdaib et al. 2007). The common symptom of these diseases is yellowing of feathered fronds followed by drying out to end by palm death. The major pest red palm weevil (*Rhynchophorus ferrugineus*) is rapidly becoming a big threat to date palm cultivation in India, Arabian Gulf countries, and Egypt in the North of Africa. This pest started spreading in early nineteenth century through shipment of adult seedling palm for landscaping purposes in the last decade. Also, drought, high salinity, over aged trees and genetic erosion are the major threats to combat with loss of date palm biodiversity globally.

There is an increase in demand of dates worldwide and requires to enhance date production by producing new improved cultivars, conservation, prevention, and utilization of spontaneous and induced date palm genetic diversity.

Fig.2 Melting glacier due to climate change.

Global Warming and Climate Change

Global warming can be defined as "the steady rise in the average temperature of the Earth's atmosphere and oceans due to trapping of heat in the atmosphere by greenhouse gases. Climate change is a multidimensional and simultaneous variation in duration, frequency and intensity of parameters like temperature and precipitation, altering the seasons, melting of glacier (Fig.2) and life on the Earth. In this scenario, plant species with increased adaptive plasticity will be better equipped to tolerate changes in the frequency of extreme weather events.

The continuing increase in greenhouse gas emissions raises the temperature of the earth's atmosphere. This results to melting of glaciers, unpredictable rainfall patterns, and extreme weather events. The accelerating pace of climate change, combined with global population and depletion of agricultural resources threatens food security globally. The overall impact of climate change as it affects agriculture was described by the Intergovernmental Panel on Climate Change (IPCC, 2007), and cited by the US EPA (2011) to be as follows:

- Increases in average temperature will result to: i) increased crop productivity in high latitude temperate regions due to the lengthening of the growing season; ii) reduced crop productivity in low latitude subtropical and tropical regions where summer heat is already limiting productivity; and iii) reduced productivity due to an increase in soil evaporation rates.
- Change in amount of rainfall and patterns will affect soil erosion rates and soil moisture, which are important for crop yields. Precipitation will increase in high latitudes, and decrease in most subtropical low latitude regions – some by as much as about 20%, leading to long drought spells.
- Rising atmospheric concentrations of CO2 will boost and enhance the growth of some crops but other aspects of climate change (e.g., higher temperatures and precipitation changes) may offset any beneficial boosting effect of higher CO2 levels.
- Pollution levels of tropospheric ozone (or bad ozone that can damage living tissue and break down certain materials) may increase due to the rise in CO2 emissions. This may lead to higher temperatures that will

offset the increased growth of crops resulting from higher levels of CO2.

- Changes in the frequency and severity of heat waves, drought, floods and hurricanes, remain a key uncertain factor that may potentially affect agriculture.
- Climatic changes will affect agricultural systems and may lead to emergence of new pests and diseases.

Climate is changing and, as a consequence, some areas that are climatically suitable for date palm (*Phoenix dactylifera* L.) cultivation at the present time will become unsuitable in the future.

In contrast, some areas that are unsuitable under the current climate will become suitable in the future. Consequently, countries that are dependent on date fruit export will experience economic decline, while other countries' economies could improve. Knowledge of the likely potential distribution of this economically important crop under current and future climate scenarios will be useful in planning better strategies to manage such issues. This study used CLIMEX to estimate potential date palm distribution under current and future climate models by using one emission scenario (A2) with two different global climate models (GCMs), CSIRO-Mk3.0 (CS) and MIROC-H (MR) (Shabani et al 2012). The results indicate that in North Africa, many areas with a suitable climate for this species are projected to become climatically unsuitable by 2100. In North and South America, locations such as south-eastern Bolivia and northern Venezuela will become climatically more suitable. By 2070, Saudi Arabia, Iraq and western Iran are projected to have a reduction in climate suitability. The results indicate that cold and dry stresses will play an important role in date palm distribution in the future. Also the climatic conditions (air temperature and humidity) and soil type play a significant role in the fruit properties of any cultivar during months of ripening. As the cv. 'Deglet Noor' develops black nose (blackening and shriveling of the tip) and fruit checks (small, linear scars near the apex) when grown in humid conditions. These results can inform strategic planning by government and agricultural organizations by identifying new areas in which to cultivate this economically important crop in the future and those areas that will need greater attention due to becoming marginal regions for continued date palm cultivation. Deglet Noor' is a native cultivar of Algeria and Tunisia where it performs as a dry cultivar while it is generally a semi-dry cultivar under USA environmental conditions (Krueger 2015). It is noticed that the soft cultivar of Egypt 'Samany' showed semi-dry fruit quality when cultivated in the date palm repository in USA. Moreover, under non appropriate environmental conditions, cv. 'Deglet Noor' yields, and quality were often unsatisfactory. Sometimes these differences happened even in small climatic differences in intra-zones. Date palms grown on hills or mountain range contains low moisture and subsequent having the longer shelf- life in comparison with same cultivar grown warmer and dry and plain areas. These results clearly indicated intra-cultivar variability due to environmental effects on fruit quality.

Climate Change and People Migration

Climate change adverse impact on people migration from rural to the urban areas in

Vietnam. The Vietnamese Mekong Delta is one of Earth's most agriculturally productive regions and is of global importance for its exports of rice, shrimp, and fruit. The 18million inhabitants of this low-lying river delta are also some of the world's most vulnerable to climate change. The commune had lost its entire sugarcane crop after unexpectedly high levels of salt water seeped into the soil and killed

Fig. 3 Genetic diversity in date palm, clearly showing variation in fruit color and shape

the plants. Those without a safety net were living in poverty. Over the following weeks hundreds of smallholders, many of whom had farmed the delta for generations, were changing and their livelihoods would soon be untenable. In 2015-2016 disaster struck with the worst drought in a century. This caused salt water to intrude over 80km inland and destroyed at least 160,000ha of crops. In Kiên Giang (pop. 1.7m), one of the worst affected provinces, the local net migration rate jumped and in the year that followed around one resident in every 100 left. Climate change is the dominant factor in the decisions of 14.5% of migrants leaving the Mekong Delta. And its worth pointing out the largest factor in individual decisions to leave the Delta was found to be the desire to escape poverty. As climate change has a growing and complex relationship with poverty, 14.5% may even be an underestimate. All this demonstrates that climate change threatens to exacerbate the existing trends of economic migration. One large scale study of migration in deltas has found that climate factors such as extreme floods, cyclones, erosion and land degradation play a role in making natural resource-based livelihoods more tenuous, further encouraging inhabitants to migrate. Climate change could have impact on people migration in date palm growing countries,

Date Palm Genetic Diversity

Jaradat (2015) defined genetic diversity as the genetic variation between species, subspecies, cultivars, populations, or individual clones that can be measured morphologically, physiologically, biochemically, and at the molecular level. Date palm cultivars have evolved by thousands of years of seedling selection with desired characteristics and wide range of genetic diversity in fruit quality, and shape (Fig.3). Each cultivar is derived from a unique single seed, cloned and vegetative propagation (Adel-Soad et al, 2017). At the global level, over 5000 date palm cultivars exit in date palm growing countries, but sometimes might be synonyms of one cultivar found in different countries under a different name, but about 10% of them of a commercial importance (Johnson 2011). However, each country got its own top elite cultivars of commercial value. An Egyptian most famous cultivar 'Siwy' is widely cultivated in Siwa oasis. A Libyan date palm cultivar, Fruit of 'Saidi' is characterized with a brown ring made the fruit having two colors. This cultivar is also maintained in Date Palm Repository, USA.
Dates are categorized into soft, semidry, and dry cultivars as per their moisture content,

texture, fruit appearance, and sugar content. For instance, the dry substances in soft cultivars are nearly 80% of invert sugars (mixture of equivalent extent of fructose and glucose) with high moisture (>30%) and soft flesh. The second group is the semidry cultivars that maintain about 40% invert sugars and 40% sucrose with firm flesh and fairly low moisture (20–30%), This group is the top exporter due to excellent the taste and good shelf- life. The dry cultivars are distinguished by having around 20–40% invert sugars and 40–60% sucrose with hard or dry flesh and low moisture (<20). Cultivars are also considered as early, mid-season, and late cultivars on the basis of duration of time required to mature fruits.

Panga (2014) reported that date palm has 36 chromosomes (n = 18; 2n = 36), but polyploidy cases are also reported with some Iraqi date palm cultivars (n = 64). In other cultivars chromosome number differed (2n = 32, 36) depending on early or late maturing type. Aneuploidy and euploidy were also reported. The climatic conditions (air temperature and humidity) and soil type play significant role in fruit quality during ripening. Cultivar Deglet Noor develops black nose (blackening and shriveling of the tip) and fruit checks (small, linear scars near the apex) when grown in humid conditions. 'Deglet Noor' is a native cultivar of Algeria and Tunisia where it performs as a dry cultivar, while it is generally a semidry cultivar under USA environmental conditions (Krueger 2015). It is noticed that the soft cultivar of Egypt 'Samany' showed semidry fruit quality when cultivated in the date palm repository in USA. Moreover, under non-appropriate environmental conditions, cv. 'Deglet Noor' yields and quality were often unsatisfactory as in case when cultivated in 'Punjab' Province in Pakistan, 'Wadi an Natrun' in Egypt. Sometimes these differences occur even in small intra-zones, e.g. hilly or mountain range has low moisture and that is helpful in the longer shelf-life of date fruits. Brac de la Perrière and Benkhalifa (1989) also found some intra-cultivar variability due to environmental effects on fruits of cv. 'Deglet Noor' in

Photo By Miksu - Own work; https://commons.wikimedia.org/w/index.php?curid=61440471

Fig, 4. Svalbard Global Seed Vault, Norway

Algeria and observed that the fruits from Tolga or Biskra oasis are excellent in quality, i.e., semi dry with 20–30% moisture content, buttery, and shiny as compared to the same cultivar grown in M'zab region which were largely drier and smaller and thus of less quality. Abul-Soad et al. (2017) reviewed that the date cultivars around well known date producing countries evaluated so far are about 450 in Saudi Arabia, 400 in Iran, 400 in Iraq, 1000 in Algeria, 250 in Tunisia, 244, 453 in Morocco, 95 in Libya 400 in Sudan, 250 in Oman; 321 in Yemen, 52 cultivars in Egypt 300 in Pakistan, beside numerous cultivars in other dates producing countries. Each dates growing country has its own won cultivars in addition to various other cultivars and their distribution is restricted to these regions due to numerous reasons.

Results And Discussions

Conservation of Date Palm

Ex Situ Conservation

When conservation of plant genetic resources attempted to perform outside or away from their natural habitat, it is termed as ex situ conservation. It can be done by seed and DNA storage, gene banks, collection farms, in vitro preservation or cryopreservation, and botanical gardens (Bekheet and Taha 2013). There are some limited efforts have been made in date palm ex situ conservation that can lead to preserve date palm germplasm for the purposes of successful propagation and improvement programs.

Seed Bank

The seed bank conservation is one of the most widespread and valuable ex situ conservation approach maintaining seed viability at low temperatures and by desiccation. As compared to the 'orthodox' seeds which can be stored for longer durations at subzero temperatures, date palm seeds being 'Recalcitrant' and heterozygous nature cannot be stored for the purpose of conserving genetic resources (Bekheet 2011). Stored date palm seeds in the seed banks can be germinated in in vitro condition. These seedlings could be maintained in vitro at low temperature in order to slow down the growth. Date palm seedlings are widely grown for date palm production with high production.

Svalbard Global Seed Vault

The Svalbard Global Seed Vault, also called Doom's day vault, is a secure seed bank on the Norwegian island of Spitsbergen near Longyearbyen in the remote Arctic Svalbard archipelago, about 1,300 km (810 mi) from the North Pole. The seed vault is an attempt to ensure and provide safety net against accidental loss of genetic diversity in other gene banks during large-scale regional or global crises or loss of samples due to mismanagement, accident, equipment failures, funding cuts, and natural disasters. These events occur with some regularity. War and civil strife have a history of destroying some gene banks. This is a backup for the world's 1,750 seed banks, storehouses of agricultural biodiversity. The seed vault functions like a safe deposit box in a bank. The bank owns the building and the depositor owns the contents of his or her box. A seed sample consists of around 500 seeds sealed in an airtight aluminum bag, and the facility has a storage capacity of 4.5 million seed samples. Date palm seeds could be stored in this international gene bank.

Community Seed Bank

The community seed banks are common at the village level for the preservation of local cultivars and agriculture production in many developing countries (Jain, 2011a). Farmers rely on informal seed systems based on local growers' retention of seed from previous harvests, storage, treatment and exchange of this seeds within and between

the communities (Jain, 2011b). The informal seed sector is typically based on indigenous structures for information flow and exchange of seeds. Seed banks managed within this local seed system operate on a small scale at the community level. Community Seed Banks are cost effective with limited resources and facilities. In date palm also the local high quality genetic material is conserved at the village or community level by preserving seeds. For more see http://www.bioversityinternational.org

In Vitro Conservation / Repository

In vitro conservation or in vitro gene bank of the plant genetic resources, various tissues are used such as shoot tips, axillary buds, embryos, callus, and cell suspension cultures (Singh 2009) (Fig.5). They are easy to maintain, less expensive and effective way of storing the plant genetic resources particularly the dioecious nature plants like date palm. In vitro conservation basically involves two stages: at first the in vitro culture establishment and secondly in vitro storage. The in vitro cultures can be conserved for short time (less than one year) or for years to loss some of the viability after sawing once again because of freezing damage. (a) Slow growth or Cold storage-in vitro cultures Slow growth methods are used to conserve plant cultures for relatively longtime storage (few months) by reducing the growth parameters either the temperature and light intensity, adding growth inhibitors, reducing O2 concentration, modifying the nutrient medium which includes dilution of mineral elements, reducing sugar concentrations, and by changing the use of growth regulators, choosing small explants, adding chemicals with osmotic properties (Lédo et al. 2014). Depending on the plant species, slow growth technique allows cultures to be held for 1–15 years under tissue culture regimes with periodic sub-culturing (Jain 2011a, b). However, the high costs of labor and the potential risks of somaclonal variation for some species are the major problems (Cruz-Cruz et al. 2013). There are certain limiting factors of this technique, i.e., reducing temperature cannot be handled effectively when tropical plant species are concerned due to their higher temperature growth habit. Not all types of explants were tested in date palm. Shoot tip explants and callus cultures were successfully employed through slow growth conservation of cv. 'Zaghloul' for 12 months at 5 °C in the darkness (Bekheet et al. 2001). Callus explants of cv. 'Gundila'

Fig.5 In vitro conservation of germplasm

Fig.6 Basic equipment for cryopreservation

were also successfully applied for slow growth conservation for the period of 6 and 12 months. The modified medium contained 0.3 M of different sugars with the recovery of 90.73% after four weeks of thawing in normal conditions (Zaid et al. 2011). Incubation temperature during slow growth conservation is reduced from 27 to 15 °C for callus cultures (El-Dawayati et al. 2012). However, it becomes necessary to get high survival rate over 90% and prevent loss of germinated embryos from the conserved embryogenic callus (El-Ashry et al. 2013). However, slowing the growth of callus culture under appropriate conditions could allow enough time for somatic embryo maturation. Subsequently, it will increase the developed somatic embryos. In addition, stored callus culture could serve as stock for micropropagation as per need. In vitro cultures, maintained in slow growth medium, can easily be transported safely. It is worth to mention that the in vitro cultures of date palm are very sensitive for endogenous bacterial contamination. At any time, it may appear when the growth condition is inappropriate.

Cryopreservation

Reed (2017) the cryopreserved collections are highly valuable for the future plant breeding programs and ecosystem restoration. They provide important back up collections for vegetative propagated plants and those with small natural populations or those threatened by human development, environmental changes or development of new diseases. Cryopreserved collections provide long-term security for the plant genetic resources of all types. They provide a secure backup for field collections, insure that little used but unique genotypes are preserved, and store research material worldwide otherwise that would be discarded, save important disease resistance genes and save genes combating future problems facing food and agriculture. Cryopreservation should be considered as Food and nutrition security for the future agriculture. Cryopreservation involves maintaining of living cells and tissue organs at ultralow temperature or in liq-

uid nitrogen (between −79 and −196 °C) for longer periods by halting all the metabolic activities and cell division (Fig.6).

Thus, cells will not undergo genetic changes or somaclonal variations during storage as compared to serial sub-culturing where the cultures are exposed to the risks of contamination and handling errors (Cruz-Cruz et al. 2013). Plant regeneration from cryo-preserved material, e.g. embryogenic cells or somatic embryos is necessary otherwise this approach has no value. There are two modes of cryopreservation protocols based on their physical mechanisms. The classical cryopreservation technique is performed in the presence of ice or ice formation, while the vitrification usually does not involve the ice formation. Since date palm is a dioecious plant, conservation of its genetic resources, using cryopreservation is the best solution being cost-effective and requires small space with the capacity to store large genetic resources without the fear of natural disasters, disease outbreaks, etc. Depending on the plant species and type of cultivars, the cryopreservation technique involves several steps such as selection of the plant material preferably young rapidly growing material, which show resistance against freezing due to smaller size, fewer or small number of vacuoles, and dense cytoplasm; pretreatment of explants in a medium containing osmotically active compounds for dehydration of the tissues and protection of cell membranes; freezing requires to avoid injuries through ice crystal formation); storing at a freezing point where the metabolism activity is suppresses; thawing is done to prevent damage of the cells from the intracellular ice crystals; and post-cryo-treatment minimizes the toxic effect of cryo-protectants and reduce the osmotic shock. Abul-Soad, et al (2017) reported testing of several date palm explants to cryo-store using caulogenic meristem, friable callus, pro-embryogenic masses, somatic embryos, shoot apices, and pollen. Bekheet et al. (2007) cryopreserved nodular callus of date palm initially at 0 °C for 2 h and then transferred into liquid nitrogen (−196 °C) for 48 h. The recovery percentage after thawing was 80% on 1 M sucrose-pre-culture medium. Fki et al. (2011, 2013), the Tunisian group, tested three cryopreservation vitrification protocols -, standard (tube) droplet, and encapsulation- were tested.' The standard vitrification gave the highest recovery rates using small explants (2 mm), while the larger explants (>3 mm) died after thawing stage. Salma et al (2014) cryopreserved poly-embryonic masses (PEMs) using droplet-vitrification and dehydration cryo-plate techniques. The recovery percentages of pro-embryos or PEM of cultivar was highly dependent on genotype after transfer to the standard culture medium containing 3.3 M glycerol + 2.4 M ethylene glycol + 0.4 M sucrose + 1.9 M dimethyl sulfoxide. Bekheet (2015) studied the effect of salt mixture (NaCl, MgCl, and CaCl2) along with other osmotic stimulators such as mannitol and polyethylene glycol (PEG) for cryopreservation of embryogenic cultures of date palm. The highest values of fresh mass were at salt tolerance ratio of 1500 ppm.

