

Radio-Controlled Date Pollinator Suitable for Small Growers

Fallak S. Sial and Muhammad Khalid

Agriculture Engineering Department, King Faisal University, Hofuf, Saudi Arabia

ABSTRACT. One-man ground-level operated radio-controlled date pollinator, mounted on a light weight telescopic support, helps dust controlled amounts of pollen directly onto the female palm flowers. Increased fruit set and yield are obtained, with less time required, compared to hand pollination.

The date palm is a dioecious plant and the pollen carrying palms are either absent from the Saudi Arabian palm gardens or scarcely available. The pollen is often brought from other gardens or, in some cases, it is even imported from the neighbouring states. The pollen can be stored in desicators to maintain its viability for a good length of time. The female flowers remain receptive for a few hours or days during which the application of the pollen is essential for good fruit setting, final yield and fruit quality. Growers formerly placed whole or parts of male blooms in female palm gardens, hoping to provide enough wind-borne pollination to achieve satisfactory fruit setting. The present practice is to place a few strands of male bloom into each individual female bloom, then loosely tie the female bloom together to secure the male strands and ensure pollination as well as avoid pollen loss. In some cases, dry pollen is simply broadcasted over the female flowers. All these pollination procedures require the worker to climb the palm, which is a dangerous, cumbersome and time consuming process.

Pollination is a seasonal practice. The Kingdom is short of manpower, and it is difficult to find skilled labor to work during the peak pollination season. The concept of artificial pollination is centuries old, but the need for mechanical pollination was realized in the early 1950's. Since then, several approaches have been tried:

1. Pollinating poles, rotary hand dusters and motorized backpack dusters were used to reduce labor requirements for pollination (Perkins and Burkner 1973, Veldhuis 1968).

2. For substantial labor reduction, a fixed-wing aircraft equipped for crop dusting was used for pollination (Brown and Perkins 1969, Preston 1964).

3. Ground-level equipment was developed in which a duster operator stood above the ground on an adjustable height platform to direct the pollen delivery pipe at the bloom area of the palm (Brown *et al.* 1970, Perkins and Burkner 1973).

The existing date gardens in the Kingdom are typically small holdings of randomly scattered or clustered palms without any uniform format. The gardens are frequently intercropped and there are irrigation ditches spread all over. Often there is a wide mix of date varieties, palms of various ages and heights, and thus different flowering and pollination timings. The available mechanical pollination procedures are suitable for large scale gardens having uniform layout, date variety and palm heights. Therefore, mechanization of the existing palm gardens in the Kingdom will ultimately require improvement on the farm as well as modification in the available date mechanization technology. For complete fruit setting, palms must be pollinated several times in a season because such repetition helps all female flowers receive pollen as they open. Therefore, there is a need to develop a simple ground-level operated pollinator to help solve the problem of small growers of the area who are unable to recruit skilled seasonal labor, and cannot afford the available capital-intensive date mechanization technology.

Material and Methods

Telescopic support

The telescopic support for the pollinator was made of 5 pieces of circular aluminium tubes, each 2.25 m in length. The diameter of the tubes increased in steps of 1.27 cm from 3.81 to 8.89 cm. The tubing was 1.63 mm thick and was made of strong aircraft quality aluminium (T 6061). The support was extended to the palm crown with a simple winch-and-pulley hoisting mechanism (Fig. 1). When extended to its full height of 10 m, each tube had 25 cm of overlap. The support retracted to almost a single tube length for easy transport. On cranking the winch backward, the inner tubes retracted due to gravity. The support was gimble-mounted on a flat wooden base that stabilized its operation. For taller palms, an extension tube was attached on top of the innermost tube. Additional telescopic section(s) could also be added. The mass of the support to reach 13 m in height was 10 kg.

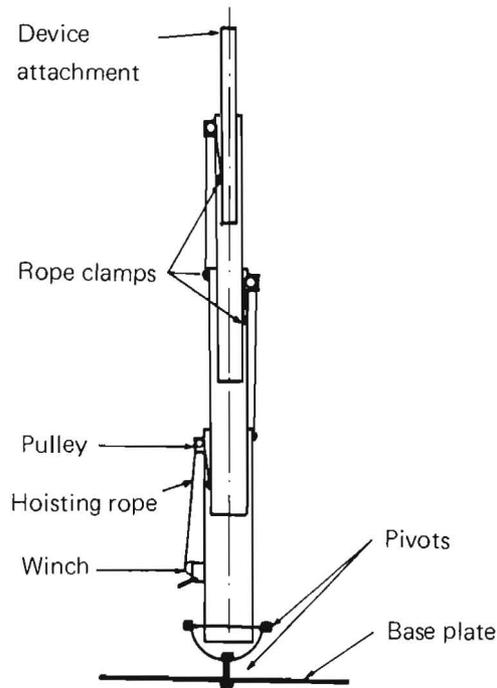


Fig. 1. Telescopic support and its hoisting mechanism.

