



Receptivity of Female Inflorescence in Major Date Palm Cultivars of Saudi Arabia

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ABSTRACT

Date palm, *Phoenix dactylifera* L. is a major fruit crop of Saudi Arabia where over 400 cultivars are known to exist. The crop is characterized by unisexual female (pistillate) and male (staminate) inflorescence that are on separate palms, where artificial pollination is traditionally carried out manually, so as to sustain yield levels and also ensure better fruit quality. During 2013 and 2014 we tested the receptivity of the female inflorescence after spathe cracking (opening) by adopting manual pollination in five major Saudi Arabian date palm cultivars *viz.* Sagae, Sheshi, Ruzeiz, Sukary and Khalas at 1, 8, 16 and 20 days after opening of the female spathe. Results revealed that both fruit set and fructification were significantly superior in all the cultivars studied when pollination was taken up at 1 and 8 Days After Spathe Cracking (DASC). Interaction effects reveal that maximum cumulative and statistically similar fruit set of 72.00 and 67.37% was observed when the cultivar Ruzeiz was pollinated at 1 and 8 DASC, respectively. Further, significant and maximum cumulative fructification was recorded in the cultivar Sukary (49.79%) when pollination was carried out 1 DASC, which was statistically similar to the cultivar Ruzeiz pollinated at 1 and 8 DASC. Delaying pollination in the test cultivars to 16 and 20 DASC resulted in significant decline in both fruit set and fructification.

Key Words: *Phoenix Dactylifera*, Pollination, Female Flowers, Spathe Cracking, Receptivity

1. INTRODUCTION

Date palm, *Phoenix dactylifera* L. (Arecales: Arecaeae) is a major crop of the arid regions of the world. It is estimated that there are over 100 million date palms throughout the world. The production of dates, which was just 1.8 million tons in 1962, has increased to nearly 8 million tons in 2012 (FAOSTAT, 2012). The Kingdom of Saudi Arabia is among the top three date producing countries, with an annual production of 1.3 million tones accounting for 17% of the global date production. Date palm has played an important role in the economy, society, and environment of several countries in the arid regions of the world, especially in the Middle East and North Africa, where it is a main income source and staple food for local populations (Chao and Krueger, 2007).

The crop has a wide genetic diversity due to a high degree of out breeding (Popenoe, 1992). Zaid and De Wet, 2002 reported 3,000 date palm cultivars to exist around the world. However, most of the well established date palm cultivars in several countries could have originated from seedling progenies (Johnson *et al.*, 2013). Saudi Arabia has a rich genetic pool of over 400 date palm cultivars of which 10 are important including Khalas, Sheshi, Reziz, Sagae and Sukary which are popular and have a high consumer preference (Anonymous, 2006). Date palm is a dioecious crop where the staminate (male) and pistillate (female) inflorescences are on separate palms (Popenoe 1992). Traditionally female inflorescence is pollinated manually by inserting male flowers between female flower clusters during the first few days when the female spathe opens and flowers are receptive, which ensures good fertilization (Sawaya 1986). This enhances fruit set, sustains yield levels and overcomes disadvantages associated with dichogamy. The

most common technique of pollination in date palm is to place two to three fresh male flower strands, lengthwise and in an inverted position, between the strands of the female inflorescence, which should be done after some pollen has been shaken over the female inflorescence (Dowson, 1982). Artificial pollination in date palm is traditionally carried out by manually inserting the male flower strands in between female inflorescence or mechanically, by blowing pollen on receptive female flowers using pollen dusters (Carpenter, 1981). Timely pollination, when the female flowers are most receptive is crucial to sustain yield levels and ensure better fruit quality in date palm (Zaid and De Wet, 2002; El-Salhy *et al.*, 2011; Al-Obeed and Soliman 2011).

During 2013 and 2014, studies were carried out at the Date Palm Research Centre, Al-Hassa, Saudi Arabia to determine the receptivity of the female inflorescence after spathe cracking in five major date cultivars of Saudi Arabia *viz.* Sagae, Sheshi, Ruzeiz, Sukary and Khalas by adopting manual pollination at 1, 8, 16 and 20 days after opening (cracking) of the female spathe.