Cryopreservation of date palm germplasm is still at the infancy stage in terms of plant regeneration from cryo-stored explants. This technique has been tried mainly in Egypt and Tunisia, and the results have been published. In vitro date palm culture is highly genotypic dependent for high efficiency of plant regeneration, and that why limited number of date cultivars has been tested for somatic embryogenesis and other tissue culture activities. Genetic fidelity of plant regenerated from cryo-stored material must be determined by using molecular markers, just to confirm genetic stability of regenerated plants.

In Situ Conservation

In situ as the term indicates literally mean 'in place,' involving conservation of plants in its natural habitat to which it is adapted and maintained by farmers within the traditional agricultural systems and allows the recovery of germplasm in their natural surroundings (Singh 2009; Rao and Sthapit 2012). Date palm growers are playing an important role in preserving the biodiversity of traditional date palm grove and gardens by continuous use of century-old practices in maintaining the traditional date cultivars and propagation of the newly developed races with distinctive properties. Since the conservation of such agro-biodiversity is carrying out as on-farm, therefore such type of conservation is also termed as on-farm conservation. In such a way, the genetic diversity of target species is managed and wild plants have been maintained within the traditional agricultural or horticultural systems. It has helped the species to adapt gradually with new variations in the gene pool caused by environmental conditions such as global warming, changed rainfall patterns (Heywood and Dulloo 2005). Sustainable on-farm and in situ conservation of date palm diversity is only promising when farmers, academia, and government organizations show interest in recognizing the benefits in terms of genetic, economic, social, and environmental point of view and by implementing the private utility benefits to the individual grower or user. On-farm conservation is encouraging in several Middle East and North African countries as a potential method of date palm conservation strategy. When farmers get motivation from the state, they also show their interest in this global cause (Jaradat 2015). Nowadays, in date-producing countries, the major crops growing concern is to exchange the information to develop the date palm sector. The great advance and wide usage of social media programs made groups with direct contact able to exchange the photographs and movies instantly either on national or on international levels. This is expected to not only encourage the on-farm conservation but also support all other activities in date palm. The status of on-farm conservation of date palm is still limited. However, there are numerous small-scale conservations or rather germplasm collection stations or farms maintaining the local cultivars in more or less all date-producing countries. This could keep the progeny of elite landraces and commercial cultivars of a limited population at same place and prevent losing such valuable genetic resources. It is a practice for the date palm growers in the non-systematic farms to regularly clean their orchards by detaching the offshoots from parent female productive trees and plant them once again in between the adult trees or establish a new orchard.

Field gene bank

Field gene bank is one the ways to collect, maintain and conserve the date palm genetic resources by vegetative propagation for maintaining their genetic makeup true to type for the long-term preservation of the genetic or inter-specific variability. This approach for germplasm conservation is always risky of damage by natural disasters, pest and pathogen problems (Singh 2009), and relatively expensive and requires huge space. However it is providing easy and ready access to conserve palms for research and their utilization. There are number of field gene banks in almost all date-producing countries including for example King Faisal University, in southeastern Al-Hassa (Saudi Arabia), comprising 31 Saudi Arabian cultivars collected from 7 major growing regions and 26 exotic cultivars (Al-Ghamdi

2001; Aleid et al. 2015). A project started by General Board of Date Palm (GBDP) with the help of the ministry of Agriculture in Iraq has collected 497 cultivars in various regions of Iraq (Khierallah et al. 2015). The Kuwait Institute for Scientific Research (KISR) at Kuwait university main campus maintains 34 female and 6 male cultivars (Sudhersan et al. 2015) (Fig.7). The establishment of such collective farms is helpful in evaluating and comparing the fruit quality of alien cultivars at the experimental stations, and in making growers to take the right decisions to introduce valuable alien cultivars that suit the local environment.

Fig.7 Date palm germplasm collection at The Kuwait Institute for Scientific Research (KISR) at Kuwait university main campus

Conclusions

The collected elite germplasm are highly valuable for the future plant breeding programs and ecosystem restoration. They provide important back up collections for plants, which are in danger of losing due to human development, environmental changes or development of new diseases. All collections from different means of conservation provide long-term security for the plant genetic resources of all types. These collections provide a secure backup for field collections and save important abiotic and biotic resistance genes and save genes combating future problems facing food and agriculture. Climate changes endanger the economic migration. Climatic factors such as extreme floods, drought, cyclones, erosion and land degradation make natural resource-based livelihoods more tenuous, force inhabitants to migrate for better living. In vitro conservation has several distinct advantages, e.g. the material can be maintained in a pathogen-free state facilitating safer distribution without going through quarantine. Furthermore, the cultures are maintained under the controlled growing conditions without subjected to any environmental disturbances. Cryopreservation is a long-term in vitro storage of genetic material, however needs a reliable plant regeneration system from cryo-stored material without showing any genetic variability. The regenerated plants Date palm conservation is an excellent system for Food and nutrition security for the future sustainable production facing climatic changes and genetic erosion. Together with the air we breathe and the water we drink, crop diversity and conservation are most fundamentally important resources for human life on earth.

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Carbonated non-Alcoholic Beverage from Sudanese Dates (Brakawi) Processing, Stability and Bottle Cost

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The possibility of producing a carbonated non-alcoholic beverage from Dates and the product produced was found to be highly acceptable by consumers and at lower cost value compared to popular similar beverages.


Photographed By: Shibu Varghesa Joseph

Abstract

This study investigates the possibility of producing carbonated non-alcoholic beverages from dates. The suitability of local varieties was tested with regards to easiness of extraction, richness in natural flavor and coloring material. Also the processing properties of the Date was investigated by studying the effect of extraction time, extraction temperature, use of preservative, pasteurization, and filtration. The optimum value of the significant value of the significant factors was reported. The stability of the product during storage and consumer's acceptance of the product with was calculated. The study indicated that the suitability of some local Varity for processing, Using Factorial design method and Yeats method to analysis the experimental data. The effect of extraction time of 1- 4 h; extraction temperature of 30-70oC; and ratio of Dates to water of 100g: 500 ml- 100g: 1000 ml on product quality were found to be highly significant in affecting the product quality of fruit extracts, the possibility of producing a carbonated non-alcoholic beverage from Dates and the product produced was found to be highly acceptable by consumers and at lower cost value compared to popular similar beverages. Pasteurization, filtration, and addition of preservative material influenced the storage stability of product. The formula used to prepare 36000 bottles (280 ml) of the carbonated drinks from dates was 600 kg of dates, 3000L of extraction water , yield of extracts 2520 L(5% T.S.S), 13 kg of citric acid,1200kg of Sugar, 1800 L of water for sugar syrup, 5040 L of water for dilution, 5 kg of sodium benzoate and 45 kg of CO2.

Key word: Solid-liquid extraction, Dates, extraction, and non-alcoholic carbonated

1.Introduction

Carbonated non-alcoholic beverages [CNB] may be defined as beverages that are acidified and have salts or minerals added those are artificially charged with carbon dioxide, and finally contain no alcohol. Their name was derived from the original method of charging the water with carbon dioxide (1,2,3) Most of the carbonated non-alcoholic bever-

ages derive their characteristic aroma and flavor from synthetic organic or inorganic derivatives, which do not contribute much to the nutritive value of the product (4,5,6,7,8,9,10,11,12,13). Food service establishment looks upon soft drinks as highly profitable and easy item to serve and sell. However, because of lack of understanding of the fundamentals of the product, the dispensing equipment involved, little or no testing and poor sanitation procedure the resulting beverage is often substandard, and dos not yield anticipated profits (4,5,6,7,8,9,10,11,12,13,14). Selection of suitable types of fruits and processing technology is highly demand. There are more than fifty – two different types of vegetables and fruits available in the Sudan (15). Dates available in large quantities in Sudan. Cold refreshing drinks most liked by Sudanese are used to be prepared from it, it is of a high nutrition and medical value, the by-product of this fruit can be used as a base for some other industries e.g. James, squashes and an animal feed. In addition, it offers higher income returns to thousands of local farmers who grow and care for it. Dates pulp contains 7% moisture, 2.3% ash, 200 mg Ca/100g minerals, 5.7% insoluble solids, 67% total sugar, and 2%protein. (4,5) .

The aim of this work is to study the effect of extraction variables (temperature, extraction time and ratio of dates/water) on product concentration to determine the optimum value of the significant factor and the possibility of producing non-alcoholic carbonated drinks from dates and to produce a more nutritive natural drink. And to find the unit cost of the product

2. Experimental Work

Sudanese Date [Barkawi], treated water from New Industries Co. (Sudan) plants (Pepsi-Cola) in Khartoum and granulated sugar from Kenana Sugar Company Ltd. (in Sudan) were used in this investigation. Replication and Yates methods were used to calculate the effects of factors and analysis of variances (16). Total soluble solids [TSS] and Refractive index (RI) were measured by Abe refract meter at 200C, pH value was determined by a Beckman pH meter with a glass electrode at 200C. Color intensity (percentage transmission, PT) was measured by Zeiss spectrophotometer (Automatic Absorption systems Beckman Models 484 & 495) at wavelength of 560 nm at 200C. For organolptic analysis, ten-experienced panel's members were asked to evaluate flavor, taste, and overall acceptability of carbonated non-alcoholic beverages. The test was done as follows: Please taste the samples in the order given, assign to each sample a number from 0 to 7 (o for extremely dislike, 1 dislike very much, 2 dislike, 3 slightly dislike, 4 slightly like, 5 like, 6 like very much and 7 extremely like). Also state any comments e.g. bitter, acidic, sweet, flat etc. Microbiological test: For total plate counts, media of Yeast extract 2.5 g, Tryplone 5.0g and Dextrose 1.0g was used. For total Yeast and Mould counts a media of Yeast extract 3.0 g, Petone 5.0g and Agar 9.0g was used.

3. Results and Discussion

3.1 Factors affect Product quality and Significant Factors.

Table 1 shows the pH, TSS, RI, P.T and oS of the extracts (extraction of 100 g dates in 500 ml or l000 ml treated water at 30 or 70oC for 1 & 4 hrs of extraction time) at different treatment combination. From data in table 1. The increase in the extraction time in the range of 1-4 hrs, will result in decrease in pH value and in P.T, but leads to an increase in 0S, TSS and R.I., such changes were caused by the increase in acidity, color intensity, sugar contents and total soluble extracts. Increase in extraction temperature in the range of 30 to 700C caused the same effect as for extraction time, where an increase in P.T, 0S,T.S.S & R.I values, occurred the P.T decreased.

Table 1: The pH, TSS, RI &PT of the extract at different treatment combination

Time, h	Temp°C	Ratio, g/ml	TC	Factors	pH	PT	°S	TSS	RI
1	30	100:500	I	I	6.51	70.0	-0.89	1.5	1.3350
4	30	100:500	a	A	5.88	60.7	-4.37	4.5	1.3395
1	70	100:500	b	B	5.56	49.3	-4.12	5.5	1.3410
4	70	100:500	ab	AB	5.04	24.5	-12.8	13.5	1.3530
1	30	100:1000	c	C	6.7	79.2	-0.50	0.5	1.3340
1	30	100:1000	ac	AC	6.22	74.7	-2.23	2.5	1.3365
1	70	100:1000	bc	BC	5.91	70.3	-1.48	2.0	1.3360
4	70	100:1000	abc	ABC	5.23	48.0	-5.65	7.0	1.3420

Table 2. Factors and Interactions, which are Significant (1 significant 0 non-significant)

S.V	pH 1%	5%	10%	TSS 1%	5%	10%	RI 1%	5%	10%	PT 1%	5%	10%	°S1%	5%	10%
A	1	1	0	1	1	0	1	0	0	1	0	0	1	1	0
B	1	1	1	1	1	0	1	1	0	1	1	1	1	0	0
C	0	0	0	1	0	0	1	0	0	1	1	0	0	0	0
AB	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
AC	0	0	0		0	0	0	0	0	0	0	0	0	0	0
BC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ABC	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Increase of water/dates ratio in the range of 100g: 500 ml to 100g: 1000 ml caused increase in pH and P.T. The oS, TSS and R.I showed reduction in value. Such increase and decrease could be related to decrease in acidity, color intensity sugar extracts and soluble solids extracts and could be readily explained as a concentration effect i.e. the concentration of the extracts decreases with the increase of water/dates ratio. From table 2 it could be observed that increase in the extraction time from 1 to 4 hours, extraction temperature from 30 to 700C and ratio of dates to water from 100 g: 500mb to 100g: 1000ml were found to be significant at probability level of 1%. All interactions of the above factors were found to be insignificant. Since all factors were found to be significant then they should be examined in details. This agrees with our earlier work (4, 5) which reported that the extraction time and extraction temperature was highly significant on quality of juice extracted from dates using tap water as a solvent.

3.2 Determination of the Optimum Values of the Significant Factors

3.2.1. The Ratio of Dates to Water

Table 3 shows the pH, T.S.S, R.I, and P.T of the extraction of 100g dates in treated water at 300C for 10 hrs. After comparing these val-

ues versus ratio of dates to water Figure1 the ratio of dates/water of 1:5 was chosen as optimum ratio, because good color and higher T.S.S could obtained at this ratio. It could also be noticed from table 3 & fig (1) that: the pH and P.T were directly proportional toThe ratio, while the oS, T.S.S and R.I were inversely proportional to it, the reasons for that was the decrease in acidity, color intensity, sugar content and soluble solids due to the dilution of the extract.

3.2.2. The Extraction Time.

Tables 4, 5 and 6 show the pH, T.S.S R.I, P.T and 0S of the extracts from the extraction of 100 g dates in 500 ml treated water at 30, 65 and 980C for different extraction time. Figs 2, 3 and 4 show the variation of the pH, T.S.S, R.I, P.T and 0S of the above extracts VS extraction time at extraction temperature of 30, 65 and 980C respectively. From the results the pH & P.T will decrease while the 0S, TSS and R.I will increase with the increase of the extraction time. Such changes could be due to the increase of soluble solids extracted and could be a direct concentration effect. After the extraction, time of 9th hrs (300C) the taste of the extracts began to change and became yellow, and foamy, most probably due to effects of micro- organism (fermentation), for above reasons 8 hours were chosen as optimum extraction time at the temperature of 300C.The results of ta-

Table 3: The pH, RI, TSS &P.T of the extract at different ratio of Dates / water for extraction time of 10 hours at 30°C

Ratio g/ml	pH	P.T	°S	TSS	R.I
100:200	5.48	59.8	-15	14.5	1.3550
100:400	5.55	60.7	-9.05	9.0	1.3460
100:600	5.65	63.2	-6.22	6.0	1.3420
100:800	5.70	67.8	-4.56	5.0	1.3400
100:1000	5.82	70.5	-3.60	4.0	1.3390
100:1200	6.04	77.7	-2.85	3.5	1.3380

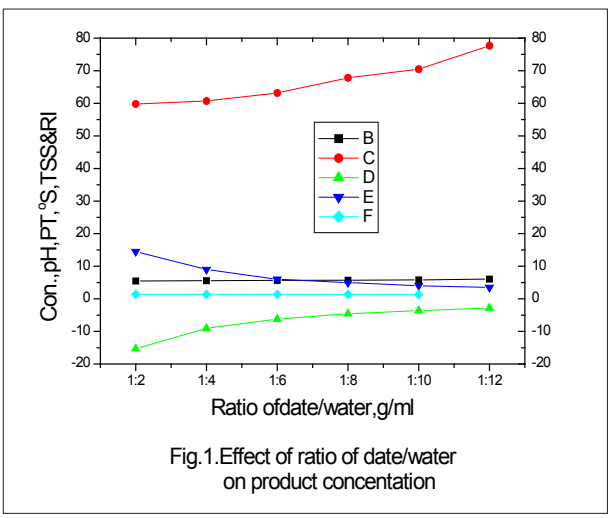

Fig.1.Effect of ratio of date/water on product concentation

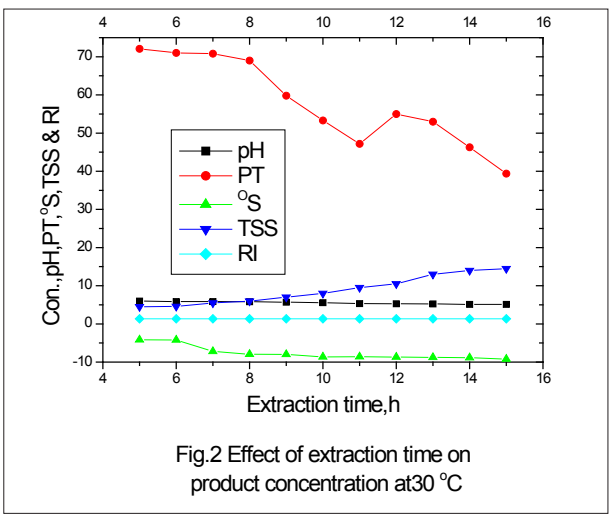

Fig.2 Effect of extraction time on product concentration at30 °C

Table 4: The pH, RI, TSS and PT of the extract at different extraction time, ratio of 100 g Dates / 500 ml water and extraction temperature of 30°C

Extraction time, h	pH	PT	°S	TSS	RI
5	6.00	72.1	-4.18	4.5	1.3395
6	5.86	71.0	-4.2	4.6	1.3400
7	5.84	70.8	-7.22	5.5	1.3410
8	5.83	69.0	-7.94	6.0	1.3420
9	5.68	59.8	-7.99	7.0	1.3435
10	5.55	53.3	-8.60	8.0	1.3450
11	5.32	47.2	-8.64	9.5	1.3470
12	5.27	55.0	-8.70	10.5	1.3480
13	5.23	53.0	-8.75	13.0	1.3530
14	5.12	46.3	-8.86	14.0	1.3540
15	5.10	39.4	-9.21	14.5	1.3550

Table 5: The pH, RI, TSS and PT of the extract at different extraction time, ratio of 100 g Dates / 500 ml water and extraction temperature of 65°C.

