(39) - 24/9/11

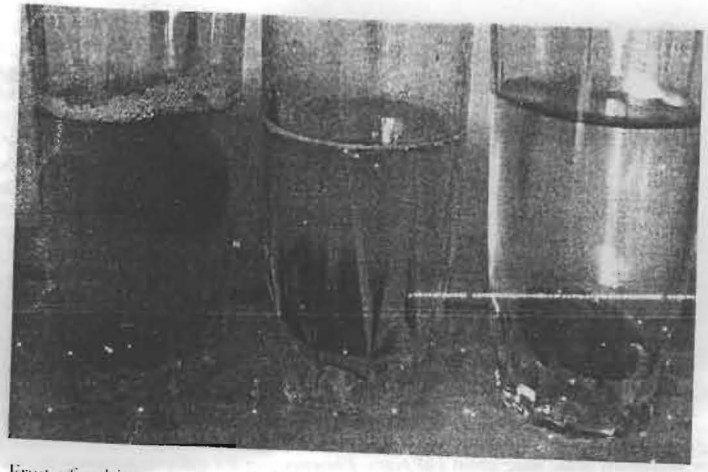

Fig. 3. Fruit of cultivars such as 'Mejhool' at left, 'Khodari' center and 'Deglet Noor' at right sink at first only to rise up when enough gases are trapped in their cavity to float them (e.g., 'Majhoul' at left). Some extra-dry individual fruits of 'Deglet Noor' (not shown) can float at first immersion.

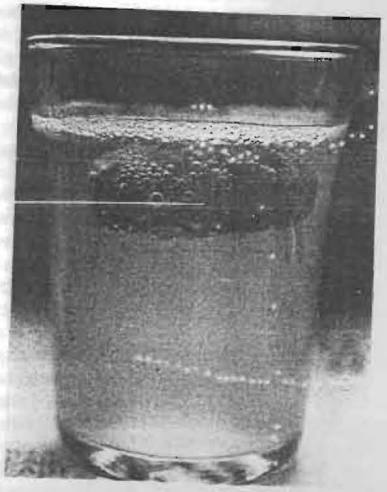

Fig. 4. 'Deglet Noor' here shown floating 3 days after first sinking. They will sink again if, either the gas in them is evacuated or in another week to 10 days time.

Xenic and Metaxenic Effect of *Phoenix pusilla* Pollen on Certain Date Palm Cultivars

C. Sudhersan[a], S. Jibi Manuel and I. Al-Saibah
Biotechnology Department, Food Resources and Marine Sciences Division
Kuwait Institute for Scientific Research
Kuwait

Keywords: *Phoenix pusilla*, date palm, pollination, metaxenia, xenia

Abstract

Pollinated female date palm flowers produce normal date fruits with a seed after fertilization. Un-pollinated flowers produce non-edible parthinocarpic fruits. Pollen from *Phoenix pusilla* which is closely related to the date palm fertilized the female date palm flowers of three date palm cultivars: 'Barhi', 'Majdool' and 'Sultana' which were experimented on. The female date palm trees were produced via tissue culture technology and maintained in the KISR date palm orchard, while plants of *P. pusilla* plants were raised from the seeds. The fruit characteristics of all the three cultivars pollinated by *P. pusilla* pollen were studied and compared with the fruits produced by the date palm pollen for three successive seasons from 2003-2005. The fruit characteristics such as fruit set, diameter, shape, color, maturity time, taste, flesh weight and yield per bunch were recorded. Seed morphology from the khalal, rutab and tamar stages of fruit maturation were recorded. The study showed that pollen of *P. pusilla* fertilizes the date palm flowers similar to the date palm pollen in all the three cultivars experimented. Fruit development was similar up to khalal stage in all the three cultivars studied. Significant variations in fruit and seed characteristics were noticed in the rutab and tamar stages. Fruit maturity was delayed when compared to the normal fruits and the fruits were seedless or with rudimentary seeds at maturity. Further studies of pollination with *P. pusilla* may lead to production of seedless dates and dwarf date palm hybrids.