Radio-controlled pollinator

A radio-controlled (RC) pollinator was designed which consisted of a high speed dc motor, radio receiver, servo-mechanism, lever switch, and battery packs for the motor and the receiver, placed in their respective compartments in a small rectangular control box (Fig. 2). The box mounted to the top of the inner tube of the telescopic support. The dc motor was fixed with the box lid with its shaft extending outward. A small centrifugal fan was fixed on the shaft. An annular pollen hopper was made of 2 circular tubes. The outer tube 8.9 cm inside diameter, sat on the box lid, while the inner tube, 3.8 cm inside diameter, remained just above the fan. The inner tube and the fan intake coincided circumferentially. The hopper bottom was provided with a pollen tube extending inward to the fan outlet. The lower half portion of the pollen tube in the annulus was cut to permit free pollen movement in the hopper base, while the upper uncut part helped avoid pollen bridging. The pollen tube diameter was 2 cm and it extended 25 cm out of the hopper.

The control box was switched on manually, then the servo-mechanism in the circuit was controlled with the radio receiver. The servo-mechanism further ac-

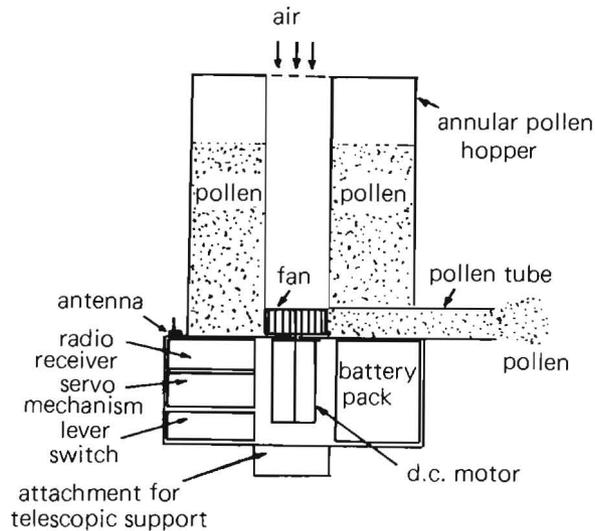


Fig. 2. Schematic diagram of RC pollinator.

tuated the lever switch to complete the power supply circuit to the motor. A small radio transmitter held by the operator signalled the radio receiver to turn on or off.

A hopper lid allowed air passage through the inner tube of the hopper, but was air tight around the annulus. When the dc motor was switched on with the remote control, the centrifugal fan agitated the pollen and blew it out through the pollen tube.

The RC pollinator has a mass of less than 1 kg. The solid-state RC components used to built the device are cheap and easily available at electronic hobby shops.

Experimentation

The pollinator was tested on several palms of varying varieties and heights (6-13 m), and controlled experiments were also carried out to assess its performance based on fruit setting, fruit quality and final yield.

Twenty palms of variety 'Shibiby' were selected from those randomly scattered on a farm in Al-Hassa, Saudi Arabia. The average height of the palms was 9.30 m and the palms were of approximately similar vigor. Each selected palm had 8 spathes (female blooms). The spathe number was cut to 8 on palms bearing more than 8 spathes. Ten of these palms were hand pollinated and 10 were pollinated with the RC pollinator.

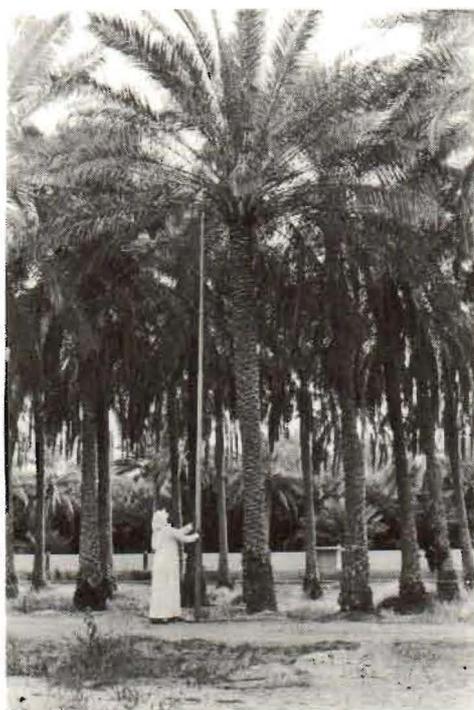
In hand pollination, 5 strands of unsplit male flowers were placed in each female flower bunch and tied in place by a worker who climbed the palm once

during the season. In this way, 40 strands of male flowers per female palm were used.