Extraction time, h	pH	PT	°S	TSS	RI
1	6.15	76.5	-2.20	2.5	1.3370
2	5.72	70.4	-3.35	4.0	1.3390
3	5.66	56.7	-4.24	5.0	1.3405
4	5.51	53.6	-5.59	6.5	

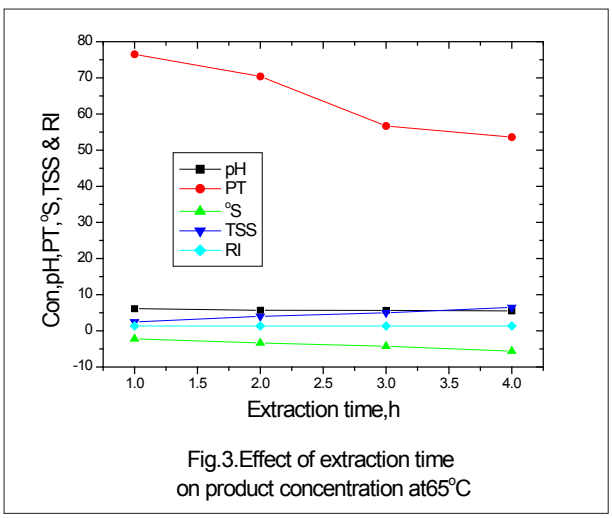

Fig.3.Effect of extraction time on product concentration at65°C

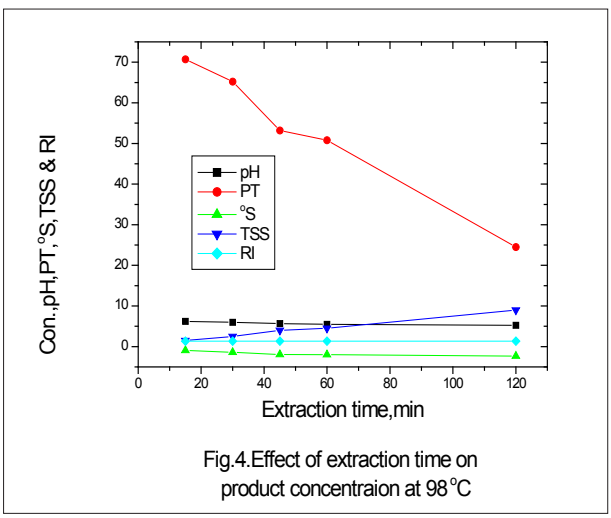

Fig.4.Effect of extraction time on product concentraion at 98 °C

Table 6: The pH, RI, TSS and PT of the Extract at different extraction time, ratio of 100 g Tamarinds / 500 ml water and extraction temperature of 98°C.

Extraction time, min	pH	PT	^{0}S	TSS	RI
15	6.23	70.7	-0.93	1.5	1.3350
30	5.99	65.2	-1.40	2.5	1.3363
45	5.66	53.2	-1.95	o.4	1.3490
60	5.47	50.8	-1.97	4.5	1.3395
120	5.24	24.5	-2.35	9.0	1.3465

ble 5 and figure 3 confirmed the findings already presented in table 1 that is, with the elapse of time: the pH, and P.T will decrease. The 0S, R.I and T.S.S will increase It had been noticed that after an elapse of 3 hours of extraction, the color of the extract was getting dark and taste getting sour. For this reason, the 3 hrs time was chosen to be the optimum extraction time at the temperature of 650C.Table 6 & figure 4 show the pH, T.S.S, R.I, 0S and pH of the extracts at 980C. Following the same procedure for an extraction temperature of 980C. It was found that the optimum extraction time is 60 min. In general, hot water at 650C and above extracts soluble solids from date pulp more easily in a shorter time than cold one, but it adversely affects the taste, color and flavor of the extracts. Also long extraction time at lower cold extraction temperature causes a change in the taste of extracts due to fermentation of the extracts. According to the above mentioned the optimum extraction conditions for further experiments should be as follows: Ratio of dates to water 1:5 ml, extraction time 8 hrs, extraction temperature of 300C.At extraction temperature of 650C the ratio of dates/water 100g: 500ml extraction time of 3 hrs. At extraction temperature of 980C, the ratio of dates/water 100g: 500mb, and extraction time 60 minutes.

3.2.3. Effect of Extraction Temperature on Final Product

Three extracts were prepared at optimum conditions: product No. 1, with extraction temperature 300C and extraction time of 8 hrs, product No. II with extraction temperature of 65oC and extraction time of 3 hrs, Product No. III with extraction temperature of 98oC and extraction time of 1 hr. Citric acid was added .TSS of the extract was raised to 26TSS by addition of sugar, diluted to 13 TSS by water. And then cooled, carbonated, bottled, crowned and pasteurized. The samples were numbered I, II &III. Table 7 shows the formula used to prepare the products and table 8

Table7: Formula used to prepare carbonated drinks from the extracts of 600 g Dates in 3000 ml treated water at different temp. And extraction Time

Ext. time, h	Ext. temp. °C	Ext. Vol, ml	Ext. PH	TSS	Citric acid, g/100 ml 0f Ext.	Sugar syrup (41% TSS), ml	Water for Dilution	Product. TSS
8	30	2480	5.77	6.0	0.805	1200	1500	13
3	65	2480	5.48	6.0	0.6188	1200	1500	13
1	98	2480	5.54	6.5	1.015	1200	1500	13

shows the scour given by taster to products I, II and III. All the three products were found to be acceptable among the taster, but the product No. II (65oC& 3 hours) was the best of all, and therefore, chosen for further investigations.

3.2.4. Optimum pH for The Final Product.

Four samples, of extract; having a pH value of 5.5 and the T.S.S of 6 were first prepared. Citric acid was then added to lower the pH of the extracts to 3.2, 3.3, 3.4 and 3.5 values. Sugar syrup was added to each of the extracts then diluted, filtered, cooled, and carbonated according to the ratios shown in table 9. Table 10 shows the scoured given by taster to products of table 9.The panelist accepted all four products. However, the product of pH value 3.3 products Io. IT came first. Hence the final products will be prepared according to the following formula: Extraction of dates / water (100g: 500m1) at 650C for 3 hours, addition of citric acid 0.5g citric acid/ 100 dates extracts (5% T.S.S) and 0.5g/ L sodium benzoate of final solution.

Table 8: The score given by taster to product no.1 [30°C], II [65oC] & III [98°C]

Colour1	Taste1	Overall1	Colour2	Taste2	Overall2	Colour3	Taste3	Overall3
6	6	5	6	7	6	5	6	6
4	6	5.5	6	7	6	6	5	5
5	6	5	6	7	4	5	6	5
4	5	5	5	5	6	6	6	6
5	5	6	5	5	6	4	5	5
5	5	6	5	6	5	6	5	5
6	6	5.5	6	5	6	3	3	5
5	5	5	5	5	5	3	4	4
6	5	5.5	5	6	6	4	5	4
6	5	5	5	5	5	3	3	4
Av.5.2	5.4	5.5	5.4	5.8	5.5	4.4	4.9	4.9

Table9: Formula used to prepare different pH. Products

Products	Ext. ml	Sugar syrup (41% TSS), ml	Water for Dilution, ml	Sodium benzoate	Finial pH	Citric acid added, g	Final, TSS
1	500	500	1000	2	3.2	3	13
2	500	500	1000	2	3.3	2.5	13
3	500	500	1000	2	3.4	2.0	13
4	500	500	1000	2	3.5	1.5	13

Table10: The scoured given by taster to products of Table 9.

Prod. pH 3.2			Prod. pH 3.3			Prod. pH 3.4			Prod. pH 3.5		
C	T	O	C	T	O	C3	T	O	C	T	O
6	6	6	6	6	7	6	6	6	6	6	4.5
6	5	6	6	6	6.5	6	6	5	6.5	5	5
6	5	5	6	6	6	6	5	5	5.5	5	5
5.5	5	6	7	7	6.5	6	6	5	6	5	5.5
6.5	6	6	6	7	7	6	6	6	6	5	5
6	6	6	6.5	6	7	6	6	6	6	5	5
6	5	5	6	6.5	6	6	6	5	5.5	5	4.5
5.5	5	5	6	6.5	6.5	6	5	5	6.5	5	5
6	5	6	6.5	6	6.5	6.5	5	5	6	5	5.5
6.5	6	6	7	6	6	6	6	6	6	6	5
6.0	5.4	5.7	6.2	6.3	6.1	6.1	5.7	5.7	6.o	5.2	5.o

C: Colour1, T: Taste and O: Overall

3.2.5. Storage of the Final Products and Storage Properties.

The CNB syrup was prepared at optimum conditions. The syrup was then carbonated, bottled and crowned. The bottles were divided into two equal numbers of bottles. One group was pasteurized in water bath at 800C for half an hour while the other half was not pasteurized. Both group of bottles were stored at room temperature of 30- 450C for 75 days and then analyzed. Tables.11 and 12 show the pH, T.S.S, P.T, oS, and R.I, organoptic and microbiological values of the stored products (both unpasteurized and pasteurized)

The following could be observed from the above tables: -

(i) The pH, T.S.S & R.I values were found to be constant during the storage period of 75 days.

Table 11: Analysis of pasteurized carbonated product.

Storage time, day	pH	PT	TSS	RI	°S	Gas volume	Bact.	Yeast	mold	Coll	col	Taste	Over-all
0	3.60	76.8	13.0	1.3525	37.81	3.4	Nil	Nil	Nil	Nil	6.5	7	6.5
15	3.65	77.4	12.5	1.3520	34.10	3.4	Nil	Nil	Nll	Nil	6.0	6	6
30	3.64	77.2	13.0	1.3525	31.00	3.4	Nil	Nil	Nil	Nil	6.5	6	6.7
45	3.67	74.8	12.5	1.3520	26.70	3.5	Nill	Nil	Nil	Nil	6.5	7	7
60	3.60	75.2	12.5	1.3520	18.00	3.4	Nil	Nill	Nill	Nil	6	6.5	6.5
75	3.61	76.8	12.5	1.3520	8.53	3.4	Nil	Nil	Nil	Nil	6	6	6

°S Sucrose Content TNTC Too mummers to count more than 50

Table 11: Analysis of pasteurized carbonated product.

Storage time, day	pH	PT	TSS	RI	°S	Gas volume	Bact.	Yeast	mold	Coll	col	Taste	Over-all
0	3.60	76.8	13.0	1.3525	37.81	3.4	Nil	Nil	Nil	Nil	6.5	7	6.5
15	3.65	77.4	12.5	1.3520	34.10	3.4	Nil	Nil	NIl	Nil	6.0	6	6
30	3.64	77.2	13.0	1.3525	31.00	3.4	Nil	Nil	Nil	Nil	6.5	6	6.7
45	3.67	74.8	12.5	1.3520	26.70	3.5	Nill	Nil	Nil	Nil	6.5	7	7
60	3.60	75.2	12.5	1.3520	18.00	3.4	Nil	Nill	Nill	Nil	6	6.5	6.5
75	3.61	76.8	12.5	1.3520	8.53	3.4	Nil	Nil	Nil	Nil	6	6	6

°S Sucrose Content TNTC Too mummers to count more than 50

Table 12: Analysis of non-pasteurized carbonated product.

Storage time, day	pH	PT	TSS	RI	°S	Gas volume	Bact.	Yeast	mold	Coll	col	taste	Over-all
0	3.70	77.5	13.0	1.3525	41.33	3.4	Nil	Nil	Nil	Nil	6	6	6
15	3.65	77.6	12.5	1.3520	35.55	3.3	5	Nil	NIl	Nil	6.5	6	6.5
30	3.62	77.0	13.0	1.3525	32.18	3.4	TNTC	5	Nil	Nil	5	5	5
45	3.61	78.0	12.5	1.3520	26.18	3.5	TNTC	TNTC	Nil	Nil	5	5	5
60	3.59	79.0	12.5	1.3520	18.4	3.6	TNTC	TNTC	Nill	Nil	4	4	4
75	3.60	80.0	12.5	1.3520	16.66	3.6	TNTC	TNTC	Nil	Nil	4	3	3

Nil <5, TNTC >50, °S Sucrose Content, TNTC Too mummers to count more than 50, Coll Colliform bacteria

(ii) P.T slightly increased such an increase may be due to the decrease in color intensity which is directly 'affected by the changes in temperature.

(iii) Gas volume in the pasteurized bottles was found to be constant during the storage period, while slight change in gas volume was noticed in unpasteurized bottles. This was most probable due to presence of yeast and bacteria, which might have spoiled the products.

(iv) The pasteurized products preserved their taste and flavor throughout the storage period of 75 days. On the other hand, some change of the taste of the unpasteurized was observed after an elapse of 45 days. This was due to growth of microorganisms, which usually change the taste of the products.

(v) All products were found to be free from mould and collator bacteria, due to the use of treated water which is free from colliform bacteria and mould. No yeast or bacteria (more than 5 colonies) were seen in the pasteurized one during the storage period. While countless number (T.N.C) i.e. more than 50 colornies bacteria, were seen in unpasteurized one in 30 days of the storage and TNT yeast in 45th days of the storage. Considering all these reasons, the final product should be pasteurized. The same equipment and procedure used for manufacturing any Carbonated non-alcoholic beverages can be used to manufacture carbonated drinks from date. The only difference the addition of extraction, concentration and pasteurized unit (17-22)

3.2.6. Martial Balance and Unit Cost

Basis one operating day for production of 6000botels per day per hour (280 ml), one shift/day and 6 hours production hours/ shift. The optimum conditions were considered in the production of stable products from dates. The amount of dates is 600 kg need to produce 36000 bottles of CNB from dates comparing the data to the annual production of 115000 tons dates produced in the Sudan it could observed that it's possible to produce more than this capacity in the Sudan due to availability of raw materials.

3.2.7. Cost Estimation

The unit cost of CNB from dates was based on the current price of raw material in Khartoum market and on the production cost data used by the Ministry of Industry for Pepsi-cola and Vimto on the last study done on 29-2-1989. the unit cost of CNB from dates was found to be equal to 88% of Pepsi cola and 90 % of Vimto which is less than that of Pepsi cola and Vimto due to low cost of dates and dates was natural fruits it don't need synthetic color or flavors.

4. Conclusion

Increasing of extraction temperature, time and ratio of dates to water were found to be highly significant in affecting the product concentration. The suitable Optimum ratio of date to water was 100g date: 500ml water. Optimum extraction time at 30 oC was 8 hrs, at 65 oC was 3hrs and at 98 oC was 1h. The study indicated the possibility of producing non -alcoholic carbonated drinks from dates. And product produced was found to be highly acceptable by consumer. Optimum processing was extraction of 100g of dates to5oo ml of water at 650C for 3 hrs. adding, citric acid, sugar, water, cooled, carbonated, bottled crowned and pasteurized the unit cost of CNB from dates was found to be less than that of Pepsi cola and Vimto.

Nomenclature

CNB: Carbonated Non-Alcoholic Beverages
pH: pH Value
P.T: Percentage Transmission
R.I: Refractive Index
T.S.S.: Total Soluble Solids
TC: Treatment Combination

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A new interspecific date palm hybrid

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Crop improvement research in date palm (Phoenix dactylifera L.) lags behind due to its slow growth and long life cycle.

Abstract

Crop improvement research in date palm (*Phoenix dactylifera* L.) lags behind due to its slow growth and long life cycle. High quality fruit production in date palms depends on crop management practices such as leaves pruning, removal of leaf spines, pollen dusting, bunch thinning, fruit bagging and harvest. These operations are easy when the palm trees are up to 3 m in height and very difficult when the trees grow taller. Climbing on tall palm trees for these operations is difficult and expensive nowadays. Therefore, we undertook a research activity in our laboratory to develop short date palm trees through interspecific hybridization. The tissue culture date palm orchard maintained at the Kuwait Institute for scientific research (KISR) was used for the experimentation Date palm cultivars Barhi, Madjhool and Sultana were used as female parent and *Phoenix pusilla* was used as male parent. Selected female date palm inflorescences were dusted with *p. pusilla* pollen carefully and bagged immediately after the pollen dusting to avoid pollen mixing. Normal fruit development, growth and ripening was occurred similar to the bunches pollinated with date palm pollen. However, the seed development was arrested and the embryos aborted at the ripening stage due to the failure in endosperm development during seed formation. Therefore, interspecific hybrid embryos were isolated from the immature fruits and germinated in vitro. Rooted hybrid plantlets were produced, acclimatized and planted in the field. The first interspecific date palm hybrid was planted in the

Photographed By: Mohammed Al-Harbi

field during 2009 and fruiting occurred in 2014. The tree showed stunted growth, and the fruit morphology and seed morphology were differed from both the parents. This is believed to be the first successful trial on interspecific hybridization in date palm.

Keywords: *Phoenix dactylifera, p. pusilla*, hybridization, field evaluation.

Introduction

Date palm (*Phoenix dactylifera* L) crop improvement through breeding has been slow when compared to other crops, due to the long life cycle of date palm, 6-7 years for first flowering and slow growth habit (Simmonds, 1979). It usually takes 30 years to complete three back crosses and to obtain the first offshoots from the inter-varietal crosses. During past centuries, many new date palm inter-varietal hybrids were selected from the natural open pollinated seedling populations. The first inter varietal date palm breeding attempt on the cultivar Deglet Noor was carried out in 1912 at Arizona (Anon, 1982). Nixon and Farr started date palm breeding program at USDA during 1948 (Nixon and Far 1965; Carpenter and Reem, 1976) and their date palm breeding program was terminated in 1978 (Krueger, 1998). Inter-varietal hybridization trials were carried out in many countries for developing Boyoud resistance (Saaidi et al., 1981) and improved fruit quality (Carpenter, 1979).