2. MATERIAL AND METHODS

During 2013 and 2014 manual pollination of five date palm cultivars *viz.* Sagae, Sheshi, Ruzeiz, Sukary and Khalas was carried out at 1, 8, 16 and 20 days after opening of the female spathe at the Date Palm Research Centre (DPRC), Al-Hassa (25°19' 60"N latitude and 49° 37' 60" E longitude), Saudi Arabia. Two to three strands of male flowers from a freshly opened male spathe were placed lengthwise and in an inverted position, between the strands of the female inflorescence. After pollination, each female inflorescence

was loosely tied to ensure successful pollination. During both 2013 and 2014 pollination in all the five test cultivars was completed during March using male strands of the same male palm of the date palm gene bank at DPRC, Al-Hassa.

Subsequently, observations on fruit set in each treatment palm were recorded about 60 days after pollination during

$$\text{Per cent fruit set} = \frac{\text{Fruits per strand}}{\text{Fruits per strand} + \text{Parthenocarpic fruits per strand} + \text{Trace buds per strand}} \times 100$$

$$\text{Per cent fructification} = \frac{\text{Fruits per strand}}{\text{Fruits per strand} + \text{trace buds per strand}} \times 100$$

During both 2013 and 2014, data on % fruit set and fructification was subjected to two factor ANOVA ($p=0.05$), where the five cultivars constituted the main treatment (A : A1-A5) while the four treatments to pollinate the female inflorescence at different days after opening was the sub-treatment (B : B1-B4). In all there were 20 treatments. Three palms (replications) were maintained for each treatment. Statistical analysis was carried out for fruit set and fructification during 2013, 2014 and cumulative mean using the web based agricultural statistical package (WASP 1) available on www.icargoa.res.in.

3. RESULTS

Results pertaining to the main treatment for cultivars (Table 1) reveals that among the five date palm cultivars tested, cumulative fruit set ranged from 57.81 to 29.36%, in Ruzeiz and Sukary, respectively. As regards fructification, the cultivar Sagae recorded the highest cumulative value of 37.57% and was statistically similar to the cultivar Ruzeiz (34.98%). The cultivar Khalas recorded the lowest % fructification (16.04%).

Further, for pollination days (sub-treatment) table 1 shows that % fruit set varied significantly when pollination was delayed after opening of the female spathe and ranged from 56.31 to 25.09 % when pollination was carried out at 1 and 20 Days After Spathe Cracking (DASC), respectively. Fructification values were also statistically significant and ranged from 35.67 to 19.86% for pollination at 1 and 20 DASC, respectively.

Interaction effects indicate that the treatments significantly impacted both fruit set and fructification (Table 1, Figure 1 & 2). Fruit set and fructification varied significantly among treatments and was statistically superior in all the five cultivars evaluated when pollination was carried out at 1 and 8 DASC. Pollinating date palm cultivars at 16 and 20 DASC significantly reduced per cent fruit set and fructification. Maximum cumulative per cent fruit set of 72.00% was

observed when the cultivar Ruzeiz was pollinated at 1 DASC, while lowest fruit set of 17.00 % was registered in the cultivar Sukary, pollinated at 20 DASC (Table 1 & Figure 1). Further, maximum cumulative fructification was recorded in the cultivar Sukary (49.79%) pollinated at 1 DASC while least fructification (6.13%) was registered in the cultivar Khalas pollinated 20 DASC (Table 1 & Figure 2). In Saudi Arabia's premier date cultivar Khalas, fruit set was statistically similar when pollination was taken up 1, 8 and 16 DASC. However, delaying pollination to 16 DASC significantly reduced fructification in Khalas.