INTRODUCTION

Date palm is a dioecious species, with staminate and pistillate flowers produced on separate trees. Female flowers are pollinated naturally by wind and effectively by hand pollination in commercial plantations. The female flower has three carpals, one of them develops into fruit after fertilization and the other two abort. The date fruit is technically referred to a drupe having fleshy mesocarp and hardy endocarp with seed. Normal date fruits are highly nutritious and edible. When the pollination fails, all the three carpels develop simultaneously into parthinocarpic fruits. These fruits are smaller than the normal fruits and non edible. They contain fibrous pulp with less sugar and rudimentary seedless endocarp.

Generally, pollens from male date palms were dusted on the female flowers for the normal fruit development in commercial plantations and home gardens. There are reports on direct pollen effect on date palm fruit physical and chemical characters (Swingle, 1928; Abdelal et al., 1983; Nixon, 1928, 1934). Pollens from other related species of date palm like *Phoenix reobelenii*, *P. reclinata*, *P. cameriensis* and *P. rupicola* were also successfully used to produce date fruits (Nixon, 1928, 1935). Recently, pollen of *Phoenix pusilla* (dwarf date palm) male was successfully used to pollinate female date palm cultivars (Sudhersan et al., 2009).

Fruit size and yield can be affected by various factors such as nutrition, climate, chemicals, bunch thinning and also by the genetic expression of the cultivars. In the case of inter-cultivar cross pollination, the genetic material derived from the pollen parent could have also an influence on fruit and seed characteristic features. This phenomenon is

[a] schellan@safat.kisr.edu.kw

Proc. 4th Int. Date Palm Conference
Eds.: A. Zaid and G.A. Alhadrami
Acta Hort. 882, ISHS 2010

defined as xenia where the morphology of the seed is affected and metaxenia where the morphology of the whole fruit is affected (Sedgley and Griffin, 1989).

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 tree grows longer due to high labour cost in many 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. The tree height is one of the major constraints in good quality date production. While attempting to develop dwarf date palm hybrids by crossing a dwarf species *Phoenix pusilla* with selected cultivars of female date palms at the Biotechnology Department of Kuwait Institute for Scientific Research (KISR), the authors have observed interesting pollen effect on date palm fruit characteristic features. The details of *Phoenix pusilla* pollen effect on three important date palm cultivars is presented herein.

MATERIAL AND METHODS

Plant Material

Phoenix pusilla called as dwarf date palm (Figs. 1 and 2) belonging to the same date palm family was introduced recently to Kuwait (Sudhersan, 2004) and three different female date palm cultivars propagated by tissue culture method growing inside the plant tissue culture orchard at the Kuwait Institute for Scientific Research (KISR) Shuwaikh campus were used as plant materials for the pollination experiments. The pollen from the male dwarf date palm was collected whenever flowering occurs in the dwarf date palm and stored at 1-5°C under dry condition was used as pollen materials for pollinating the three selected female date palm cultivars. The fresh pollen mix collected from male date palm cultivars: 'Gannamy', 'Garvis', 'Diary' and unknown males was also used to compare the results with the pollen of the dwarf date palm.

Pollen Preparation

Mature male inflorescences were cut immediately after the breaking of the spathe and kept in paper bags and later transferred to a shady and moisture free area for drying. Spathe was removed carefully and bunches were spread over clean paper. Bunches were frequently changed from one paper to the other in order to avoid moisture logging. After 24h drying, the inflorescence strands were removed from the main rachis and again spread over clean paper for drying. All the male flowers were dried separately to avoid any pollen mixing. Dried pollens were collected in sterile dry containers which were sealed, labeled and stored at cool temperatures. A pollen mix was prepared by mixing the pollen of all the male date palms. Dried pollen mix and cotton balls were placed inside the sealed containers and shaken to infuse the balls with pollen during the experiments. These cotton balls containing pollen mix were used later to facilitate pollination.

Preparation of Female Date Palm Flowers

Female date palm cultivars 'Barhi', 'Madjhool' and 'Sultana' trees were identified inside the KISR Shuwaikh campus, Kuwait. The thorns around the female inflorescences of the selected cultivars were removed using a sharp pruning knife. After pruning the thorns around the selected unopened inflorescences, the spathe was removed using a sharp knife. From each of the 3 female date palm cultivars, 6 inflorescences were selected for the pollination experiment.