In date palm cultivation, pruning, pollination, fruit thinning, bunch removal and fruit picking are highly essential for good quality fruit production. The cost of date production increases when the trees grow taller due to the high labour cost in many of date producing countries. Mechanization is also expensive and unjustifiable in the case of small growers. Frequent climbing for fruit picking is highly dangerous in the case of taller old trees. Tree height is one of the major constraints to good quality date production. In order to develop dwarf date palms, a dwarf species *Phoenix pusilla* was crossed with selected cultivars of female date palms in our Biotechnology Program of Kuwait Institute for Scientific Research (KISR). The interspecific crossing was successful, however, the hybrid embryos aborted due to poor endosperm formation during seed development. Therefore, we used *in vitro* embryo rescue technique and produced few interspecific hybrids. Details of the study are presented in this paper.

Materials And Method

Dwarf date palm pollen was collected from the male dwarf date palm (Phoenix pusilla) introduced and maintained at KISR campus (Sudhersan, 2004). The dry pollen were stored in the refrigerator for the experiments. Female date palm cultivars Barhi, Majdhool and Sultana were selected from the tissue culture date palm orchard established in 2000 at KISR campus Kuwait. During the date palm flowering season, unopened female flowers of the selected date palm cultivars were opened with a surgical knife and the *Phoenix pusilla* pollen was dusted over the female flowers and covered immediately with paper to avoid date palm pollen mixing (Figs 1,2). After the fruit set, the seed development was observed periodically by dissecting different stages of fruit development. Hybrid embryos were developed and aborted at the fruit maturity stage. Therefore, immature hybrid embryos were isolated carefully and through *in vitro* embryo rescue, hybrid plants were produced. The rooted hybrid plantlets were successfully acclimatized in a temperature and humidity controlled greenhouse, and hardened for about 6 months. Hardened interspecific hybrid plants were transferred to the field and maintained in the tissue culture date palm orchard for further field evaluation.

Result And Discussion

The interspecific hybridization between date palms and *Phoenix pusilla* was successful. The pollen of the P. pusilla affected the fruit development during the first two stages hababouk and kimri (Zaid and De Wet, 2002) and morphology at the stages of Khalal and Tamar stages. Initially fruit development was similar to normal fruit development but during later stages, fruit morphology changed. The size of fruit in Barhi was smaller than the fruit size attained by normal date palm pollen, while in the other two cultivars, Madjhool and Sultana, fruits were larger in size than the normal fruits. Previous reports on such interspecific crosses revealed that pollen from *Phoenix reclinata, P. caneriencis, P. robelenis* and *P. rupicola* crossed with date palm for the fruit quality improvement failed to produce better quality fruits, while the cross between the date palm and *P. sylvestris* produced slightly larger fruits than the normal (Nixon, 1935).

Seed development occurred at the early stages but arrested at the later stages due to less endosperm development. In the early stages, seeds showed embryo development but the embryos were aborted at the final stage. Therefore, seeds of hababouk, kimri, khalal and Rutab stages were sterilized and placed on MS basal medium with high sucrose under in vitro condition. Seeds from different stages showed different responses according to their stages of development. Initially, a swelling occurred at the region where the embryo is located. The seeds collected from the kimri stage fruit swelled 100 % and the others failed to swell. After two weeks, the embryo came out of the seed coat from the seeds that responded to the culture medium. The ma-

Fig. 1. Male Parent

Fig. 2. Female Parent

Fig.3. Interspecific hybrid

Fig. 4. Hybrid with fruits

ture hybrid embryos germinated in growth hormone-free culture media.

All hybrid plantlets rescued from the embryos produced adventitious roots and elongated to about 15 cm height after 30 days in MS medium containing 0.1 mg/l NAA. All the plantlets were acclimatized to the open environmental conditions gradually.

The hardened interspecific date palm hybrids were planted in the field for experimentation. After 4 years of field growth the hybrids started producing flowers (Fids. 3, 4). Some of them were males and others were females. The female flowers were pollinated using date palm pollen and fruits were developed. The new interspecific hybrid date palm fruits were entirely different from the mother date palm in fruit colour, fruit shape, and size. The seed size and shape were also changed from the mother (Figs. 5-8). The hybrid palms are taller than the male parent and shorted than the female parent. The field evaluation, yield characteristic features and fruit quality analysis are not yet completed and are ongoing in our laboratory.

Fig. 5. Fruit of male parent and hybrid

Fig. 6. Seed of male parent and hybrid

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Fig. 7. Fruit of hybrid 1

Fig. 8. Fruit of hybrid 2

Photographed By: Omar Ahmed Bin Saif Al-Bosaidy

Mass catches efficacy of a new trap (ELECTRAP™) for Red Palm Weevil (*Rhynchophorus ferrugineus*) (Olivier) (Coleoptera: Curculionidae) compared with traditional traps in date palm orchards

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The results showed the statistical superiority of the Electrap on the traditional trap at different infestation levels

Photographed By: Fahed Abd Al-Hameed

Abstract

A research has been conducted in Jordan valley to detect the efficacy of the Electrap compared with that of traditional traps in capturing Red Palm Weevil (RPW) at different field infestation levels with determined male / female ratio).. And determined the source of the efficiency of the Electrap, and evaluated the permanence of pheromone and kairomone Electraps capsules

In the three experiments all traps were placed randomly between trees in direct sunlight with at least 100 metres between traps ,also readings were taken biweekly for all experiment, in the first experiment the 6 Electraps and 6 traditional traps were placed in four different infestation sites using completely randomized plot design. For the second experiment 6 Electrap and 6 traditional traps were placed in site A using completely randomized design, after one month, capsules were changed to the all traps using Electrap capsules. While in the third experiment 12 Electrap were placed in site A using completely randomized design capsules of 6 Electraps were replaced with new one,six ratio was calculated depend on all RPW caught by all traps

The results showed the statistical superiority of the Electrap on the traditional trap at different infestation levels; the Electrap caught up to 6 times in mean more than the traditional trap did. Six Electraps caught a total of 549 adults over four months, while 66 adults were caught by the traditional traps. Additionally, when the Electrap pheromone and kairomone were placed in both trap types, capture by the traditional traps did not significantly improved, On the other hand, the permanent of Electrap capsules decrease after one month from trap hanging, The female/male ratio ranged from 5.7:1 to 3:1. Finally, a theoretical calculation revealed that one Electrap may control 732 infestation spots/month and 22 thousand infestation spots/30 Electraps/10 hectares.

KEY WORDS

Electrap, RPW, male/female ratio, traditional traps, pheromones, kairomones, infestation spots, maser, date palm, food bait, control capacity

Introduction

Red Palm Weevil (Rhynchophorus ferrugineus) is the most invasive, dangerous and deadly pest on 40 palm species (Sami Al-Saroj 2017) in most palm-planting areas of the world (Abraham, et al. 1998). South and Southeast Asia are the home of RPW, which is considered a major pest of coconut (Lefroy, 1906). Weak quarantine measures permitted the rapid spread of RPW to more than 50 countries (Giblin-Davis et al. 2013). RPW was reported on date palm in the Middle East during the mid-1980s (Zaid ,et al. 2002). Millions of RPW-infested palm trees died, with continuous losses every year, millions of USD were lost. In the GCC countries, 1 and 5% infestation have been estimated to cause losses ranging from $5.18 to $25.92 million, respectively (El-Sabea, et al. 2009). In Jordan, which contains a small area planted with date palm including half a million trees, more than 10 thousand trees have been lost, and losses are ongoing (Mashal& Obaidate, B, 2015).

RPW (all stages: egg, larva, pupa, and adult) spends its life inside the palm itself, resulting in trunk destruction and then tree death (Faleiro, et al. 2003). Adult males and females fly out of the damaged trees to find succulent hosts, mating and depositing thousands of eggs to generate a new infestation and thus causing more losses (Faleiro, et al, 2011, Riley 1894.).

RPW females deposit approximately 300 eggs in separate holes on the palm trunk. These eggs hatch in 2 to 5 days into legless grubs that bore into the interior of the palms, feeding on the soft tissues and discarding all fibrous material. The larval period varies from 1 to 3 months. The grubs pupate in an elongated, oval, cylindrical cocoon made of fibrous strands. At the end of the pupation period, which lasts 14 to 21 days, adults emerge and fly out of the tree, searching for a new host, mating and repeating the infestation (El-Sabea, A. M. R., 2009)

Control strategies for RPW depend on monitoring, protection and treatment using integrated pest management, including sanitation, cultural, mechanical, biological, physical and chemical practices (Dembilio& Jacas. 2012). Monitoring is the first step in control programmes, to detect the infestation very early before it causes tree destruction (Faleiro 2006, Oehlschlager 1994). Monitoring is conducted mainly by direct inspection of the trees or indirectly by using pheromone traps with aggregation pheromones (Hallett,1993). These traps have many functions, which include detecting the first appearance of the insects in the orchard and detecting their population dynamics to determine suitable times for control (Faleiro, 2006). Traps also have an important role in mass trapping (Hallet,t 1999); placing many traps (one trap/1000 m2) will capture and kill adults before they mate and deposit eggs, which would introduce a new generation that exacerbates the infestation (Mashal& Obaidate 2015).

Many pheromone traps have been used to capture adult weevils, including traditional traps (food-baited traps) (Faleiro&Satarkar, 2005) such as PicusanTrapTM and bucket traps (Pic1,Pic2). These traps contain pheromone 625+ and kairomone capsules (Oehlschlager, 2016), fermented fruits, yeast, insecticide, and water in a pail (Faleiro &Satarkar 2005). Manipulation of traditional traps is difficult due to their continuous requirement for field services, such as frequent addition of water, as well as the other components and the regular cleaning of traps contaminated by mud, house flies and other insects and vertebrate s (Pic3), which result in very bad odours (Vacas, et al 2013). Most of the time, traditional traps in the field become inefficient be-

cause of capsule expiration and water drying due to evaporation, which allows the attracted insects to enter and leave the trap container without dying. On the other hand, the traditional traps used in Jordan consist of the body of the trap: a 10-litre white plastic pail (with six vents, two at the lid and four on the side), a onelitre plastic pail placed inside the trap, fermented fruits placed inside the small pail, a pheromone lure capsule (625+) (El-Shafie, &Faleiro 2017) and kairomone bottle (ethyl acetate), ten to fifteen grams of yeast, insecticide powder and water. This trap captures adults by attracting to the very strong scent dispersed from the components of the trap (Wright, 1977). Adults enter through the rounded vents and then are killed by either drowning in water or poisoning from the insecticide. Monthly renewal of the pheromone and kairomone capsules is required. However, renewal of water, yeast, and fermented fruits is conducted based on the dryness of these substances (Vacas, et al. 2013). Overall, the trap needs periodic service to be efficient at all times.

Electrap (Pic4 & Pic5) was invented to overcome all these obstacles and simplify the trap manipulation process. Once the traps are placed in the orchard, no service is needed, except for changing the pheromone and kairomone capsules after some months.

This new black trap, which has a flying saucer shape, was invented to capture RPW adults (Pic6), disable them using pulsed MASER (Microwave Amplification by Stimulated Emission of Radiation) emissions (Callahan 1965, Laithwaite 1960) and let them die (Pic 7). Inside the Electrap device core are the specially designed Phero-Kairo 925+, a pheromone lure (Ferrolure) (Oehlschlager 2016) and the kairomone formulation (ethyl acetate) (Al-Saoud 2013). No addition of water, insecticide, food bait, or yeast is needed. This invention has already been granted a patent by the UAE as well as the GCC.

This experiment was conducted to evaluate the efficacy of the Electrap in the capture of RPW adults; to make a comparison between the Electrap and the traditional traps that are already used in Jordan; to determine the importance of traps in control management +

programmes; to determine the main cause of effectiveness of these traps, i.e., whether it is caused by the chemical composition of the pheromone and the kairomone or by the composition of the trap itself; and finally to detect the male/female ratio in the captured weevils.

Material and method

to achieve the efficacy of the Electrap in capturing RPW compared to the traditional trap under different infestation level an experiment was conducted on 11Sept 2017 and finished on 11Jan 2018 (four months) in the Jordan Valley (area infested by RPW) in four sites, each site was one hector ,all the trees on the four sites were of nine to ten years old. the selection of the sites according to the infestation density of RPW (high, medium and low),Site(A)the infestation reached more than 70% of the trees;,Site (B) the infestation reached more than 50% of the trees, Site(C) infestation reached more than 20% of the trees ,Site(D) infestation reached less than 5% of the trees

the experiment was conducted using completely randomized plot design, with six replicate using six Electraps six traditional traps that 12 traps were placed in each experimental sites at the four sites (four treatments with four infestation levels), capsules of both pheromones and kairmones of Electrap were placed inside the Electrap capsules chamber and they didn't change at all experiment period(four months) while pheromones and kairmones of traditional traps were changed

monthly for traditional traps and the other content as yeast, water ,insecticide and 100gm of ripened date fruits) were changed every two weeks.

For the second experiment; the evaluation of the efficacy of Electrap in capturing RPW compared to that of the traditional trap using phermone and kairomone capsules of the Electrap, the experiment was done on 11 Sept 2017 at site A which was the most infested site in order to get good result, it was using completely randomized design by using six replicates as six Electraps and six traditional traps, at the first month the Electrap pheromones and kairmones capsules were used to the Electraps to record the normal efficacy of the both trap types, after one month, pheromones and kairmones capsules were changed for both the traditional traps and the Electrap using Electrap pheromones and kairmones capsules with biweekly renew the content of the traditional traps(yeast, water ,insecticide and 100gm of ripened date fruits), the experiment was finished on 11 Jan 2018.

the third experiment which was conducted to detect the longevity of Electrap capsule pheromones and kairomones under field condition, this experiment was done at site A using Completely Randomised Design with two treatments (changed and non changed capsules) and six replicates using 6 Electraps for each treatment, the experiment was started on 11Sept 2017 , after one months six Electraps pheromones and kairomones capsules were changed and the other six Electrap capsules didn't change their capsules,the experiment was finished on 11 Jan2018 (four months).

All traps In the three experiments were randomly placed in the open spaces amongst trees in direct sunlight, keeping at least 100 metres between each pair of traps to avoid scent interference. On the other hand, to prepare the Electraps for use, pheromone (Phero-Kairo 925+,Ferrolure) and the kairomone formulation (ethyl acetate) capsules were placed in the Electraps, inside the resonance chamber without the addition of water, insecticides or food bait inside Electraps. While the traditional traps were prepared for use in all four locations. By using pheromone (625+) capsule and kairomone (150 ml of ethyl acetate) these capsules were placed under the lid of the trap (10litre white plastic pail), and food bait (fruit), 10 grams of of yeast, water and insecticide were placed inside the traps. Monthly renewal of the pheromone and kairomone capsules, while the water and fermented fruits were renewed biweekly.

Trap readings were taken biweekly; all captured adults were collected, taken to the laboratory and read to determine the male/female ratio. Data were gathered from 11 Sept 2017 to 11 Jan 2018 and analysed by one-way ANOVA for correlated samples using the Tukey High Significant Differences(HSD) test [.05] for the .05 level, HSD [.01] for the .01 level and description analysis.

Results and Discussion

the efficacy of the Electrap compared with that of traditional traps in capturing Red Palm Weevil (RPW) at different field infestation levels.

Table one strongly indicates clear differences between the average numbers of RPW caught by the Electrap and the traditional trap at the four experimental sites. These data show the superiority of the Electrap to the traditional trap at different infestation percentages at the four experimental sites, regardless of the level of RPW field infestation. This result was confirmed statistically using the Tukey test at the .05 and .01 levels, between readings from Electraps and traditional traps.

Table one: Means of RPW Caught by Electraps and Traditional Trap at the Four Experimental Sites

Exp sites	A		B		C		D	
Date	E (M1)	T (M2)	E (M3)	T (M4)	E (M5)	T (M6)	E (M7)	T (M8)
24/09/2017	10.8	2	17	2.7	14.2	2.1	0.3	0
08/10/2017	8.8	1	14.1	1.7	11.5	1	0.3	0
15/10/2017	5.7	1.25	12.4	0.6	8.5	1	0.3	0
29/10/2017	5.8	0.2	11.5	0.6	6.8	1.1	0	0
13/11/2017	12.5	0.2	7.6	2.6	5.2	1.5	0	0
30/11/2017	12.1	4.8	7.5	1.2	4.5	1.5	0	0
15/12/2017	12.2	2.75	6.8	0.04	4.3	1	0	0
30/12/2017	11.8	1.2	4.2	0	4.1	0	0	0
11/01/2018	10.57	1.2	3.9	0	4	0	0	0

Results of Data Analysis at the Four Sites Using the *Tukey HSD Test* [.01]

Significant at	Non-Significant at
M1 vs M2 P<.01	M1 vs M3
M1 vs M4 P<.01	M1 vs M5
M1 vs M6 P<.01	
M1 vs M7 P <.01	
M1 vs M8 P<.01	

Each number represents the mean number of RPW caught by six traps at site A and three traps at experimental sites B, C and D. E = Electrap – T = Traditional trap

Tukey HSD Test [.01] = 25.93

M = means; HSD = the absolute difference between any two samples means required for significance at the designated level. HSD[.01] represents the .01 level.

The results of the statistical analysis show that the Electrap captured significantly more RPW than the traditional trap did at three sites, A, B and C, whereas at the fourth site (D), the orchard infestation was nearly eradicated at one month after the beginning of the experiment, and the Electrap stopped capturing insects at that time, whereas the traditional traps had not captured any weevils at site D from the beginning.