DISCUSSION

Results presented above indicate that, pollination at 1 and 8 DASC resulted in significantly superior and best fruit set in all the five cultivars as compared to when pollination was done at 16 and 20 DASC. Our findings are in agreement with the report by Ahmed *et al.*, 2013 from Saudi Arabia who found that fruit set in the cultivar Rotana progressively decreased when pollination was carried out at 2, 4 and 6 days after spathe opening. Brown *et al.*, 1969 reported that fertilization and fruit set is better in date palm when pollinated soon after female spathe opening as it facilitates easy germination and penetration of the pollen tube. Previous studies indicate that the receptivity of female flowers is the best within three to four days after the spathe opening (Gupta and Thatai, 1980; El-Kassas and Mahmoud, 1984; Moustafa, 1998; Abdalla *et al.*, 2002 and Al-Wasfy, 2005). Often the availability of male flowers becomes scarce due to the high demand to take up pollination during the short period of time when the female flowers are receptive. To overcome this problem it was recommended to carry out pollination using stored-pollen charged sponge strips when female flowers are most receptive (Ben Abdallah *et al.*, 2014).

Receptivity of female inflorescence in date palm is known to vary among cultivars. Al-Obeed and Soliman, 2011 reported that delaying pollination to three weeks after spathe cracking in Bahry date palm resulted in a significant reduction in initial

fruit set, fruit retention, bunch weight which is in agreement with our findings where fruit set and fructification was the least in all the cultivars pollinated at 20 DASC. However, Al-Obeed and Soliman, 2011 also reported that delaying pollination to three weeks after female spathe cracking resulted in fruit thinning and consequently better physical and chemical characteristics of Bahry dates. Previous reports indicate that Zahedi date cultivar should be pollinated within 10 days of spathe opening. In Kestawy and Sayer cultivars pollination should be completed not more than 15 days after spathe cracking, while Barhy and Kadrawy cultivars pollination could be delayed the pollination up to 20 days after the spathe cracking to give economic yield (Rahim, 1975). Furthermore, studies carried out in Saudi Arabia (Nasr *et al.*, 1988) on pistillate receptivity in four date palm cultivars (Khudari, Nabt Saif, Seleg and Sagae) revealed that a delay in pollination for more than 10 days, resulted in greatly reduced fruit setting and is in agreement with our findings.

In conclusion, among the five date palm cultivars studied, female inflorescence receptivity was the best when pollination was carried out at 1 and 8 DASC. Delaying pollination to 16 and 20 DASC significantly reduced both fruit set and fructification.

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Table 1. Fruit set (%) and fructification (%) in date palm cultivars pollinated at different days after female spathe cracking (2013 and 2014)

Treatments	Fruit set (%)			Fructification (%)		
	2013	2014	Cumulative	2013	2014	Cumulative
Factor A : Cultivars (Main treatment)						
A1: Sagae	44.25a	35.43b	39.84b	42.48a	32.66b	37.57a
A2: Sheshi	43.45a	26.55c	35.00b	38.80a	18.30d	28.55b
A3: Ruzeiz	54.08a	61.54a	57.81a	25.53b	44.42a	34.98a
A4: Sukary	32.16b	26.57c	29.36c	22.33b	24.27c	23.30c
A5: Khalas	37.71b	33.40b	35.56b	13.64b	18.44d	16.04c
CD (p=0.05)	10.94	8.71	7.33	14.78	8.55	8.01
Factor B : Pollination (Sub-treatment)						
B1: 1 DASC	55.33a	57.30a	56.31a	26.98a	44.35a	35.67a
B2: 8 DASC	51.61a	42.28b	46.94b	36.91a	32.27b	35.19a
B3: 16 DASC	32.54b	26.87c	29.71c	26.04a	18.45c	22.24b
B4: 20 DASC	29.85b	20.33c	25.09c	24.31a	15.41c	19.86b
CD (p=0.05)	9.79	7.79	6.56	13.22	7.65	7.16
Interaction (A x B)						
A1B1	75.79	55.02	65.40	57.66	41.92	49.79
A1B2	57.14	46.46	51.80	41.97	37.44	39.71
A1B3	28.60	21.69	25.14	34.66	28.07	31.37
A1B4	15.46	18.54	17.00	35.63	23.19	29.41
A2B1	56.81	42.80	49.81	23.32	36.14	29.73
A2B2	48.15	28.41	38.28	50.52	19.20	34.88
A2B3	38.32	18.49	28.40	35.14	7.57	21.35
A2B4	30.53	16.50	23.51	46.21	10.27	28.24
A3B1	58.03	85.98	72.00	16.77	63.76	40.27
A3B2	67.77	66.98	67.37	38.13	45.65	44.89
A3B3	39.98	49.97	44.98	24.22	37.44	30.83
A3B4	50.55	43.22	46.89	23.01	30.83	26.92
A4B1	51.11	51.58	51.35	14.45	43.27	28.86
A4B2	32.87	32.87	32.87	40.74	39.19	39.96
A4B3	19.52	12.34	15.93	24.03	7.59	15.80
A4B4	25.14	9.48	17.31	10.11	7.04	8.58
A5B1	34.89	51.12	43.00	22.68	36.68	29.67
A5B2	52.10	36.69	44.39	13.17	19.84	16.51
A5B3	36.26	31.88	34.07	12.14	11.57	11.85
A5B4	27.58	13.93	20.75	6.57	5.69	6.13
CD (p=0.05)	21.89	17.42	14.67	29.55	17.10	16.01