Pollination

The cotton balls infused with pollen from dwarf date palm and pollen mix from date palm cultivars: 'Gannamy', 'Garvis', 'Diary' and unknown male date palms were inserted inside the inflorescence individually without any pollen mixing between the dwarf date palm pollen and normal date palm pollen. Each inflorescence was opened manually for the pollination experiment. The pollen infused cotton balls were inserted into the inflorescence and tied with a twine to form a cage around the cotton balls. After the insertion of the cotton ball with pollen, each individual inflorescence was completely covered with a paper cover to protect from contamination through the wind. The paper covers were removed after 15 days from the date of pollination.

Fruit Sample Collection and Observation

All the treatment and control bunches were carefully observed and the fruit characteristic features at different stages of fruit development: hababouk, kimri, khalal, rutab and tamar (Zaid and De Wet, 2002) were studied through the samples collected from the fruit bunches frequently till the fruit reaches maturity. The fruit weight, seed weight, seed size, fruit colour and number of days required for fruit ripening were observed and recorded. The readings were taken from 50 randomly selected fruits from bunches of each treatment and the mean value with standard deviation was calculated.

RESULTS

Metaxenia

The inter-specific pollination between date palms and dwarf date palm was successful and fruit set was noticed similar to the normal date palm pollination by known or unknown male date palm cultivars. *Phoenix pusilla* pollen fertilized the flowers of all the three cultivars experimented. The fruits from all the inflorescences pollinated by date palm pollen and dwarf date palm pollen grew, elongated and matured (Figs. 3-6). At the mature stage, the fruits developed through dwarf date palm pollen were different from the normal fruits in shape. The pollen from the dwarf date palm affected the fruit development and morphology at the stages of khalal and tamar. The size of fruit in 'Barhi' was a little smaller than the fruit size attained by normal date palm pollen, while in the other two cultivars, 'Madjhool' and 'Sultana', fruits were almost equal to the size of the normal fruit. The normal fruits produced by date palm pollen were oval in shape and the fruit produced by dwarf date palm pollen were dumbbell in shape. The mature fruits of the cross pollinated 'Sultana' and 'Madjhool' fruits were dumbbell in shape. The dumbbell shape was due to the aborted seed leaving a long seed cavity inside the fruit. The fruit characteristic features observed were tabulated (Table 1). In all the three cultivars studied, the pollen of *P. pusilla* delayed fruit ripening. About 15-20 days delay in fruit ripening was observed. There was no fruit colour change observed between the control and the treatment.

Xenia

Seed development was noticed in both treatment and the control at the initial stages. Later on the arrest of seed growth and development was noticed in the fruits developed by the dwarf date palm pollen. When the fruit developed by the dwarf pollen was cut into two halves, we noticed a seed cavity inside and a small rudimentary seed at the anterior end (Fig. 6). The normal seeds developed in date palm cultivar 'Majdool' were peculiar in shape having two wings (Fig. 7). The rudimentary seeds were small and similar to a grape seed in shape and size (Fig. 7). In the early stages, seeds showed embryo development, but the embryos were aborted in the ripened fruits due to the total arrest in endosperm development. A total of 50 fruits were cut in to two halves to study the endocarp and seed. In all the 50 fruits, we found rudimentary seeds at the anterior end of the endocarp. The rudimentary seed of 'Madjhool', 'Sultana' and 'Barhi', was 0.4, 0.3 and 0.3 cm respectively in length and 0.3, 0.2 and0.2 cm respectively in width. The seed weighed about 0.03 g in 'Madjhool', 0.2 g in 'Sultana' and 0.2 g in 'Barhi' (Table 1). The normal seed of date palm cultivar 'Madjhool' was 2.5 cm in length, 1.2 cm in width and 1.2 g in weight. The seeds collected at the khalal stage when cultured under in vitro conditions germinated and produced plantlets while the seeds collected from the ripened fruits failed to germinate due to the abortion of embryos at the fruit ripening stage.