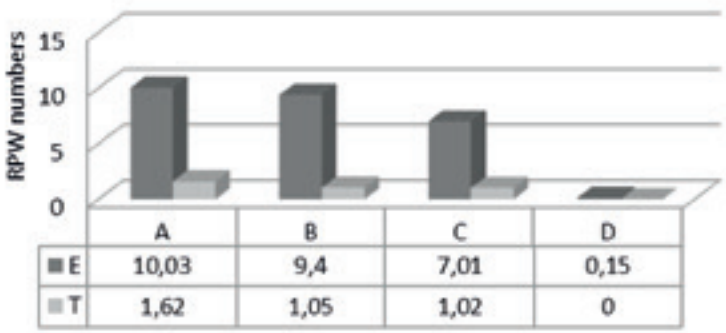
It was noted that the capture rate was directly proportional to the severity of the infestation at the four experimental sites. The rate of adult capture was highest in the infested farm, then the averages gradually decreased to zero at site D. Thus, traps are an important method of capturing RPW to determine the level of field infestations, as well as a part of control programmes.

On the other hand, the Electrap

was more efficient in capturing insects than the traditional traps were (traditional traps were supplied with pheromone, kairomones, food bait, yeast, water, and pesticides, while the Electrap was supplied with only pheromone and kairomone capsules). This conclusion is shown in Fig 1, which represents the average means at the four experimental sites, predicting the ability of both trap types to capture RPW adults, regardless of the level or severity of the RPW infestation in the field or of the time of reading during the year, which correlated with the flight movements of the weevil inside the orchard. The graph showed a clear and significant difference between the traditional trap and Electrap, with great superiority in capture of the latter, which captured 6 times more than the traditional trap did.

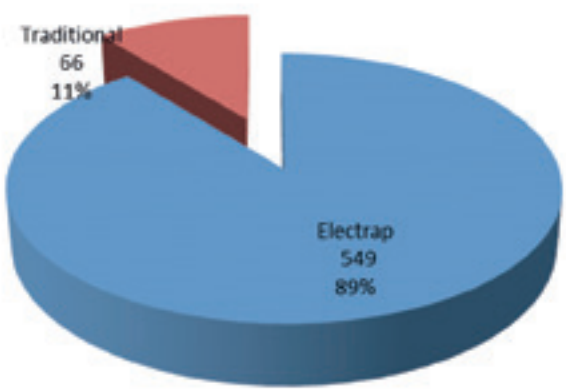
In addition, traps have an important role in control programmes.

Fig 1: Total RPW Captured by Electraps and Traditional Traps at the Four Trial Sites



E(Electrap) ,T(traditional trap)

Fig 2: Total RPW Caught by Both Traps During Four Months at Site A



As shown in Fig 2, which demonstrates trap capture efficiency for RPW adults, six Electraps captured 549 adults during four months (89%), while 66 adults were captured by traditional traps (11%) at the first experimental site (A).

Determination the source of the efficiency of the Electrap,

Fig 3 shows the results of replacing all the pheromone and kairomone capsules of both traditional traps and Electraps with the pheromone and kairomone capsules of the Electrap, two months after starting the experiment at site A. The curves in Fig 4 show the effect of this change on trap capture efficiency. These curves show rapid capture improvement in the Electraps, which continued until the end of the experiment, while the capture improvement in the traditional traps was minor, as shown in the first reading after the arrow showing interference in Fig 3. Then, the capture count returns to its previous level. This result indicated that the technical operating system of the Electrap in spreading the semiochemical code through the space is especially and highly efficient and that its success is not due only to the concentration and composition of the pheromone and kairomone

capsules (Vacas 2016). In addition, the mechanical capture operation of the Electrap is very efficient. In fact, once RPW adults enter the Electrap, they cannot escape, due to the presence of the one-way bristle crown at the entrance. Subsequently, the trapped weevils die rapidly due to dehydration. Then, the dead insects are removed after the traps are filled with dead weevils.

In addition, the principle of the operation system (abbreviated as MASER) (Porcella 2013), where a fully mirrored interior 'resonance chamber' (the core Electrap device), loaded by natural sunlight and incessantly reflecting that light, starts a resonance process that causes the saturation of light reflection inside the chamber (Wright 1977, Laithwaite 1960), thereby emitting infrared electromagnetic radio waves loaded by the lure molecules and so attracting the insects (Vacas,. et al. 2016).

The permanence of pheromone and kairomone Electraps capsules under field condition

Fig 4 represents the effect of renewing the capsules of pheromones and kairomones on the efficiency of RPW capture for a long run (three months as per manufacturer instructions). The black horizontal arrow in this diagram represents the renewal of pheromone and kairomone capsules for 6 Electraps(blue line), while the red line represents the other six Electraps that didn't change their capsule, Curve A showed a rapid improvement in Electrap captured, while there were dramatic declines in adult capture in the unchanged Electrap capsules. However, the general trend of curve A showed the occurrence of an autumn peak in the RPW population in November, which was emphasized by the improvement in trap capture after the renewal of the capsules. Thus, there is a reduction in the effectiveness of capsules after a maximum of two months (under high field temperatures reaching more than 40 degrees Celsius) or three months (at 30 degrees Celsius).

According to this result of decreasing the longevity of pheromone and kairmones per-

Fig3: Fluctuation of RPW populations before and after Electrap capsule replacement

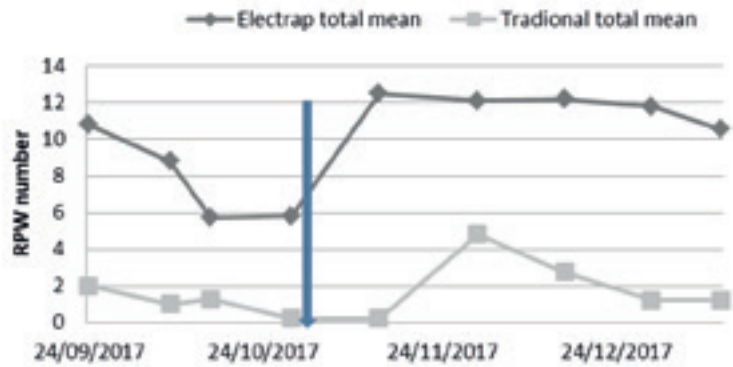
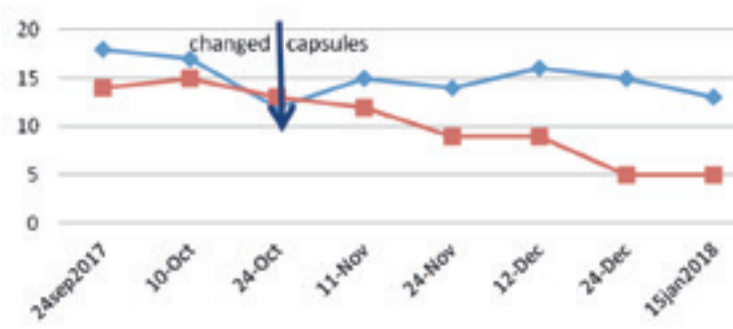


Fig 4: reading of RPW chught by changed and non changed phermoe and kairmone capsules



Preparation of traditional trap

Traditional trap setting

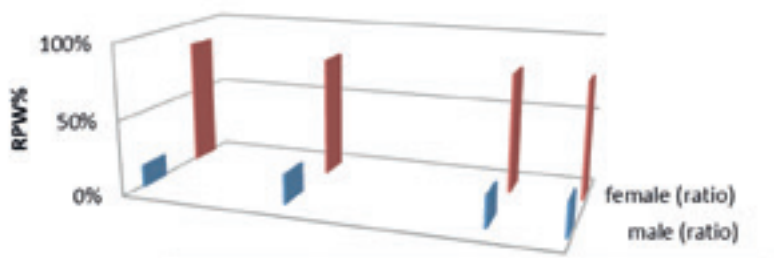
Contaminated traditional trap two weeks after setting

sistence in the field after two months,the Electrap owner company solved the problem of the degradation and the company CIQ (Crop IQ Technology Ltd) exclusively manufactured, in synergy with FIRST – UAE, a new RPW pheromone/kairomone v.41 microencapsulated IQ PHERO-KAIRO 925+ 925 mg IQ RPW lure + (9 parts 4-methyl-5-nonanol & 1 part 4-methyl-5-nonanone) + IQ RPW-Kairomone (ethyl acetate - kairomone). the validity of the new capsules were 6 months at -2- +40 Celsius the efficacy was 5/6 months at +40 Celsius (Safety Data Sheet, January 20, 2018). We have been already started field evaluation to these new capsules under field condition since may2018

Sex ratio

Fig 5 shows the male/female capture ratio; the female percentage was significantly higher than that of the males, ranging from 5.7:1 at the beginning of the experiment to 3:1 at the end, which agreed with Landolt, P.J. (1997). The end coincides with the onset of winter, and the increasing male percentage with the arrival of winter will encourage additional mating and produce a new generation to endure the winter. Notably, the greater number of females captured by traps contributes more to controlling RPW than capturing males would, as females mate many times with one or more males and then lay an average of 250 eggs that will hatch into new RPW individuals. A total of 54,900 RPW could have lived and caused 54,900 infestations.

Fig5: Male/female ratio of RPW caught by traps



	29/10/2017	22/11/2017	22/12/2017	02/01/2018
male (ratio)	15%	20%	21%	22%
female (ratio)	85%	80%	79%	77%

Control capacity

To evaluate Electrap efficiency as a part of an RPW control programme, a theoretical calculation applies as follows:

- 549 total RPW captured by Electrap (Fig 9)/6 traps*4 months = 22.875 RPW/trap/

capsules mounted in Electrap resonance chamber

The Electrap body

RPW landingon Electrap cascade

month.

- 22.875 RPW/trap/month*80% females (Fig 9) * 200 (eggs/adult)*40% (expected natural mortality for different insect stages) = 732 RPW individuals or infestation spots/trap/month.

Thus, if the farmer is placing 30 Electraps/3 hectares (Jordan orchard unit), this will lead to a rapid decrease of the infestation as follows:

- 30*732 = 21,960 RPW individuals or infestation spots/30 traps/month/3hectares.

These 22,000 females, if not captured by the traps, would lead to 22,000 infestation spots (on the same tree or different trees) and, under suitable conditions, cause a disastrous outbreak of the insect population in the orchard and high losses within the infested area and its surroundings.

Therefore, traps such as the Electrap play an essential role and strongly help to control weevils; they should be a part of any control programme for RPW.

Conclusions

The results of the Electrap assessment and the comparison with the traditional trap show that the Electrap is very efficient in capturing RPW adults, reaching up to 6 times more efficient than the traditional trap, even though the traditional trap includes pheromone and kairomone capsules, food bait, yeast, insecticide, and water. Also,the Electrap is simple to operate and easy to handle and process. which is dry and does not need continuous field service, unlike traditional traps, which can lose all efficiency if the water inside evaporates

Although the Electrap costs more than the traditional trap, the nature of the Electrap body makes it able to withstand weather conditions and stay in the orchard for as long as possible. Part of the additional cost can thus be saved in maintenance costs.it is advisable to change the pheromones and kairomones every two to three months so as not to lose full capture capacity.Theoretically, one Electrap may control 732 infestation spots/month and 22 thousand infestation spots/30 Electraps/3 hectares.

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RPW caughtinside the Electrap

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STUDIES ON POLLINATION OF SAIDY DATE PALMS WITH DIFFERENT POLLINATION TECHNIQUES UNDER EL-KHARGA OASIS CONDITIONS

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Results revealed that different pollination techniques had significantly affected the fruit setting and other quality parameters.

Photographed By: Abdulla Ibraheem Al-Saab

Abstract:

The effect of different pollination techniques on fruit set, yield and fruit quality of saidy date palm cultivar were studied during 2013 and 2014 seasons. The experiment was designed to compare the effectiveness of different pollination techniques i.e. Hand pollination as well as artificial methods and their response to fruit setting percentage, yield and fruit quality. The treatments including hand pollination (traditional pollination), dusting of pollens 1.25g plus starch levels namely 1.25 , 5 , 8.25 and 12.5. Dusters was diluted each at 1:1, 1:4, 1:7 and 1:10 ratios and spraying of suspension pollens was at the same previous levels. Results revealed that different pollination techniques had significantly affected the fruit setting and other quality parameters. Is worth mentioning that the dusting pollination and spraying water suspension pollen with the use of starch as a carrier are better than the manual pollination to reduce the amount of pollens used as well as pollination process offers a good treatment of horticultural and economic aspects.

It is worth to mention that water suspension pollen was better than dusting because it combines both mechanical pollination, fruit thinning and reducing the quantity of pollen grain.

Key words: Pollens, pollination, fruit setting percentage, starch, yield and Saidy date palms.

Introduction

Pollination process of date palms is considered the most important horticultural practices in date palms orchards for obtaining an economical yield and fruits with better quality. The traditional method of pollination included the use of seven to ten male strands inside each female spathe just it opens. Pollination is repeated and normally carried out at the day time of morning . It was carried out by ascending the workers on the female date palms. Since this method is a very dangerous for the workers and need more experience and times especially when the palms are taller.

Date palm is a dioecious crop where male (pollen bearing) and female (fruit bearing) inflorescences are on separate palms.

Unisexual flowers of date palm are either pistillate (female) or staminate (male) in character where the male palm produces pollen and female palm bears fruit Popenoe, (1992); Zaid & De Wet, (2002); Vijayalaxmi Kinhal & Parthasarathy, (2008). To ensure good fertilization and overcome disadvantages of dichogamy and also reduce the number of male palms in the field, artificial pollination is carried out in commercial plantations, where pollen harvested from staminate flowers are used for artificial pollination which is done manually as traditionally taken up by date farmers throughout the Middle East or mechanically through pollen dusters.

The first attempt to mechanically pollinate the date palm was reported in India by Bonavia (1885) who applied pollen by pressing a rubber bulb to push pollen through a pipe. That was followed by Monceiro (1952) and Alexander (1952). Since then different methods have been developed. Ground-level dusters, including bloom and palm dusters were used in the USA by Brown and Perkins (1969), Brown et al. (1970), and Perkins and Burkner (1973). Mechanical pollination was also intensively investigated in Iraq by Shabana et al. (1998); Mawlood et al. (1986); Ghalib et al. (1987) and Ibrahim (1988);

Therefore, Previous studied showed that pollination by dusting or spraying pollens mixed with different carriers had an announced effect on yield and fruit quality in various date palm cvs rather than pollination with the traditional method (Mostafa, 1994; El- Kassas et al. 1995; El- Khawaga, 1995 ; El-Shazly, 1999; El- Sese et al, 2000a and 2000b; El- Sese et al, 2001; Hussein and Hassan, 2001; Soliman and El- Kosary, 2002; Ashour et al, 2004; Ragab et al., 2004; El- Agamy et al, 2008; Abdel – Galil et al, 2008; El- Sese et al, 2010; El- Salhy et al 2010 ;Eshmawy, 2010; Iqbal et al 2010; Al-wusaibai et al ,2002; Al- Wasfy,2014 and Ahmed, 2014).

This study aimed to innovate an untraditional method in date palm pollination which combined both mechanical pollination and fruit thinning effect in order to get high yield with good quality.

Materials and Methods

This study was conducted in date palm Research Farm in Agricultural Research Station, at El-Kharga Oasis, New Valley Governorate, Egypt, during two successive growing seasons 2013 and 2014, on 43 years old saidy date palm cultivar (as semi dry date palm cv.)

Eight date palms that are uniform in vigor and in good physical condition, free of insect damage and diseases were selected. The number of spathes per palm were adjusted to ten by removing excess earliest, latest and smallest clusters for achieving of the following nine treatments:

For prepared of fresh pollen grains, eight fully ripening male spathes were detached and the male strands were excised from them.

The pollen Grains were extracted by shaking the strands on a white paper sheet. Then, the pollens were separated from other floral parts by using thin silk bolters (Mesh80). The extracted pollen grains were put in paper sacks till the times of pollination. Pollen viability was tested using the aceto- carmine stain. One drop of 1% ace tocarmine dye was placed on glass slide and then, as mall amount of pollens was dispersed. A cover slip was placed on the slide and allowed to stand for few seconds. Finally; the slides were examined under the microscope for pollen viability. Colorless or unstained pollen grains were considered non- viable. Several counts at various fields were examined to determine the percentage of viability Al- Taher and Asif, (1983).

1- Hand pollination (traditional) T1
2- Dusting of 1.25g Pollen + 1.25g starch (1:1) T 2
3- Dusting of 1.25g Pollen + 5g starch (1:4) T3
4- Dusting of 1.25g Pollen + 8.75g starch (1:7) T4
5- Dusting of 1.25g Pollens + 12.5g starch (1:10) T5
6- Spraying pollen grains suspension (1.25 g pollens/L + 1.25 g starch/L water) T6
7- Spraying pollen grains suspension (1.25 g pollens/L + 5 g starch/L water) T7
8- Spraying pollen grains suspension (1.25 g pollens/L + 8.25 g starch/L water) T8
9- Spraying pollen grains suspension (1.25 g pollens/L +12.5 g starch/L water) T9

These treatments were applied on the same palm. Pollination was uniformed in respect of source and method to avoid residues of metaxenia. The experiment was set up in a complete randomized block design with eight replications of one bunch each. Treatment dusting and sprays were applied at the third day of spathe cracking. Sprays of pollen suspension are thoroughly applied to the bunch by small hand sprayer (1/2 liter capacity) at the amount of 50 ml/ bunch. To prevent contamination of pollens, after the spraying of pollen suspension.

$$\text{Fruit set \%} = \frac{\text{Number of fruits setting on the strand}}{\text{Total number of flowers per the strand}} \times 100$$

Measurements:

Fruit set %:

Fruit set percentage was evaluated after one month of pollination. Five female strands per bunch were randomly selected from each replication. The number of fruit set was recorded, then fruit set percentage was calculated as the equation above.

Yield And Fruit Quality:

Bunches were harvested at tamr stage (last week of September), fruit weight/bunch (kg) was recorded. Twenty-five fruits from each bunch were picked at random for determination of the following physical and chemical fruit characters:

1- Fruit and seed weight (in g), then pulp percentage was calculated
2- Fruit length (L) and diameter (D) were measured by vernier caliper (in cm).
3- Percentages of total soluble solids by hand refractometer.