Figures followed by same letters within a column are statistically similar. DASC = Days after Spathe Cracking

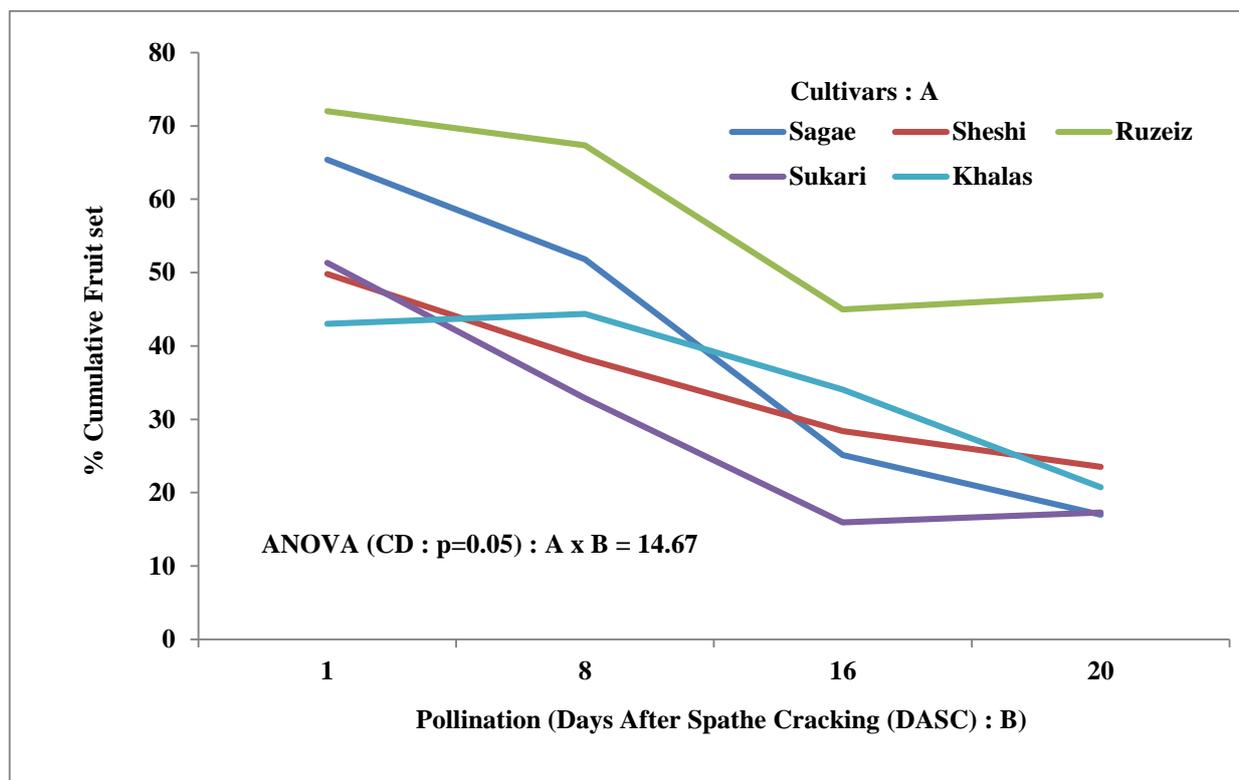


Figure 1. Per cent fruit set in date cultivars (A) pollinated at different days after female spathe cracking (DASC: B). Treatment Bars = Standard Errors. [A1= Sagae ; A2 = Sheshi ; A3= Ruzeiz ; A4= Sukary; A5 = Khalas. B1= 1DASC; B2=8 DASC ; B3=16 DASC ; B4= 20 DASC]