DISCUSSION

Dwarf date palm pollen showed interesting variations on the fruit and seed morphological characters of the three cultivars: 'Barhi', 'Madjhool' and 'Sultana'. The seed size at the fruit maturity was 30 times reduced from the normal date seed produced by the normal date pollen.

In this trial, crossing was carried out between two species (interspecific) and both species were found to be compatible with each other and fertilization occurred in all the three species studied. However, seed development at the khalal stage was totally arrested due to endosperm formation.

Previous reports on such interspecific crosses revealed that pollen from *Phoenix reclinata*, *P. canariensis*, *P. robelenis* and *P. rupicola* crossed with date palm for fruit quality improvement failed to produce better quality fruit, while the cross between the date palm and *P. sylvestris* produced slightly larger fruits than the normal (Nixon, 1935). In this present study using *P. pusilla* pollen fruits were without seed and were larger in size in the case of 'Madjhool' and 'Sultana', and of the same size in 'Barhi'.

In many inter-specific crosses, fertilization and early embryo development occurs but some irregular events subsequently take place, mainly the failure of the endosperm to develop properly resulting in embryo abortion and seed collapse (Ragavan, 1977). Similar results were obtained in this breeding trial with dwarf date palm. Seed development had begun at the kimri stage, however at the ripened stage only rudimentary seeds were observed at the upper end of the fruit.

Boyes and Thompson (1937) found shrivelled small seeds with floury endosperm in inter-specific crosses that failed to germinate. They attributed the difference in seed development to the chromosome imbalance in the endosperm. Brink and Cooper (1947) suggested that endosperm breakdown was the main reason for the failure in inter-specific and intra-specific crosses in plants. The concept of endosperm imbalance was proposed by Johnson et al. (1980) to explain endosperm development in inter-specific and intra-specific crosses and it was due to post fertilization incompatibility. Similar post fertilization incompatibility was observed in our inter-specific crossing in date palms.

Fruit development without fertilization is termed as parthinocarpy. Parthinocarpic fruits were reported in several fruit crops such as citrus, grapes, peaches, cherries, bananas and pineapple. Parthinocarpy occurs normally without pollination or stimulation by the pollen or induced by chemicals. Here in our study, the fruits are not true parthinocarpic but developed after fertilization. Initially the fruit developed with seed after fertilization by the dwarf date palm pollen and later on the seed development was arrested during the fruit growth due to the failure in endosperm growth. Finally, at fruit maturity a small rudimentary aborted seed was noticed at the anterior end of the endocarp.

Seed formation in an inter-specific cross is influenced by the mutual ratio of the chromosome number within the embryo, endosperm, and the tissue of the ovary surrounding it. This mutual ratio is disturbed in crosses between two different species. As a consequence of the altered mutual ratios between the chromosome numbers of embryo, endosperm, and ovary, morphological and physiological changes in the seed formation can occurr (Kuckuck et al., 1991). The current study supports the above approach. Although seed development was noticed initially, the breakdown of endosperm development was noticed latter on. Due to the development of disorders in the endosperm development, the embryo growth and development also ceased. Embryo culture techniques in vitro were carried out in our laboratory in order to rescue the hybrid embryos and get hybrid date palms (Sudhersan et al., 2009).

Seedless fruits have advantages over seeded fruits through longer shelf life and greater consumer appeal. Date fruit consumers have a liking for seedless dates because date seeds are hard and unpalatable. The naturally developed parthinocarpic date fruits are non edible and, the chemically induced ones are highly expensive and environmentally unsafe. However, the seedless date fruits developed through pollination by dwarf date palm were edible and economically feasible. The present finding could pave the way to produce edible seedless date fruits commercially. Perhaps this is the first report on the seedless date fruit production using dwarf date pollen.

ACKNOWLEDGEMENT

The encouragement and support by the KISR management to carry out the research activity is hereby acknowledged.

Literature Cited

Abdelal, A.F., Mahmoud, H.M. and Agamy, E. 1983. The effect of pollen source on fruit characteristics of Zaghloul dates (*Phoenix dactylifera* L.). Assuit J. of Agric. Sci. 14(3):347-355.

Boyes, J.W. and Thompson, W.P. 1937. The development of the endosperm and embryo in reciprocal interspecific crosses in cereals. J. Genet. 24:14-227.