All the obtained data were tabulated and subjected to the proper statistical analysis of variance using L.S.D. test for recognizing the significance differences among the various treatment means according to the method outlined by (Snedecor and Cochran 1980 and Gomez and Gomez 1984)

Results And Discussion

Fruit Setting Percentage

Because of similarity between the results of the two seasons (no significant interactions between seasons), data were presented as the means of both seasons for fruit set, the data regarding fruit set percentage is given in Table (1). The results show that different pollination techniques significantly affected the fruit set percentage in both years. The significantly highest fruit set (81.51% and 79.40%) as an av. to the two studied seasons were recorded in Hand pollination (T1) and Dusting of 1.25g Pollen + 1.25g starch (T2) which differed significantly from all other treatments. It was followed by dusting of 1.25g Pollen + 5g starch (T3) and spray water suspension pollens 1.25 (g/L) + 8.75 g starch (T8) was recorded (68.40 % and 55.86 %) as an av. the two studied seasons due to pollination respectively .The lowest fruit set (27.42% and 47.83%) as an av. the two studied seasons were recorded in Dusting of 1.25g Pollens + 12.5g starch (T5)

and spraying water suspension pollens 1.25 (g/L) + 1.25g starch (T6) respectively

On the other hand, manual pollination is better than dusting pollination and spraying water suspension pollen with the use of starch as a carrier which dusting pollination is better than spraying water suspension pollen.

These results are in accordance with the findings of Khan and Ghafoor (1993) who reported that maximum fruit set was obtained with adopting of Hand pollination (traditional) method for pollination of Dhakki date. Similar findings were reported by Attalla and Shaheen. (1998) who worked on different pollination techniques on the Sukari and Hellawa of date palm. and Ahmed (2014) who reported that it is necessary for carrying out pollination using water suspension pollen containing 1.25 g pollens + 5.0 g starch/ l water.

Yield index

Fruit set and fruits weight/bunch are considered as index for yield. Data illustrated in table (1) show Effect of different pollination Techniques on Fruit set, and Fruit weight /bunch (kg) of Saidy date palm Cultivar during 2013 and 2014 seasons. It is worth to mention that the fruits weight/ bunch reacted almost similarly in the two studied seasons. As a general view, data presented in

water suspension pollen was better than dusting because it combines both mechanical pollination, fruit thinning and reducing the quantity of pollen grain

mentioned table clearly indicated that fruits weight/bunch was significantly affected by different pollination methods during two studied seasons. There are insignificant differences in fruit set percentage due to pollination by Dusting of 1.25g Pollen + 1.25g starch (T2) and traditional hand pollination (T1)

On the other hand, there was a significant reduction on fruits weight/bunch. It gradually decreased with decreasing the pollen concentration in the mixture of pollination. The reduction on such percentage was associated with decreasing the pollen grain from 1:1 (T2) to 1:10 (T5). However, there was an increasing on the fruit weight/bunch with increasing of the starch concentration in water suspension pollen the use of spray treatments reduce the amount of pollen and this dose had insignificant effect on fruit retention or yield. Therefore, pollen grain suspension lead to increase the pollination efficiency, decrease consumption of pollen grains and reduce the pollination costs and such effects were similar to the fruit thinning effects The above-mentioned results are in agreement with those obtained by Hussein et al (1979), Shabana et al (1998), Ragab et al (2004) and Ahmed, (2014). They stated that pollination is considered the most important difficult and expensive practice to ensure good yield in date palms. The limited quantity of pollen grains are the basis to justify the use of mechanical pollination by sprayers and dusters. The positive action of using pollens with carriers on yield and fruit quality was mainly attributed to their important role in enhancing the efficiency of pollination and fertilization

Fruit quality

A-Physical characteristics:

Data in Table (2) clearly showed that there was significant differences in Fruit weight (g) Fruit length (cm) and Fruit diameter (cm) due to pollination by different pollination Techniques. i.e dusting of pollens 1.25g plus starch levels namely 1.25 , 5 , 8.25 and 12.5. Dusters was di-

luted each at 1:1, 1:4, 1:7 and 1:10 ratios and spraying of suspension pollens was at the same previous levels. Compared with hand pollination

However, there was an increasing on the fruit physical characteristics with reducing of the pollen grains concentration in Dusting was diluted, and starch concentration in suspension So, there was a significant increase in fruit physical characteristics due to pollination with dusting of pollens 1.25 g/L plus 5 g starch (T3), compared with 1.25 g/L plus 1.25 g starch (T2).

The best results dealt with fruit physical properties is observed on palms pollinated with Dusting which was diluted at 1.25 g plus 8.25 g starch (T4)and all spray water suspension pollens treatments .The obtained fruit weight were (8.74 , 8.83 , 10.01, 10.86, 11.47 , 11.11 , 10.83 , 10.68 , and 10.73 g) as an average of two studied seasons due to T1 to T9, respectively.

Such improvement of fruit physical properties i.e. increasing the fruit weight and size might be occurred in response to using diluted pollen grains plus starch concentration for suspension pollination. So, it could be stated that "there is a correlation between fruit weight and fruit set percentage".

These results could be due to the reduction on the fruit set percentage when using the diluted pollen grains. Such reduction in fruit set percentage cause a shortage in the number of fruits per bunch without changing the number of leaves that may induce the better supply of carbohydrates that are manufactured in the leaves. Such effects were similar to the fruit thinning effects in improving the physical fruit properties. So, it could be easily to identify the fruit set percentage which gave the considerable yield characterized by high fruit quality using either different hand pollination or fruit thinning methods.

B-chemical characteristics:

Data in Table (3) indicated that there was significant differences in T.S.S % and fruit moisture % due to pollination by different pollination Techniques. i .e dusting of pollens 1.25g plus starch levels namely 1.25 , 5 , 8.25

and 12.5. Dusters was diluted each at 1:1, 1:4, 1:7 and 1:10 ratios and spraying of suspension pollens was at the same previous levels. Compared with hand pollination.

So, there was a significant increase in T.S.S % and a reduction of the moisture content percentage with reducing of the pollen grains concentration in Dusting was diluted, and starch concentration in suspension lead to a significant improvement of the fruit chemical constituents in terms of increasing the total soluble solids, sugar contents and a reduction of the moisture content percentage.

The reduction of the fruit moisture content is very necessary for improving the quality of such cultivar and resulted in an increase in packable yield. These findings might be due to a reduction in the fruit set percentage by using the diluted pollen grain suspension. Such reduction in fruit setting was effective on lowering the competition that may be occurred between fruits and induce an adequate carbohydrates and other essential foods for the residual ones consequently enhance the fruit maturity and improve its contents of total soluble solids and sugar contents. So, it could be said that the use of diluted pollen grain has a similar effect like the fruit thinning on improving fruit quality.

These results were supported by the results of (Ahmed 2014) who recommend using 1.25 g pollens plus 5.0 g starch/ litre water Al-Sabahi et al (2006) and Alabri et al. (2006) who recommended that the use 0.1 g pollen grains/liter of H2O for Helaly Oman date palm. To get an economic yield with good fruit quality. Moreover, (El- Salhy et al 2010) concluded that pollination of Saidy date palm using pollen grain suspension concentration at 2.5 g/L plus 1g ascorbic acid

In regard of the previously mentioned results, it can be recommended that pollination of the saidy date palm using dusting of pollens 1.25g plus 8.25 g starch or spray pollen grain suspension concentrations at 1.25 g/L plus 5 or 8.25g starch/L water was sufficient to get a high yield with good fruit quality. The advantages of such pollination method is the reduction of manpower and duration of pollination, both contributing to the reduction of the cost of pollination. Furthermore, it does not require a highly trained labors as with the traditional technique. It ensures the possibility of pollinating a palm at several times in a short period of time.

Conclusion

The objective of this experiment was to examine the effect of some pollination technique to innovate an untraditional method in date palm pollination which combines both mechanical pollination, fruit thinning and reducing the quantity of pollen grain It can be said that the spraying water suspension pollen is better than dusting pollination so we recommend using 1.25 g pollens plus 5.0 to 8.25 g starch/ litre water this leads for a harvest good fruits as well as properties provides the amount of pollen and pollination process offering a good treatment of horticultural and economic aspects.

Table 1. Effect of different pollination Techniques on Fruit set, and Fruit weight /bunch (kg) of Saidy date palm Cultivar during 2013 and 2014 seasons

Characteristics. Treat. Year	Fruit set%			Fruit weight/ bunch (Kg)		
	2013	2014	Mean	2013	2014	Mean
Hand pollination (traditional) T_1	83.30	79.72	81.51	10.86	10.55	10.71
Dusting of 1.25g Pollen + 1.25g starch (1:1) T_2	81.25	77.55	79.40	10.50	10.22	10.36
Dusting of 1.25g Pollen + 5g starch (1:4) T_3	69.36	67.44	68.40	9.64	9.50	9.57
Dusting of 1.25g Pollen + 8.75g starch (1:7) T_4	54.3	52.88	53.59	8.73	8.57	8.65
Dusting of 1.25g Pollens + 12.5g starch (1:10) T_5	27.00	27.84	27.42	4.34	4.40	4.37
spray water suspension pollens 1.25 (g/L) + 1.25g starch T_6	49.00	45.83	47.83	8.48	8.25	8.37
spray water suspension pollens 1.25 (g/L) + 5g starch T_7	54.62	51.62	53.12	8.73	8.50	8.62
spray water suspension pollens 1.25 (g/L) + 8.75 g starch T_8	56.43	55.29	55.86	8.84	8.81	8.83
spray water suspension pollens 1.25 (g/L) + 12.5 g starch T_9	55.54	53.52	54.53	8.79	8.66	8.73
L.S.D. 5%	3.62	3.31	3.51	0.81	0.74	0.76

Table 2. Effect of different pollination Techniques on Fruit weight (g), fruit length (cm) and fruit diameter (cm) of Saidy date palm Cultivar during 2013 and 2014 seasons

Characteristics. Treat. Year	Fruit weight (g)			fruit length (cm)			fruit diameter (cm)		
	2013	2014	Mean	2013	2014	Mean	2013	2014	Mean
T_1	8.65	8.83	8.74	3.41	3.46	3.44	2.02	2.05	2.04
T_2	8.74	8.92	8.83	3.44	3.48	3.46	2.04	2.06	2.05
T_3	9.85	10.16	10.01	3.67	3.70	3.69	2.21	2.21	2.21
T_4	10.80	10.92	10.86	3.77	3.80	3.79	2.27	2.29	2.28
T_5	11.45	11.48	11.47	4.00	4.02	4.01	2.33	2.33	2.33
T_6	11.02	11.20	11.11	3.90	3.94	3.92	2.31	2.32	2.32
T_7	10.77	10.89	10.83	3.75	3.78	3.77	2.27	2.28	2.28
T_8	10.65	10.70	10.68	3.76	3.76	3.76	2.27	2.27	2.27
T_9	10.70	10.76	10.73	3.75	3.76	3.76	2.27	2.80	2.29
L.S.D. 5%	0.32	0.27	0.29	0.15	0.13	0.13	0.06	0.04	0.05

Table 3. Effect of different pollination Techniques on T.S.S % , and fruit moisture % of Saidy date palm Cultivar during 2013 and 2014 seasons

Characteristics. Treat. Year	T.S.S %			fruit moisture %		
	2013	2014	Mean	2013	2014	Mean
Hand pollination (traditional) T_1	77.60	78.50	78.05	14.50	14.68	14.59
Dusting of 1.25g Pollen + 1.25g starch (1:1) T_2	77.82	78.6	78.21	14.50	14.60	14.55
Dusting of 1.25g Pollen + 5g starch (1:4) T_3	78.82	78.96	78.89	14.20	14.14	14.17
Dusting of 1.25g Pollen + 8.75g starch (1:7) T_4	79.00	79.62	79.31	13.73	13.55	13.64
Dusting of 1.25g Pollens + 12.5g starch (1:10) T_5	81.00	80.90	80.95	12.06	12.00	12.03
spray water suspension pollens 1.25 (g/L) + 1.25g starch T_6	79.80	80.00	79.90	13.20	13.11	13.16
spray water suspension pollens 1.25 (g/L) + 5g starch T_7	78.88	79.60	79.24	13.70	13.60	13.65
spray water suspension pollens 1.25 (g/L) + 8.75 g starch T_8	78.80	79.50	79.15	13.85	13.70	13.78
spray water suspension pollens 1.25 (g/L) + 12.5 g starch T_9	78.84	79.55	79.20	13.80	13.65	13.77
L.S.D. 5%	1.13	1.12	1.09	1.06	1.03	1.04

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Selection of some Promising Males for Pollination of Three Commercial Date Palm Varieties in Northern State of Sudan

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Barakawi results showed that M3 gave highest yield ,larger and heavier fruits and highest amounts of non- reducing sugars while the lowest yield, smallest and lightest fruits and lowest non- reducing sugars were obtained when the Barakawi palms were pollinated by M4.


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Abstract:-

Male palms used in pollination of date palms in Merowe area were evaluated with the objectives of selecting highly potent male palms to raise standard males which give higher yield and good quality fruits for pollinating Barakawi ,Gondila and Mishrig Wad Khateeb varieties. Experiments were carried out in the successive seasons of 2008 and 2009 The effects of the thirteen male palms (named M1,M2..andM13) on yield, fruit set, fruit physical and chemical properties of the above date palm varieties were studied.

Barakawi results showed that M3 gave highest yield ,larger and heavier fruits and highest amounts of non- reducing sugars while the lowest yield, smallest and lightest fruits and lowest non- reducing sugars were obtained when the Barakawi palms were pollinated by M4. Gondaila and pollen sources interaction showed that male M10 gave the best fruit sets, highest yield and best fruits quality. Male M5 gave poor fruit shape and appearance, but high percentage of non- reducing sugars. Male M4 is incompatible with Gondaila cultivar. Fruit set and physical characteristics of Mishrig Wad Khateeb were not affected by male types. M10 gave the highest yield while M4 pollen resulted in poorest yield .No significant differences of pollen sources on seed physical characteristics of all varieties were seen. No significant differences were observed with regard to pollen type on time of fruit maturity of Barakawi and Gondila cultivars. Male M9 has tendency to duce earliness of fruit maturity (about ten days) when used for pollinating Mishrig Wad Khateeb

male M3 can be recommended for pollination of Barakawi while male M10 is the best pollen source for pollination Gondaila and Mishrig Wad Khateeb varieties. And M6 is alternative male for all cultivars.

Introduction

Since immemorial times, date palm (phoenix dactylifera L.) has been the most predominant fruit tree in northern Sudan and Merowe area is one of the most important date growing regions

of the area. It is a dioecious plant with separate male and female trees. Commercial date palm plantations are hand pollinated. A number of cultivars have been selected for several decades, with the dry Barakawi cultivar dominating northern state.

Gondaila which is an economically viable date palm cultivar of Sudan is known to be sensitive to pollen source. The lucrative enterprise of Gondaila cultivation necessesitates research efforts to find pollen sources that are compatible with Gondaila, boost its yield and improves fruit quality.

There is growing interest in Merowe area in the variety Mishrig Wad Khateeb as a popular variety to be consumed in rutab stage.

Date palm yields in northern Sudan are below the average world standards due to several factors, including failure to have reliable pollen sources. Several investigators found that pollen have direct influence on physical and chemical characteristics of the fruits. (+Al Delimeny 1969, El-Ghayati et al., 1983, El makhtoum et al., 1993, Desouky et al., 1993, Nasr et al., 2006 and Mohamed Eqbal, et al., 2008. while Shukur,(1969) and Jalal et al., (2006) reported that fruits produced from different pollen sources were not significantly different.

The objective of this study was to evaluate the effect of thirteen pollen sources (designated M1 to M13) on fruit sets, yield and fruit quality of Barakawi, Gondaila and Mishrig Wad Khateeb, the commercial date cultivars grown in Merowe area of Northern State in Sudan.

Material and methods:-

Experiments were carried out on karo soil in a farmer's orchard at Tangasyi for Barakawi, on high terrace soil in a farmer's orchard at Merowe area for Gondila and on karo soil in Horticultural Nursery at Elgorair for Mishrig Wad Khateeb in Merowe locality for two seasons (2008-2009). Four uniform, vigorous about 15,10and20 years old female palm trees(for all cultivars respectively), planted 8x8spacing were selected . The selected palms received the same cultural treatments.

On each selected palm trees in both seasons thirteen female spathes of nearly equal size were chosen and the remaining bunches were removed. Hand pollination was carried out by placing three strands from each male within each female spathe. The experimental design was randomized complete block with each male as treatment and bunches as replicates.

Data Collection:-

Morphological data and yield:-

Yield and morphological data of female bunches were taken after the date fruits were fully mature during the second week of September in both seasons. Yield was taken as weight of the fruits/bunch. The morphological characteristics of the bunch includes the number of strand/bunch, number of fruits/strand, average length of strands at the upper, middle and lower part of the bunch.

The economic valve of the fruit was calculated as percentage of unmarketable fruits.

Fruit and seed physical characteristics:

Samples of 20 date fruits were taken at random from each bunch for the determination of physical and chemical fruit properties for each treatment

Ten fruits were randomly selected from each treatment to measure the whole fruit weight (g), pulp weight(g) and seed weight(g) using a sensitive balance .

Vernier caliper was used to determine length, width and flesh thickness of the fruit and length (cm) and width of the seed (cm).

Fruit chemical characteristics:

The flesh of ten fruits was chopped into small pieces, dried in a forced draft oven at 70ºc to

constant weight and ground into fine powder using aWily Mill and stored in a cool place in glass jars for further chemical analysis.

The total sugars, reducing sugars and non-reducing sugars were evaluated according to Lane and Eynonn's electrometric method (AOAC, 1970).Moisture contents were determined.

The obtained data were statistically analyzed by analysis of variance and least significant differences (LDS) at 0.05% significant

Result and Discussion:

Fruit set percentage:

According to observation and fallow up the data of the fruit set indicated that no difference on fruit set on Barakawi and Gondila cultivar was observed among all tested males , expt M4 and M8. The fruit set in Barakawi with regard to M8 differed slightly from 82% to 85 % and M4 showed lowest fruit sets from 34 % to 35% for two seasons. While the results showed no compatibility between M4 and Gondala cultivar and M8 gave the lowest fruit sets percentage (30 % season 2008 and 25 % season 2009). These results confirm the findings of El-G hayati ,1983, Shaheen ,et al. ,1990, Al-Gamdi, 2002, and Eqbal , et al., 2008, that males affect fruit set..