With the RC pollinator, dry pollen obtained from 40 strands was mixed with an equal amount of free flowing whole wheat flour and dusted on the female palms in 5 attempts at 5-day intervals. An equal amount of pollen application per palm in both RC and hand pollination was used. The operator selected a spot around the palm trunk from which several flower bunches were pollinated. Once the pollinator was hoisted and positioned inside the palm crown just above the flowers (Fig. 3), it was actuated with the RC transmitter held by the operator to dust pollen. About half of the palm was pollinated from one position of the pollinator just by turning the jet direction. To pollinate the other half of the palm, the device was repositioned on the opposite side of the palm trunk. The pollinator was not used during heavy winds, but slight wind helped distribute pollen to the whole palm from one position of the pollinator.



a



b

Fig. 3a. RC pollinator is being fixed on the innermost tube of the telescopic support.
b. The pollinator is being raised and maneuvered around the palm fronds to reach very close to female flowers.

It is a common practice that when dry pollen is applied it is mixed with some free flowing carrier, usually with an equal volume of whole wheat flour. The moisture absorbing ability of the flour helps stick pollen around the flour particles. This minimizes the pollen cloud formation during application, the pollen can be easily directed towards the flowers and drift is minimized. Addition of carrier also helps in even distribution of pollen over a large area when a small amount of pollen is intended for use. The RC pollinator is a precision device, because a predetermined amount of pollen mixed with flour can be dusted right on the female flowers.

Each palm was pollinated within one half minute blowing of the pollinator. About 10-12 cc of pollen flour mix was discharged on each palm. At some rare occasions, the pollinator received signals from some unknown source and was actuated automatically or could not be turned off with its RC control.

Experimental Data and Analysis

A set of data recorded on fruit retained, fruit bunch size, and final yield for the experimental palms is given in Table 1. Fruit retained per bunch were counted and total mass was measured. The length of fruit bearing portion of the strands was measured to obtain the fruit bunch size. Fruit retained per unit strand length was calculated by dividing the number of fruits per bunch by bunch size. Fruits that were badly dried, wrinkled, or weighed less than 6 g were then discarded as poor quality. The marketable quality fruit percentage was finally obtained from:

$$\frac{\text{Mass of good quality fruit per bunch}}{\text{total fruit mass per bunch}} \times 100$$

Table 1 indicates that the RC pollinator was superior to hand pollination. Use of the RC pollinator resulted in a 40% increase in the fruit bunch mass as well as in the total yield as compared to hand pollination. The fruit bunch size difference was very small (2.4%) which suggested that overall growth pattern of the bunches was similar in both sets of palms. This clearly shows that pollen application at different intervals during a pollination season is essential for high yield.

Hand pollination is generally carried out in a single attempt, whereas the spathes open naturally over a period of several weeks. A worker climbs the palm when about one-third to one-half of the spathes are fully opened, therefore, partially opened spathes are manually opened to place the male strands. When the male strands split to release pollen, only the female flowers receptive at that time are pollinated. Remaining pollen still inside the flower bunches might drift away or lose viability before the remaining female flowers become receptive. Therefore, some of the female flowers that opened earlier might have lost receptivity due to delayed pollination, and some becoming receptive later might not get pollinated

Table 1. Fruit bunch and yield characteristics for hand and RC pollination Date Variety: Shibiby. Location: Al-Hassa, Saudi Arabia. Pollination: March 15 – April 15. Harvesting: Sep. 15 – Oct. 15, 1983.

Pollination procedure	Pollination measure	Palm number										Average \pm SE	
		1	2	3	4	5	6	7	8	9	10		
Radio-controlled pollination	Fruit retained (fruit/cm)	0.40	0.38	0.48	0.47	0.39	0.52	0.44	0.47	0.47	0.48	12.52 \pm	
	Fruit bunch size (m)	18.30	18.40	18.20	16.75	19.07	20.13	19.83	17.16	18.78	17.80		
	Fruit bunch mass (kg)	10.84	9.84	13.55	11.64	12.00	17.31	12.30	11.48	13.35	12.88		
	Final yield (kg/palm)	86.5	78.7	108.2	88.0	92.00	132.6	96.8	90.5	105.0	100.0		97.8 \pm
	Quality fruit (kg/palm)	81.8	75.3	100.0	80.6	88.3	117.6	88.3	84.0	94.8	90.0		90.1 \pm
	Quality fruit (%)	94.6	95.7	92.4	91.6	96.0	88.7	91.2	92.8	90.3	90.0		92.3 \pm
Hand pollination	Fruit retained (fruit/cm)	0.38	0.34	0.29	0.36	0.42	0.38	0.31	0.42	0.36	0.31	8.89 \pm	
	Fruit bunch size (m)	17.32	18.88	19.08	17.51	20.71	17.84	18.65	15.90	15.69	19.53		
	Fruit bunch mass (kg)	9.74	8.40	8.00	8.34	12.45	9.00	8.12	8.45	8.00	8.41		
	Final yield (kg/palm)	73.4	67.6	61.8	65.6	98.2	71.8	63.7	70.00	63.90	64.50		70.0 \pm
	Quality fruit (kg/palm)	61.2	57.1	54.8	56.5	81.3	68.4	57.0	60.2	92.6	53.9		60.3 \pm
	Quality fruit (%)	83.4	84.5	88.7	86.1	82.8	95.2	89.5	86.0	82.4	83.6		86.2 \pm