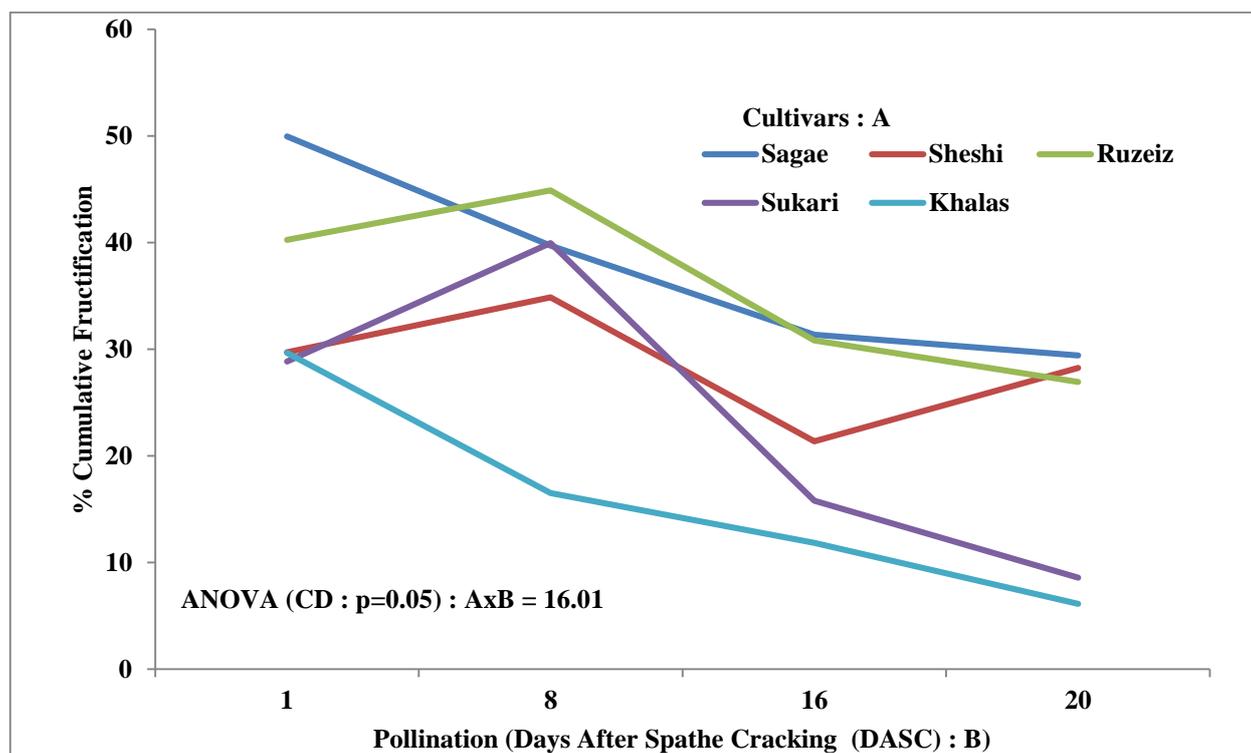


Figure 2. Per cent cumulative fructification in date cultivars (A) at different days after female spathe cracking (DASC: B). Treatment Bars = Standard Errors. [A1= Sagae ; A2 = Sheshi ; A3= Ruzeiz ; A4= Sukary ; A5 = Khalas. B1= 1DASC ; B2=8 DASC ; B3=16 DASC ; B4= 20 DASC]