No significant differences in fruit sets in Mishrig Wad Khateeb cultivar due to male sources. All males gave 100% fruit set on both seasons.

The unmarketable fruits (non economic fruits) were examined. M10, M3, M6 and M7 gave the lowest percentage. M4 showed the higher percentage followed by M8 and M5 in all cultivars.

Morphological characteristics of the female bunches and yield:

The data in tables(1-2) represents the morphological characteristics of the bunches. The data revealed that there was no significant difference among number of strands, length of strands, and number of dates per strands in all the bunches for the two seasons of study. That confirms the difference in yield was due to fruit weight rather than number of strands and number of dates / strand.

The fruit yield data of Barakawi cultivar as affected by different pollen source are given in table (1-2). The data indicate that the different male palms produced significantly different yield. The highest yield (12.33, 13.04) kg fruits per bunch was obtained when M3 was used as pollen source followed by M6(11.48,12.59kg) for both seasons respectively. While the lowest fruit yield of (3.78,3.93kg)occurred when M4 pollen were applied followed by M8 (5.61 and 6.33 kg).

Gondila cultivar yield (tables1-2) data indicate that M10 gave the highest yield per bunch (9.81kg to 10.29 kg) followed by M3 and M6 in both seasons. The lowest yield per bunch was obtained when M8 (2.87 kg in 2008 and 3.90kg in 2009) was used followed by M5 in both seasons.

fruit of female palms of Mishrig Wad Khateeb cultivar yields data are given in tables (1-2). The highest yield (14.00 kg in 2008 and 16.67kg in 2009) of fruit per bunch was obtained when M10 was used for pollination followed by M1(13.67-15.67kg in both seasons). The lowest yielding males, M4 gave 6.33 kg in both seasons followed by M8 which gave 8.00 kg in season 2008 and 10.00kg in season 2009. No significant differences between M2, M3, M11 and M13 in season 2008. M2, M6, M7and M13 showed similar results season 2009.

The result proved that the total yield per palm was positively affected by pollen sources ,which agree with , Bache et al. ,1988, Al-Gamdi et al.,2002 and Eqbal, et al., 2008who found similar trend with pollen sources.

Table (1): The morphological characteristics and yield of Barakawi ,Gondila and Mishrig Wad Khateep Bunches seasons 2008 .

Treat-ment	Barakawi				Gondila				Mishrig Wad Khateep			
	No strands	Length of strand (cm)	No. of dates/ strand	Yield/ bunch (kg)	No strands	Length of strand (cm)	No. of dates/ strand	Yield/ bunch (kg)	No strands	Length of strand (cm)	No. of dates/ strand	Yield/ bunch (kg)
Male 1	50	42.89	34	10.61 c	70	47.43	53	6.86 fg	75	37.22	29	15.67 a
Male2	50	42.92	31	8.67 e	72	45.11	50	6.50 gh	74	39.33	28	14.00 abc
Male 3	50	42.89	31	12.33 a	68	47.44	50	8.95 c	74	37.22	29	15.33 ab
Male 4	51	43.25	32	03.78 i	-	-	-	-	73	36.22	29	06.33 e
Male 5	49	42.84	33	06.66 g	68	46.56	52	5.60 l	75	39.56	28	10.67 d
Male 6	47	43.63	34	11.48 b	71	44.56	49	9.34 b	75	41.67	30	14.00 abc
Male 7	49	42.10	34	09.50 d	70	47.56	50	8.06 d	75	42.56	30	14.00 abc
Male 8	47	42.88	31	05.61 h	71	50.33	53	3.90 j	74	36.89	29	10.00 d
Male 9	48	42.59	32	08.28 e	66	48.67	52	6.64 gh	76	40.33	30	12.00 cd
Male 10	48	42.78	31	10.60 c	73	50.44	52	9.81 a	74	38.89	30	16.67 a
Male 11	48	42.73	31	07.78 f	67	45.33	48	7.18 f	75	41.78	31	15.33 ab
Male 12	48	42.81	31	08.53 e	68	46.89	48	6.29 h	7.4	37.33	29	12.33 bcd
Male 13	48	42.52	32	09.18 d	64	44.78	46	7.63 e	7.6	40.00	29	14.67 abc
SE±	3.09	0.33	2.02	0.15	2.51	1.76	1.82	0.13	0.95	1.85	0.89	0.93
Sig .level	No	No	No	***	No	No	No	***	No	No	No	***
CV%	11.01	1.76	10.93	3.05	6.32	6.46	6.27	3.06	2.20	8.21	5.28	12.81

Means in the same column followed by the same letter (s) are not significantly different at P=0.05 according to Duncan's Multiple Range test.

Table (2): The morphological characteristics and yield of Barakawi ,Gondila and Mishrig Wad Khateep Bunches seasons 2009.

Treat-ment	Barakawi				Gondila				Mishrig Wad Khateep			
	No strands	Length of strand (cm)	No. of dates/ strand	Yield/ bunch kg)(	No strands	Length of strand (cm)	No. of dates/ strand	Yield/ bunch (kg)	No strands	Length of strand (cm)	No. of dates/ strand	Yield/ bunch (kg)
Male 1	47	40.33	34	11.44 c	76	40.78	35	07.59 ef	72	38.55	29	15.67 a
Male2	47	39.78	33	9.69 f	75	38.56	36	06.83 f	71	39.55	28	14.00 abc
Male 3	46	39.56	34	13.04 a	75	40.22	37	09.60 abc	74	38.85	29	15.33 ab
Male 4	46	39.67	34	03.93 j	-	-	-	-	72	39.00	29	06.33 e
Male 5	48	40.33	34	06.89 h	75	39.56	37	04.84 g	74	39.44	28	10.67 d
Male 6	48	40.33	34	12.59 b	76	42.45	34	09.93 ab	74	40.89	30	14.00 abc
Male 7	49	39.67	34	10.51 d	74	38.33	35	08.92 bcd	73	39.22	30	14.00 abc
Male 8	47	39.99	34	06.33 i	74	37.55	35	02.87 h	72	39.16	29	10.00 d
Male 9	49	40.00	34	09.61 f	75	39.44	36	07.59 ef	73	39.78	30	12.00 cd
Male 10	47	39.89	34	11.68 c	74	37.22	35	10.29 a	72	39.56	30	16.67 a
Male 11	48	39.99	33	08.71 g	73	39.11	35	08.42 de	73	38.89	31	15.33 ab
Male 12	49	40.00	34	09.85 ef	74	37.00	36	08.66 cd	72	38.66	29	12.33 bcd
Male 13	48	40.00	34	10.26 de	75	36.67	36	08.94 bcd	73	39.11	29	14.67 abc
SE±	1.53	0.59	0.62	0.15	1.56	1.90	0.91	0.032	1.26	0.64	0.89	0.93
Sig .level	No	No	No	***	No	No	No	***	No	No	No	***
CV%	5.57	2.58	3.19	2.68	3.62	8.48	4.42	7.08	3.00	2.81	5.28	12.81

Means in the same column followed by the same letter (s) are not significantly different at P=0.05 according to Duncan's Multiple Range test. .

Fruit and seed physical characteristics:

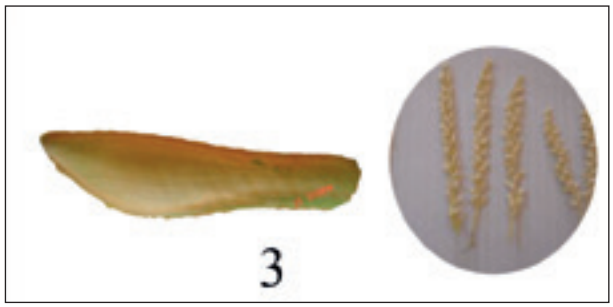
Tables (3-8) illustrate the effect of pollen sources in fruit physical characteristics (length, width, thickness, fruit and pulp weight) at tamor stage. The results show highly significant difference on fruit characters in both seasons.

For Barakawi the fruit resulting from pollination by M3 was larger and heavier than other males followed by M1, M6 and M10 which were more or less similar. The smallest and lightest fruits were obtained when pollinated by M4 and M5 in both seasons. The data of Gondila, tables (5and 6) was greatly influenced by pollen sources in both sea-

Table (3): Effect of male sources on fruit and seed physical characteristics of Barkawi cultivar at tamor stage (2008).

Treatment	Fruit length (cm)	Fruit width (cm)	Fruit thickness (cm)	Fruit weight (g)	Pulp weight (g)	Seed length (cm)	Seed width (cm)	Seed weight (g)
Male 1	4.84 abc	2.05ab	0.45 abc	8.15 ab	7.25 ab	2.77	0.70	0.90
Male 2	4.59 de	1.84 def	0.38 de	7.79 abcd	6.91 abcd	2.63	0.69	0.88
Male 3	4.94 a	2.12a	0.48 a	8.32 a	7.42 a	2.70	0.71	0.91
Male 4	4.08 I	1.65g	0.38 de	6.39 g	5.46 g	2.62	0.71	0.93
Male 5	4.20 hi	1.68 g	0.36 e	6.60 fg	5.74 fg	2.61	0.70	0.86
Male 6	4.90 ab	2.08 ab	0.46 abc	8.21 ab	7.32 ab	2.66	0.71	0.89
Male 7	4.7 bcd	1.95 bcd	0.45 abc	7.97 abcd	6.99 abcd	2.69	0.69	0.96
Male 8	4.35 gh	1.72 fg	0.38 de	7.03 ef	6.12 ef	2.62	0.68	0.85
Male 9	4.55 ef	1.79 efg	0.41 bcde	7.67 bcd	6.84 bcd	2.57	0.68	0.83
Male 10	4.79 abc	2.00 abc	0.47 ab	8.09 abc	7.11 abc	2.76	0.72	0.96
Male 11	4.39 fg	1.70 fg	0.40 cde	7.40 de	6.45 de	2.66	0.72	0.95
Male 12	4.49 efg	1.74 fg	0.43 abcd	7.56 cde	6.65 cde	2.69	0.70	0.92
Male 13	4.67cde	1.89 cde	0.42 abcd	7.90 abcd	7.04 abc	2.64	0.70	0.86
S.E±	0.06	0.05	0.02	0.18	0.17	0.07	0.01	0.04
Sig level	***	***	**	***	***	No	No	No
Cv%	2.18	4.23	8.53	3.98	4.36	4.43	3.39	7.02

Means in the same column followed by the same letter (s) are not significantly different at P=0.05 according to Duncan's Multiple Range test.



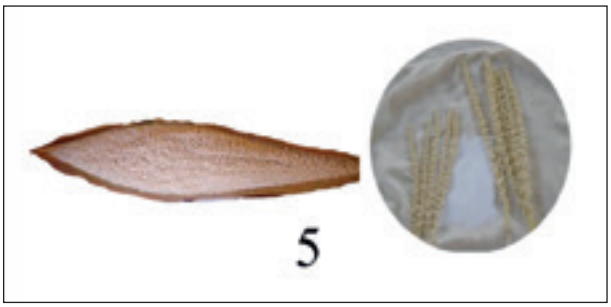
sons. M10 which produced heaviest, largest and thicker fruits surpassed other males followed by M6 and M3. M5 gave the poorest fruit quality which were smallest ,shortest and had less fruit weight followed by M8. M7 and M13 resulted in better quality fruits compared to remaining males in these studies. These result are in line with Nasr et al.,2006,El-Makhtoum and Abdel Kadar, 1993, Al-Ghamdi, 2002 ,Marzouk et al.,2002, and Eqbal, et al., 2008who observed variation in fruit physical characteristics with pollen source.

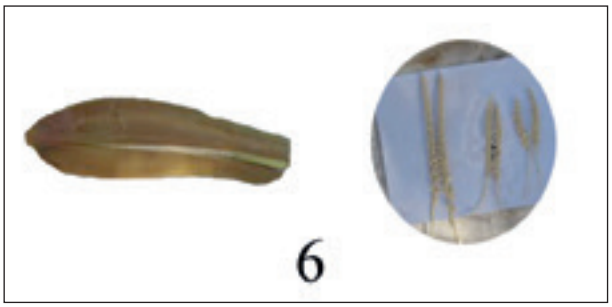
Tables (7and 8) illustrate the effect of pollen sources on Mishrig Wad Khateeb fruit. The results indicated that there were no sig-

Table (4): Effect of male sources on fruit and seed physical characteristics of Barkawi cultivar at tamor stage (2009).

Treatment	Fruit length (cm)	Fruit width (cm)	Fruit thickness (cm)	Fruit weight (g)	Pulp weight (g)	Seed length (cm)	Seed width (cm)	Seed weight (g)
Male 1	4.88 ab	2.36 b	0.54 abc	11.51 abc	10.22 abc	2.31	0.99	1.28
Male 2	4.56 cd	2.25 de	0.51 bcde	11.25 def	10.01 cde	2.36	0.93	1.24
Male 3	4.99 a	2.42 a	0.59 a	11.65 a	10.37 a	2.37	0.94	1.28
Male 4	3.99 g	1.99 h	0.46 e	10.20 j	08.95 h	2.35	0.92	1.25
Male 5	4.14 fg	2.03 h	0.47 de	10.47 I	09.17 h	2.37	0.99	1.30
Male 6	4.94 a	2.39 ab	0.56 ab	11.58 ab	10.29 ab	2.30	0.95	1.29
Male 7	4.73 bc	2.30 cd	0.50 bcde	11.39 bcd	10.09 bcd	2.29	0.97	1.30
Male 8	4.32 e f	2.12 g	0.46 e	10.84 h	09.58 g	2.31	0.94	1.26
Male 9	4.44 de	2.23 ef	0.48 c de	11.17 ef	09.90 def	2.34	0.96	1.28
Male 10	4.83 ab	2.34 bc	0.52 bcde	11.45 abcd	10.19 abc	2.34	0.95	1.26
Male 11	4.26 ef	2.12 g	0.49cde	10.92 gh	09.67 fg	2.29	0.95	1.25
Male 12	4.40de	2.20 f	0.51 bcde	11.05 fg	09.78 efg	2.34	0.96	1.28
Male 13	4.63 c	2.28 de	0.53 bcd	11.31 cde	10.06 bcd	2.32	0.93	1.26
S.E±	0.06	0.02	0.02	0.07	0.08	0.02	0.02	0.02
Sig level	***	***	***	***	***	No	No	No
Cv%	2.30	1.53	6.79	1.06	1.87	1.36	2.23	2.51

Means in the same column followed by the same letter (s) are not significantly different at P=0.05 according to Duncan's Multiple Range test. .





nificant differences on all fruits physical characteristics on both seasons.

These results are in line with Shukur,1969 , Al-Ghamdi,1988 and Jalal et al., 2006 who reported that male effect may differ from female to female. Thus, there seems to be what could be termed interaction between the pollen source and the female receiving it.

No significant differences due to pollen sources were observed in seed characteristics in both seasons for all cultivars.

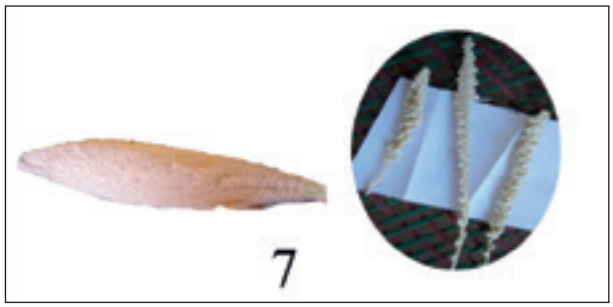
Chemical characteristics of the fruit at tamor stage:

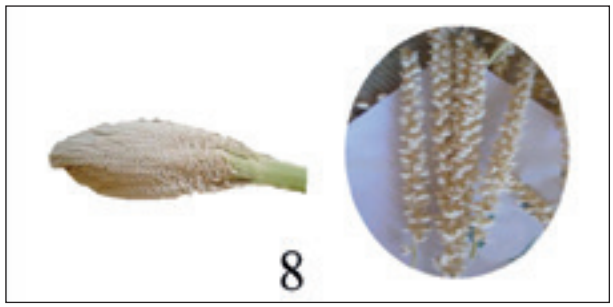
The data presented in table (9) reveals that moisture and sugar

Table (4): Effect of male sources on fruit and seed physical characteristics of Barkawi cultivar at tamor stage (2009).

Treatment	Seed length (cm)	Seed width (cm)	Seed weight (g)	Seed length (cm)	Seed width (cm)	Seed weight (g)
Male 1	2.77	0.70	0.90	2.31	0.99	1.28
Male 2	2.63	0.69	0.88	2.36	0.93	1.24
Male 3	2.70	0.71	0.91	2.37	0.94	1.28
Male 4	2.62	0.71	0.93	2.35	0.92	1.25
Male 5	2.61	0.70	0.86	2.37	0.99	1.30
Male 6	2.66	0.71	0.89	2.30	0.95	1.29
Male 7	2.69	0.69	0.96	2.29	0.97	1.30
Male 8	2.62	0.68	0.85	2.31	0.94	1.26
Male 9	2.57	0.68	0.83	2.34	0.96	1.28
Male 10	2.76	0.72	0.96	2.34	0.95	1.26
Male 11	2.66	0.72	0.95	2.29	0.95	1.25
Male 12	2.69	0.70	0.92	2.34	0.96	1.28
Male 13	2.64	0.70	0.86	2.32	0.93	1.26
S.E±	0.07	0.01	0.04	0.02	0.02	0.02
Sig level	No	No	No	No	No	No
Cv%	4.43	3.39	7.02	1.36	2.23	2.51

Means in the same column followed by the same letter (s) are not significantly different at P=0.05 according to Duncan's Multiple Range test.