Note: All information is obtained from one representative bunch per palm, except the final yield.

because pollen may be absent or nonviable. Therefore, there is a good possibility that some of the fruit setting did not take place at all with hand pollination. With RC pollination, pollen applied at intervals enables the female flowers then opening to receive pollen.

The percentage of fruit retained per bunch was 25% higher with RC pollination as compared to hand pollination. Since all the palms were exposed to the same conditions other than the mode of pollen application, the lower number of fruit retained per unit strand length with hand pollination further indicates that initial fruit setting did not take place. High fruit yields per palm with RC pollination also supports the above argument.

The quality of fruit mass per bunch was 49% higher with RC pollination as compared to hand pollination. This suggests that palm nutrition and vigor should be adequate for RC pollination, and that the greater number of fruit can be consistently matured as quality fruit.

An independent study was conducted to compare the efficiency of the two procedures based on the time (labour) requirement to perform pollination. For palms of low heights (3-6 m), the time required for hand pollination was 6-8 times that required for the RC approach (single pollination attempt). For palms of 10 m height or more, hand pollination required more than 10 times the time required by the RC method. Comparing the complete pollination operation time requirements (*i.e.*, hand pollination in a single attempt and RC approach in a 5 attempt pollination), on an overall basis the RC pollination required 33% less time than did hand pollination.

Conclusion

Several pollination attempts in a pollination season are necessary to pollinate date palms for maximum fruit setting, high number of quality fruit, and maximum final yield per palm. An economical and easy to be fabricated one-man ground-level operated RC date was developed that will enable small growers to perform pollination without making any changes in the existing garden styles. Dryness of the pollen mix was essential to help avoid bridging in the pollen hopper and clogging of the pollen tube. The device can also be used for pollinating oil palms or dusting of chemicals on bunches.

With the RC pollinator fruit mass per bunch was 40% greater, fruit retained per bunch was 25% greater, quality fruit mass per bunch was 49% greater, and time required to pollinate was 33% less compared to hand pollination.

References

- Brown, G.K. and Perkins, R.M.** (1969) Experiments with aircraft methods for pollinating dates, *Date Growers' Inst. Rep.* **46**: 35-40.
- Brown, G.K., Vis, E.G. and Perkins, R.M.** (1970) Mechanical pollination experiments with the Deglet Noor date palm in 1969, *Date Growers' Inst. Rep.* **47**: 19-24.
- Perkins, R.M. and Burkner, P.F.** (1973) Mechanical pollination of date palms, *Date Growers' Inst. Rep.* **50**: 4-7.
- Preston, R.D.** (1964) Pollinating dates by airplane, *Date Growers' Inst. Rep.* **43**: 24.
- Veldhuis, E.G.** (1968) *Methods of Assisted Pollination for Oil Palms*. Oil palm developments in Malaysia Inc., Soc. Planters, Kuala Lumpur.

(Received 05/11/1983;
in revised form 20/04/1984)

آلة لتلقيح النخيل يُتحكم فيها بواسطة موجات الراديو تناسب صغار المزارعين

فلك شير سيال و محمد خالد

قسم الهندسة الزراعية - كلية العلوم الزراعية و الأغذية - جامعة

الملك فيصل - الأحساء - المملكة العربية السعودية

بواسطة رجل واحد يتم تشغيل آلة تلقيح النخيل التي يُتحكم فيها بواسطة موجات الراديو من مستوى سطح الأرض . هذه الآلة عبارة عن جهاز التلقيح مركب على أنبوبين تلسكوبيين وزنها خفيف بحيث يسهل الوصول إلى مكان الزهور المؤنثة والتحكم في كمية حبوب اللقاح المستخدمة .

أمكن الحصول على زيادة في انعقاد الثمر والمحصول في وقت أقل من الوقت اللازم مقارنةً بالتلقيح اليدوي .