Brink, B.A. and Cooper, D.C. 1947. The endosperm in seed development. Bot. Rev. 13:423-541.

Johnson, S.A., Denijs, T.P.N., Peloquin, S.J. and Hanneman, J.R. 1980. The significance of genetic balance to endosperm development in interspecific crosses. Theor. Appl. Genet. 57:5-6.

Nixon, R.W. 1928. The direct effect of pollen on the fruit of the date palm. J. Agr. Res. 36:97-128.

Nixon, R.W. 1934. Recent pollination experiments. Date Grower's Inst. Rept. 11:9-11.

Nixon, R.W. 1935. Metaxenia and interspecific pollination in *Phoenix*. Proc. Am. Soc. Hort. Sci. 33:21-26.

Ragavan, V. 1977. Embryo in-viability in crosses. p.375. In: J. Reinert and Y.P.S. Bajaj (eds.), Plant Cell, Tissue and Organ Culture. Springer Verlag, Berlin.

Sedgley, M. and Griffin, R.A. 1989. Sexual reproduction in tree crops. Academic press, London.

Sudhersan, C. 2004. Introduction of a multipurpose palm *Phoenix pusilla* in Kuwait. Palms 48:191-196.

Sudhersan, C., Al-Shayji, Y. and Jibi Manuel, S. 2009. Date palm crop improvement via T × D hybridization integrated with in vitro culture technique. Acta Hort. 829:219-224.

Swingle, W.T. 1928. Metaxenia in date palm, possibly a hormone action by the embryo or endosperm. J. of Hered. 19:257-268.

Ziad, A. and De Wet, P.F. 2002. Date palm propagation. In: Date palm cultivation. A. Zaid (Eds.), FAO Plant Production and Protection Paper No. 156, Rome, Italy.

Tables

Table 1. Xenic and metaxenic effect of *Phoenix pusilla* pollen on date palm cultivars.

Cultivar and fruit type	Fruit			Seed		
	length (cm)	width (cm)	weight (g)	length (cm)	width (cm)	weight (g)
			Madjhool			
Control	4.8 ± 0.3	3.1 ± 0.7	28.2 ±1.0	2.5 ± 0.4	1.2 ± 0.7	1.4 ± 0.4
Treatment	4.8 ± 0.7	3.0 ± 0.1	27.1 ±0.3	0.4 ± 0	0.3 ± 0.1	0.04 ± 0
			Sultana			
Control	4.6 ± 0.1	3.2 ± 0.4	29.7 ±0.7	2.7 ± 0.7	0.8 ± 0.1	1.3 ± 0.7
Treatment	4.7 ± 0.1	3.0 ± 0.3	30.2 ±0.1	0.3 ± 0	0.2 ± 0	0.02 ± 0
			Bahri			
Control	3.7 ± 0.3	3.8 ± 0.7	23.9 ±0.9	2.0 ± 0.8	0.7 ± 0.3	1.0 ± 0.7
Treatment	3.2 ± 0.2	3.3 ± 0.1	21.6 ±0.4	0.3 ± 0	0.2 ± 0	0.02 ± 0

± Standard Deviation; Control-Date palm Pollen Mix; Treatment-*Phoenix pusilla* pollen.

Figures

Fig. 1. Male *Phoenix pusilla*.

Fig. 2. Female *P. pusilla*.

Fig. 3. Date palm 'Sultana' fruit by *P. pusilla* pollen.

Fig. 4. Date palm 'Madjhool' fruit by *P. pusilla* pollen.

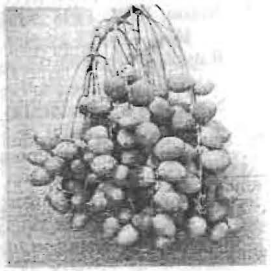

Fig. 5. Date palm 'Barhi' fruit by *P. pusilla* pollen.

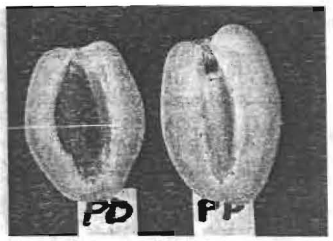

Fig. 6. Date palm 'Madjhool' normal fruit and fruit by *P. pusilla* pollen.