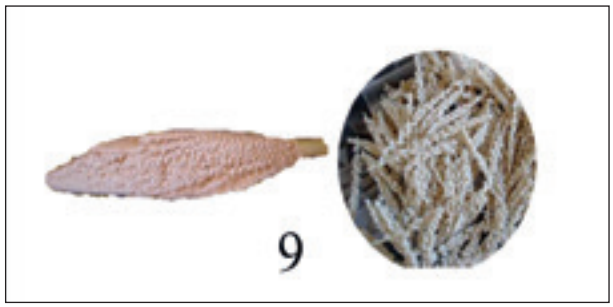


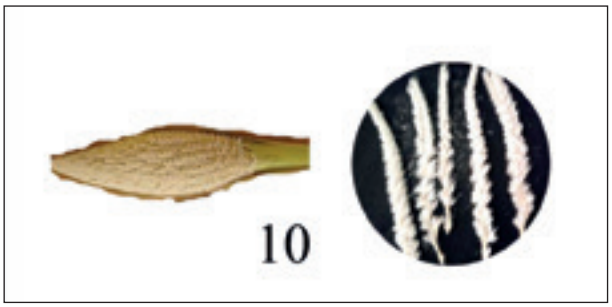
contents significantly differed due to effects of pollen types for three cultivars. In Barakawi M6 gave the highest moisture content followed by M7 while the lowest moisture content was found when palms were pollinated with M13, other males were in between. The highest value of moisture content of Gondaila occurred when was pollinated with M3 and M6 followed by M9 and M13 while the lowest moisture content was found in M10 and M11. Mishrig Wad Khateeb moisture contents was highly significantly differed especially M7 which gave the highest value followed by M6and M1while the lowest moisture content found when pollinated

Table (5): Effect of male sources on fruit and seed physical characteristics of Gondila cultivar at Tamor stage (2008).

Treatment	Fruit length (cm)	Fruit width (cm)	Fruit thickness (cm)	Fruit weight (g)	Pulp weight (g)	Seed length (cm)	Seed width (cm)	Seed weight (g)
Male 1	4.21 f	2.25 de	0.50	10.02 h	8.92 fg	2.20	0.97	1.10
Male 2	4.15 gh	2.20 e	0.52	09.61 j	8.55 h	2.18	1.02	1.06
Male 3	4.40 bc	2.31 bc	0.52	11.05 c	9.95 c	2.26	0.94	1.10
Male 4	-	-	-	-	-	-	-	-
Male 5	3.97 I	2.04 f	0.46	08.40 I	7.30 j	2.25	0.94	1.11
Male 6	4.41 b	2.36 ab	0.54	11.25 b	10.09 b	2.23	0.96	1.16
Male 7	4.38 bc	2.28 cd	0.50	10.85 d	9.73 d	2.25	0.93	1.12
Male 8	4.11 h	2.09 f	0.48	09.04 k	7.91 I	2.27	1.00	1.13
Male 9	4.27 e	2.25 de	0.54	10.15 g	9.09 def	2.26	0.92	1.06
Male 10	4.49 a	2.39 a	0.54	11.52 a	10.43 a	2.21	0.94	1.09
Male 11	4.31de	2.25 de	0.50	10.32 f	9.20 de	2.22	0.98	1.11
Male 12	4.18 fg	2.23 de	0.49	09.79 i	8.72 gh	2.17	1.00	1.07
Male 13	4.35 cd	2.27 cd	0.50	10.61 e	9.33 de	2.25	1.01	1.19
S.E±	0.02	0.02	0.02	0.03	0.08	0.05	0.04	0.07
Sig level	***	***	No	***	***	No	No	No
Cv%	0.69	1.61	7.39	0.45	1.55	3.87	7.60	11.09

Means in the same column followed by the same letter (s) are not significantly different at P=0.05 according to Duncan's Multiple Range test.





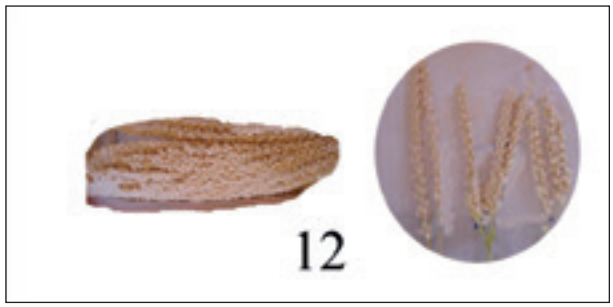
with M11and M3. The variation in moisture content in fruit according to pollen types and female cultivar was reported by El-Ghamdi, 2002, and Shaheen et al., 1989.

Barakawi total sugars were greatly higher when M7, M5, and M6 pollen was used for pollination compared to other pollen. M8 and M11 gave the lowest total sugars, while no significant differences in total sugars were observed among M3,M4 and M12. The results of Gondila indicated that male M10 gave the highest total and reducing sugar percentage compared with other males followed by M13. M2 resulted in the lowest amount. No significant dif-

Table (6): Effect of male sources on fruit and seed physical characteristics of Gondila cultivar at Tamor stage (2009).

Treatment	Fruit length (cm)	Fruit width (cm)	Fruit thickness (cm)	Fruit weight (g)	Pulp weight (g)	Seed length (cm)	Seed width (cm)	Seed weight (g)
Male 1	4.29 e	2.26 ef	0.51 bc	10.45 de	09.13 ef	2.36	0.97	1.32
Male 2	4.11 fgh	2.19 gh	0.51 bc	10.13 e	08.97 f	2.33	1.00	1.16
Male 3	4.71 bc	2.38 bc	0.53 abc	11.55 bc	10.28 bc	2.33	1.01	1.27
Male 4	-	-	-	-	-	-	-	-
Male 5	3.92 h	2.05 I	0.44 d	09.43 f	08.34 g	2.36	1.05	1.09
Male 6	4.80 b	2.41 ab	0.56 ab	11.83 b	10.45 b	2.43	1.06	1.38
Male 7	4.61 bcd	2.36 bc	0.54 ab	11.42 c	10.12 c	2.29	1.06	1.31
Male 8	3.97 gh	2.15 h	0.44 d	09.17 f	07.88 h	2.29	1.02	1.30
Male 9	4.39 de	2.26 ef	0.51 bc	10.57 d	09.38 de	2.31	1.03	1.19
Male 10	5.08 a	2.44 a	0.58 a	12.42 a	11.13 a	2.34	1.05	1.30
Male 11	4.46 de	2.30 de	0.53 abc	10.63 d	09.47d	2.35	1.02	1.17
Male 12	4.18 fg	2.21 fg	0.48 cd	10.32 de	09.12 ef	2.34	1.03	1.20
Male 13	4.53 cd	2.34 cd	0.54 ab	11.32 c	10.04 c	2.35	1.1	1.28
S.E±	0.07	0.02	0.01	0.05	0.09	0.04	0.06	0.05
Sig level	***	***	***	***	***	No	No	No
Cv%	2.68	1.15	4.72	1.77	1.72	3.07	9.49	6.41

Means in the same column followed by the same letter (s) are not significantly different at P=0.05 according to Duncan's Multiple Range test.



ference with regard to total sugars between M3, M6 and M12. For Mishrig Wad Khateeb the total sugars was greatly higher when M10,M12, and M2 pollens used compared with other pollens and M9,M4 gave the lowest total sugars .

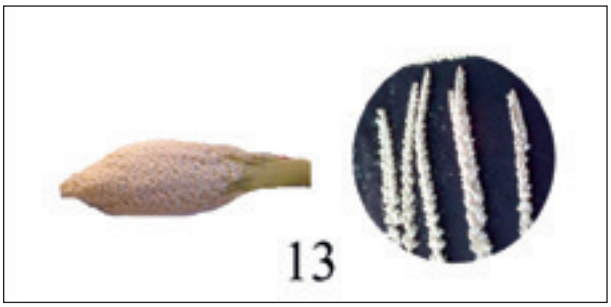
The value of reducing sugars in Barakawi showed that M7, M4and M6 gave the highest percentage and M3,M8 and M13 gave the lowest. No significant differences were observed between M1and M10 treatments. While in Mishrig Wad Khateeb results showed that M2 and M13 gave the largest percentage followed by M10 and M4, M8 gave little ones .

Data in table (9) clearly indi-

Table (7): Effect of male sources on fruit and seed physical characteristics of Mishrig Wad Khateeb cultivars at tamor stage (2008).

Treatment	Fruit length (cm)	Fruit width (cm)	Fruit thickness (cm)	Fruit weight (g)	Pulp weight (g)	Seed length (cm)	Seed width (cm)	Seed weight (g)
Male 1	2.90	2.01	0.40	5.62	4.69	1.84	0.87	0.93
Male 2	2.84	1.99	0.40	5.32	4.41	1.83	0.87	0.88
Male 3	2.76	1.96	0.39	5.48	4.59	1.80	0.86	0.88
Male 4	2.95	2.03	0.40	5.85	4.89	1.86	0.88	0.91
Male 5	2.80	1.94	0.40	5.23	4.38	1.77	0.87	0.85
Male 6	2.93	2.01	0.41	5.98	5.06	1.85	0.88	0.90
Male 7	2.83	2.01	0.39	5.63	4.79	1.79	0.86	0.86
Male 8	2.90	1.92	0.36	5.72	4.90	1.78	0.87	0.86
Male 9	2.78	1.97	0.40	5.67	4.83	1.78	0.87	0.87
Male 10	2.97	2.06	0.40	6.25	5.35	1.86	0.86	0.88
Male 11	2.93	2.03	0.39	6.14	5.20	1.85	0.88	0.91
Male 12	2.94	1.95	0.40	5.72	4.85	1.86	0.87	0.89
Male 13	2.85	1.96	0.40	5.26	4.33	1.82	0.86	0.89
S.E±	0.07	0.03	0.01	0.29	0.29	0.04	0.01	0.03
Sig level	No	No	No	No	No	No	No	No
Cv%	4.07	2.56	3.91	8.92	10.50	3.37	1.31	5.22

Means in the same column followed by the same letter (s) are not significantly different at P=0.05 according to Duncan's Multiple Range test.



Gondaila and pollen sources interaction showed that male M10 gave the best fruit sets, highest yield and best fruits quality.

cated that M3 and M5 produced high percentage of non reducing sugars in Barakawi followed by M13 and M9, while the lowest non reducing sugar percentage was produced when palms were pollinated with M8,M11 and Gondila pollinated by M3 caused the highest significant accumulation of non reducing sugars followed by M6.. M7 gave the smallest amount of non reducing sugars .

The present data in Mishrig Wad Khateeb indicated that M8, M1 and M12produced highly percentage of non reducing sugars, while the lowest percentage produced when pollinated with M2 and M13,where there no significant differences between

Table (8): Effect of male sources on fruit and seed physical characteristics of Mishrig Wad Khateeb cultivars at tamor stage (2009).

Treatment	Fruit length (cm)	Fruit width (cm)	Fruit thickness (cm)	Fruit weight (g)	Pulp weight (g)	Seed length (cm)	Seed width (cm)	Seed weight (g)
Male 1	3.03	2.01	0.46	7.24	6.24	1.93	0.89	0.97
Male 2	3.10	2.01	0.46	7.68	6.69	1.95	0.90	0.99
Male 3	3.06	2.14	0.47	7.33	6.34	1.98	0.92	0.99
Male 4	3.04	2.14	0.46	7.80	6.79	1.98	0.91	1.01
Male 5	2.98	2.20	0.45	7.62	6.63	1.97	0.92	0.99
Male 6	2.92	2.15	0.45	7.30	6.29	1.90	0.91	1.01
Male 7	3.04	2.17	0.45	7.51	6.52	1.95	0.91	0.98
Male 8	2.95	2.13	0.45	7.23	6.24	1.93	0.89	0.99
Male 9	2.90	2.15	0.45	7.28	6.32	1.93	0.90	0.96
Male 10	3.17	2.20	0.48	7.74	6.71	1.97	0.94	1.02
Male 11	3.06	2.19	0.47	7.36	6.39	1.94	0.91	0.98
Male 12	3.12	2.30	0.48	7.36	6.35	1.97	0.93	1.01
Male 13	2.99	2.21	0.47	7.27	6.26	1.95	0.94	1.01
S.E±	0.06	0.07	0.01	0.25	0.24	0.02	0.02	0.03
Sig level	No	NO	No	No	No	No	No	No
Cv%	3.47	5.58	2.77	5.65	6.39	1.87	3.75	4.95

Means in the same column followed by the same letter (s) are not significantly different at P=0.05 according to Duncan's Multiple Range test.

Table (9): Effect of male sources on fruit chemical characteristics(on dry bases) of Barakawi ,Gondila and Mishrig Wad Khateep cultivars at tamor stage (2008).

Treatment	Barakawi				Gondila				Mishrig Wad Khateep			
	Moisture %	Reducing sugar %	Non Reducing sugar %	Total sugar %	Moisture %	Reducing sugar %	Non Reducing sugar %	Total sugar %	Moisture %	Reducing sugar %	Non Reducing sugar %	Total sugar %
Male 1	09.05 g	49.45 d	10.55e	60.56 d	11.21 cd	59.70 c	2.10 h	61.91 c	11.66 b	67.58 de	6.02 b	73.92 cd
Male 2	10.64 d	48.02 e	10.70 e	59.28 e	10.96 de	46.86 l	5.25 e	52.39 h	09.87 f	72.78 a	1.80 f	74.67 abc
Male 3	10.17 e	43.46 g	18.09 a	62.50 c	12.23 a	50.55 k	9.86 a	60.92 d	10.31 e	67.48 d	4.22 c	72.92 e
Male 4	11.10 c	57.43 b	04.68 i	62.36 c	-	-	-	-	09.65 f	66.76 e	2.21 e	69.08 h
Male 5	10.07 ef	47.93 e	17.43 b	66.27 a	11.56 bc	53.56 g	5.33 e	59.17 f	11.03 cd	67.89 d	3.99 cd	72.09 f
Male 6	13.31 a	56.83 b	07.66 fg	64.89 b	13.30 a	50.89 j	9.20 b	60.57 d	11.66 b	69.73 c	1.94 ef	71.76 f
Male 7	12.80 b	59.53 a	06.63 h	66.51 a	11.66 bc	55.19 f	1.53 i	56.77 g	12.16 a	69.90 c	4.11 cd	74.23 bcd
Male 8	09.15 g	47,05 f	02.78j	49.98 f	10.84 de	58.32 e	3.13 g	61.61 c	11.31 bc	64.97 f	8.26 a	73.66d
Male 9	09.90 ef	47.88 e	12.40 d	60.93 d	11.94 ab	58.98 d	4.83 f	64.05 b	10.91 d	66.90 e	3.84 d	70.94 g
Male 10	09.80 f	50.11 d	07.95 f	58.48 e	10.53 e	61.43 a	4.99 ef	66.68 a	10.55 e	70.88 b	4.04 cd	75.13 a
Male 11	09.99 ef	48.19 e	02.31 j	50.62 f	10.57 e	52.58 i	6.80 d	59.74 e	09.50 f	70.13 bc	3.92 cd	74.26 bcd
Male 12	11.18 c	55.73 c	07.25 g	63.35 c	10.84 de	52.88 h	7.76 c	61.04 d	10.33 e	68.47 d	6.15 b	74.94 ab
Male 13	7.75 h	46.85 f	13.59 c	61.14 d	11.99 ab	60.67 b	3.32 g	64.17 b	09.74 f	72.53a	1.82 f	74.45 abcd
SE±	0.10	0.28	0.18	0.37	0.16	0.10	0.11	0.16	0.12	0.32	0.11	0.25
Sig level	***	***	***	***	***	***	***	***	***	***	***	***
CV%	1.67	0.97	3.29	1.07	2.47	0.30	3.60	0.46	1.93	0.80	4.73	0.60

Means in the same column followed by the same letter (s) are not significantly different at P=0.05 according to Duncan's Multiple Range test.

M5, M7, M10, ,M11.

These observations are in line with Shaheen et al., 1989, Soliman and Osman, 2001, Marzuk et al. ,2002.Al-Gamdi, 2002. and Nasr et al,2006, who reported that there is a lot of variation in sugar contents due to pollen types .

According to observations and follow up no economically feasible effect of pollen sources on time of ripening was observed on Barakawi and Gondila cultivars. These results are agreeable with Brown and Bahgat (1938) and Perean-Leroy (1958) who reported no effect of pollen sources on date ripening. While in Mishrig Wad Khateeb there were differences in effect on time of ripening were found among different males tested, M9 gave the highest ripe fruit percentage (more than ten days) followed by M3and M13while there was no different among other male types on both seasons. This result are on line to Al- Delaimy 1969 , and Al-Gamdi, 1988.

Conclusion:-

Evaluation of the males under study as pollen source for pollination of Barakawi palms indicates that male M3 is a potent male for Barakawi pollination followed by M6. These males gave the best fruit quality and higher yield compared with pollination by other males. M4, M5 and M8 showed poor yield and fruit quality when used as pollen source for pollinating Barakawi.

Male M5 gave poor fruit shape and appearance, but high percentage of non- reducing sugars. Male M4 is incompatible with Gondaila cultivar.

For pollination of Gondila cultivar results indicates that M10 is a potent male source for Gondaila which gave the best fruit quality (largest, heaviest fruit and maximum amount of sugars) and higher yield compared with other males followed by M6. M5 and M8 showed lower yield and poor fruit quality .M4 indicated that it is not compatible when used as pollen source for Gondila.

Results also indicated that no significant differences with regard to seed characteristics and no differences in time of ripening among different males tested were found on two cultivars.

Mishrig Wad Khateeb physical characteristics of fruit and seed were not affected by male types. M10 gave the highest yield and largest amount of total sugars. M4 resulted in low yield and low amount of total sugars.

Male M9 pollen gave a ten days earlier ripening fruit percentage which has hardly any effect in the market of dates in Northern State but can use M9 in a rainy areas. From the above results it can be concluded that Mishrig Wad Khateeb can be pollinated by any males but M10 is best ones which gave higher yield and best total sugars

Recommendation:

Evidence from the study indicates that male M3 can be recommended for pollination of Barakawi variety while male M10 is the best pollen source for pollination Gondaila and Mishrig Wad Khateeb varieties. And M6 is alternative male for all cultivars.

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