Principes, 32(4), 1988, pp. 160–164

Seed and Fruit Development of Phoenix dactylifera as Influenced by Type of Pollination and Some Growth Substances

M. M. SHUKR, M. A. CLOR, AND T. A. AL-ANI*

*Agricultural and Water Resources Research Center, Scientific Research Council, P.O. Box 2441, Baghdad; *Technical Institutes Foundation, Baghdad*

ABSTRACT

Experiments on date palm pollination were run in Baghdad, Iraq. When fresh pollen (hand pollination) was replaced by pollen extract, heat killed pollen, no pollen, 2,4,5-T,2-NOA, kinetin, or no treatment (wind pollination), a drastic reduction in fruit set was obtained. Fruit set in untreated inflorescences left open to wind pollination was 33 percent of that in hand pollinated spadices. About 96 percent of fruits produced by hand pollination were full seeded, ripe, and of good quality. A comparable percentage of fruits produced by air pollination were also ripe and full seeded; such fruits, however, were shrivelled and of inferior quality, although they were about 25 percent larger than the good quality fruits. In all other treatments where no viable pollen was applied, 60–85 percent of the remaining fruits reached *khalal* stage size but never ripened and all such fruits were seedless.

From experience gained through the ages, there is common agreement among date growers that hand pollination of the female flowers produces fruits of superior quality compared with those produced by natural wind pollination.

A tendency has been also observed indicating that fruits might be developed without pollination, but no insight into the details of these observations is available. A few attempts, however, have been made to test the effects of certain growth substances and other chemicals on fruit development, but the results have not been encouraging (Nixon 1959, Sharples and Hilgeman 1950, Ketchie 1967).

In the investigation reported here, the aim was directed at finding out the effects of non-pollination on the fruit set, development, ripening, and parthenocarpy as compared with the effects of hand pollination and natural pollination. The effects of certain other treatments, including some growth substances, were also studied.

Materials and Methods

Based on uniformity, 14 female date palms (*Phoenix dactylifera* L.), variety Zehdi, were assigned at random from an orchard located within the vicinity of Baghdad. The prophylls of two inflorescences of each were manually opened and treated as outlined below, a third one was kept under natural conditions (wind pollination) for comparison. All the remaining inflorescences and those produced thereafter were removed to minimize the nutritional competition. Two trees were exposed to each of the following treatments:

1. *Fresh pollen* which was collected from *Simaismi* (male) variety.
2. *Heat killed pollen* which was obtained by placing the fresh pollen at 70° C (in drying oven) for 24 hours.
3. *Pollen extract* which was obtained by soaking 8.75 g of fresh pollen in 400 cm^3 of distilled water. The mixture was stirred for a few hours until a homogeneous suspension was obtained which was then filtered; the filtrate was made up to 500 cm^3.
4. *No pollen* whereby the inflorescences

Table 1. Average number of fruits per inflorescence of two stages of development as affected by the various treatments, together with the average number of seedless fruits per inflorescence at the kimri *stage.*

Treatment	Number and Percentage of Fruits per Inflorescence				
	End of May "Fruit Set"	Early July, *kimri* Stage*		Seedless Fruits	
		Number	% Drop	Number	%
Fresh pollen	1,883	1,502	20	0	0
Heat killed pollen	270	157	42	86	55
Pollen extract	182	120	34	84	70
No pollen	243	152	37	99	65
2-NOA	129	96	25	77	80
2,4,5-T	329	55	83	—	—
Kinetin	86	53	38	40	75
Untreated (not covered)**	622	444	29	0	0

* *kimri*, the first (green) stage of development in dates.
** This represents the average of 7 inflorescences.

of one tree were sprayed with distilled water whereas those of the other were left dry.

5. *β-Naphthoxyacetic acid (2-NOA)*, applied at 50 ppm.
6. *2,4,5-Trichlorophenoxyacetic acid (2,4,5-T)*, applied at 50 ppm.
7. *Kinetin*, applied at 50 ppm.

In the case of solid treatment media, i.e., fresh and heat-killed pollen, 2 g per inflorescence were dusted, whereas a 100 cm^3 per inflorescence was sprayed in the case of solutions which contained two drops of Tween 80 per 500 cm^3. The inflorescences were immediately covered with polythene and cloth bags. The former was removed 20 days after the treatment and the latter was kept for an additional 15 days. At this time, the treated inflorescences would no longer be receptive.