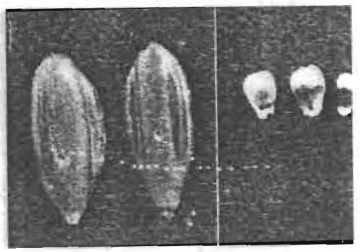

Fig. 7. 'Madjhool' seeds by normal and *P. pusilla* pollen.

The Effect of Arbuscular Mycorrhize (AM) Fungi on the Establishment of Date Palm (*Phoenix dactylifera* L.) under Saline Conditions in the UAE

G. Shabbir[1,a], A.J. Dakheel[2] and M.R.S. Al-Naqbi[2]
[1] International Centre for Biosaline Agric. (ICBA), United Arab Emirates
[2] Ministry of Environment and Water (MoEW), United Arab Emirates

Keywords: Arabian Peninsula, ICBA, AM fungi, mycorrhizae, inoculum and salinity

Abstract

The date palm (*Phoenix dactylifera* L.) has great socio-economic importance in the UAE and the Arabian Peninsula. Research at the International Centre for Biosaline Agriculture (ICBA) has shown that date palms are obligatory dependent on arbuscular mycorrhiza (AM) fungi for growth under saline field conditions. One-year-old in vitro seedlings of the date palm variety 'Khenizi' were inoculated with commercial AM inoculum, BioMyc^{Vital} in a pot trial conducted at the ICBA plastic house. Plants were irrigated with fresh water as control and 5 and 15 dS m^{-1} salinity levels. Two fertilizer levels, full fertilizer level (15, 30 and 5 g/month/plant of NPK (20:20:20), compost mix and Osmocote (12:13:13+TE), respectively) and low fertilizer level which was 1/3 of the full fertilizer level were used as fertility treatments. The results showed significant differences among treatment means. However, no interaction among treatment factors was found. The mycorrhizal inoculum stimulated growth of date palm under all salinity conditions. Within 6 months, plant height and trunk diameter of plants inoculated with BioMyc^{Vital} was increased by 60.7 and 28.8% respectively, with fresh water whereas, 45.0 and 51.8% respectively with high salinity water (15 dS m^{-1}) irrigation compared to the non-inoculated plants. Interestingly, best growth was obtained at low fertilizer level. Inoculation coupled with low fertilizer level increased the plant height by 20.4% and trunk diameter by 18.4% over the full fertilizer level. The experimental data showed that date palms should be associated with AM fungi at nursery stage using the inoculants. Plants can then better withstand salinity stress and they are available for field transplanting in comparatively shorter periods saving up to one year in the nursery. The results also showed that date palms will grow better under natural conditions when effectively associated with AM fungi. Also, less chemical fertilizer and inputs are required to grow date palms when they are effectively mycorrhized. The implications of mycorrhizal inoculation with commercial inoculum for date palm production in UAE and in the Arabian Peninsula are discussed.

INTRODUCTION

Date palm (*Phoenix dactylifera*) is widely grown in the Arabian Peninsula, North Africa, Middle East, America and Asia (Chao and Krueger, 2007). The area under date palm cultivation has continuously increased in the Arabian Peninsula during the recent decades and in UAE, for example, the number of date palm trees has reached to almost 41 million (MEW, 2005). World date production has reached to about 6.8 million metric tons of fruit (FAO, 2007). Date palm has great socio-economic importance in the Arabian Peninsula including the UAE due to its use for fruit production, ornamental, gardening and landscape purposes. Date palms are often grown under saline conditions. Salinity is a major concern for irrigated agriculture particularly in arid and semi-arid regions of the world including the Arabian Peninsula where survival and plant growth is limited only to salt tolerant species. Salinity has a major influence on plant growth and survival (Staples and Toenniessen, 1984). By inhibiting root growth, salt stress decreases the availability

[a] g.shabbir@biosaline.org.ae

Proc. 4th Int. Date Palm Conference
Eds.: A. Zaid and G.A. Alhadrami
Acta Hort. 882, ISHS 2010