The number of fruits per treatment was counted at the end of May and early July of the same season. In addition, observations on dimensions, maturity, physical appearance, and seed content of the fruits were recorded at the end of the experiment in early October. Fruit volume was determined by water displacement and by the dimensions of the fruits, and a relative volume was estimated. The dry weight of the fruits was determined as proposed by AOAC (1980). Because of the limited number of trees that were available for experimentation and because of the narrow differences between the samples under each treatment, no statistical analysis was undertaken.

Results and Discussion

Fruit Set. Early observations (May–July) on fruit development as affected by the various treatments are presented in Table 1.

The data clearly indicate that hand pollination (as it is usually practiced by the date grower) is an important factor for inducing fruit set in date palms. When no pollen, heat-killed pollen, or pollen extract was applied on receptive flowers instead of fresh pollen, a drastic reduction in fruit set was obtained. Similar results were also obtained when the fresh pollen was replaced by 2,4,5-T,2-NOA or Kinetin. The extent of the reduction as compared with the number of fruits when fresh pollen was applied varied among the various treatments, i.e., from 82 percent in the case of 2,4,5-T to about 95 percent in the case of Kinetin. This reduction clearly indicates that none of the treatments used can sub-

stitute for hand-pollination and that pollination or subsequent fertilization or both has most likely stimulated the greater percentage of fruit set in the hand pollinated flowers.

The limited fruit set obtained by all the other treatments (5–18 percent of the hand pollination) may well be attributed to: a) parthenocarpy, b) accidental pollination or c) both, as appears to be the case.

The magnitude of fruit set in the inflorescences left uncovered to natural pollination is about 33% of that exhibited by hand pollination and covered inflorescences; a fact emphasizing again the efficiency of hand pollination in fruit formation. Natural pollination by wind on the other hand, does not insure pollination of all female flowers in a given inflorescence at the same time or at the time they are fully receptive. Wind borne pollen, furthermore, reaches the stigmas in a diluted form and at times when the individual pollen grains might have lost their viability. A somewhat similar reasoning is developed in the so-called pollen population phenomenon reported by Verkerk (1957) in tomato and by Akamine and Girolami (1959) in passion fruit where it was found that heavy pollination resulted in an increase in fruit set. This explanation, which is based on the quantitative aspect of auxin synthesis, cannot rule out the possibility that perhaps some factor, other than auxin, also induced by pollination, is involved in fruit set. It has been found, for example, that gibberellins can cause fruit set in a number of species (Presser and Jackson 1959, Crane et al. 1960, Weaver and McCune 1958).

Kimri Stage and June Drop. The second fruit count was made in July 7–10, at the so-called *kimri* stage, where usually a considerable natural fruit drop takes place, and the results are shown in Table 1. It appears that the percentage of June drop was the lowest when the flowers were hand pollinated and covered, and the 20 percent loss is about what is expected in date cultivation. This is also close to the 29 percent loss which occurred in the flowers left open to natural pollination. If the effects of the various treatments are considered, June drop in all these cases was higher than that which occurred in the case of hand-pollinated flowers, indicating again the efficiency and the advantage of hand pollination.

Another conspicuous aspect of the results at this stage is the effect of 2,4,5-T in causing the greatest June loss, i.e., 83 percent. It must be mentioned also that the 17 percent of the fruits retained under these treatments after the first fruit count in later May, actually never grew to *khalal* stage later. Thus the 50 ppm of 2,4,5-T used in this work seems to be very damaging. A similar trend is also apparent in the case of kinetin.

A test for seed development at this stage showed that the fruits produced by the hand pollinated (covered) inflorescences, were all fully seeded, and that all the fruits produced by the naturally pollinated inflorescences left uncovered, were also fully seeded (Table 1). In all the other treatments, where the inflorescences were covered, 55–80 percent of the fruits were seedless.

Maturation and Seedlessness. The final harvesting was done in early October where a little less in the total number of fruits was observed in all cases. The fruits were segregated into unripe *khalals* and mature *tamars*. The few damaged fruits found in many treatments were discarded. At least one sample of ten fruits from each group of all the treatments was picked up randomly and tested for seedlessness. Although seedlessness was often complete, yet in some fruits a small thread-like rudimentary seed was developed, but such fruits were considered seedless for practical purposes. The results, which are summarized in Table 2, are discussed for convenience, under the following aspects:

1. *Effect of kind of pollination on fruit morphology and quality.* It is seen that

Table 2. Average number of fruits per inflorescence, as khalal *(unripe) and mature (ripe) fruits, together with the percent seedless fruits in the* khalal *groups of the untreated inflorescences.*

Treatment	Number of Fruits per Inflorescence		
	Mature Seeded (*tamar* Stage)*	*Khalal* (Unripe) Stage**	Seedless % of *khalal*
Fresh pollen	1,267	54	0
Heat killed pollen	57	90	100
Pollen extract	20	90	100
No pollen	33	105	95
2-NOA	12	70	80
2,4,5-T	—	—	—
Kinetin	20	25	100
Untreated (not covered)	429	9	95

* *tamar*, the fourth, fully mature, stage of development in dates.
** *khalal*, the second, variety characteristic colored stage of development in dates.

about 96 percent of the fruits produced by the hand pollinated flowers were fully seeded, mature, and good quality. A comparable percentage of fruits, 98, on the inflorescences exposed to natural pollination, were also mature and fully seeded. Such fruits, however, were rather shrivelled and of inferior quality. These fruits showed similar dry weight but, on the average, they were about 25 percent larger than the good quality fruits produced by hand pollination (Table 3). This fact has been known through the ages of date cultivation, where hand pollination became essential for the development of good quality dates.

2. *Fruit ripening.* Considering all the treatments where no viable pollen was applied and where all the non-pollinated flowers were covered, it was found that 60–85 percent of the fruits reached the full size *khalal* stage, marking the end of the growth period (Table 2). Such fruits, however, never ripened and practically all were seedless. The remaining 15–40 percent of the fruits were full seeded, ripe dates, but again of the shrivelled inferior quality described earlier. This observation establishes clear-cut evidence for the dependence of fruit ripening on the presence of full growing seeds. It seems, therefore, that fertilization and subsequent seed development stimulated the production of some growth factor, other than auxin, which is responsible for fruit ripening.

3. *Parthenocarpy.* As mentioned earlier, most of the unripe *khalals* were seedless fruits, developed by the non-pollinated covered flowers. Whether the various treatments had any effect on parthenocarpy, is a question that cannot be answered by the results of the present work. This is

Table 3. Average length (L), width (W), volume and dry weight of fruit produced by hand pollinated and naturally pollinated flowers.

Type of Pollination	Fruit Volume			Dry Weight (Pericarp) % of Fresh Weight
	L × W cm	Volume by Displacement, cm^3	Relative Volume	
Hand pollination	3.3 × 2.3	7.9	75	86.94
Natural pollination	4.2 × 2.3	10.7	100	86.67

because parthenocarpy was induced to the same extent even when nothing was added to the flowers or when only heat-killed pollen was added. It appears, therefore, that natural parthenocarpy is a tendency in date fruit development when no pollination takes place. And since the total number of fruits developed under the various treatments was so small compared with that developed from flowers that were hand pollinated, it is possible that the small percentage of mature and seedless fruits developed under the various treatments resulted from accidental pollination.

4. *Rudimentary seeds.* An observation of considerable interest, as mentioned earlier, is that some of the unripe *khalals* had a small and elongated structure, reminiscent of a rudimentary seed. This fragile and dried-up structure represents an early stage of ovule development, where the already present auxin in the ovary, which was responsible for the observed parthenocarpy, stimulated the early parallel growth of both ovary and ovule. A similar correlated growth in the early stages of development of the ovary and ovules also occurs in parthenocarpic banana fruits (Audus 1965).

Conclusions

Hand pollination is an important factor in fruit set and production of good quality fruits in the date palm. When fresh pollen was replaced by pollen extract, heat killed pollen, no pollen, 2,4,5-T,2-NOA or kinetin, a drastic reduction in fruit set occurred. The magnitude of fruit set in the inflorescences left open to natural pollination was about 33 percent of that in hand-pollinated and covered inflorescences. About 96 percent of fruits produced by the hand pollinated inflorescences were fully seeded, ripe, and of good quality. A comparable percentage of fruits on the inflorescences exposed to natural wind pollination were also ripe and fully seeded. Such fruits, however, were rather shrivelled and of inferior quality, although they were on the average, about 25 percent larger than the good quality fruits. If all the treatments where no viable pollen was applied and where all the inflorescences were covered for five weeks after treatment are considered, it was found that 60–85 percent of the fruits reached the full size *khalal* stage but never ripened and all such fruits were seedless. This clearly establishes the dependence of fruit ripening on the presence of fully growing seeds. It also appears that natural parthenocarpy is a tendency in date fruit development when no pollination takes place.

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