

DESIGN FACTORS FOR PALM-TREE POLLINATOR

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ABSTRACT

The aims of this study are to design, construct, and evaluate a simple pollination-device for date palm trees. The designed pollination device consists of fan fixed on small electrical motor of 12 volt, operated by a dry battery, pollination conical-hopper, a vibrated plastic roller (feeder) that moves by second small motor of 12 volt and conical tubes

The best conditions which gave the suitable performance were: carried material of "flour + fine bran" with ratio of 1 : 1, air speed of 1.8 m/s, and quantity of mixture inside the hopper 50 - 100 g (all sizes). It gave a maximum throw of 10 cm, lateral spread of 40 cm and mixture discharge of 0.3 - 0.33 g/s.

It was found that the highest fruit set of 64.2 and 69.4 % were obtained by using designed pollination-device one and three times respectively. Whereas, the fruit set was about 51.2 % by using manual pollination method.

INTRODUCTION

Egypt is considered one of the greatest countries in palm date production in the world. The palms productivity in Egypt in year of 2005 is about 1.16 million tons from 10.4 million-palms which give fruits (total palm-trees of 11.4 million and area of 86.88 thousand feddan (Agricultural Economics Issue, 2006).

Date palms are considered one of the oldest trees known to ancient people as a source of food. However, recently the fruit growers are not interested in increasing the date palm plantations due to problems of pollination, thinning and harvesting. All of these practices are still carried out manually, which consume a lot of time and cost besides the danger of palm climbing (Lovghavi, 1993).

The pollination operation of palm tree is considered one of the most important technical operations. The pollination operation needs trained workers who can climb the palm tree to pollinate it. In addition, because of the shortage of workers and increase of manual cost, the pollination operation is mechanized by ground-operated rig. So, the pollination device put on the top of telescopic tubes was designed, which has the following advantages:

(1) simplicity of construction, (2) uniformity distribution of pollinate mixing, (3) easy control of discharge rate of pollinate mixing, (4) light of weight, (5) ease of operation, adjustment, maintenance, and repairs, and (6) low cost of the device.

Awady et al. (1998) designed a pollination machine that consists of a manual trailer, telescopic tubes, and 4 pollination devices. Four pollination devices were developed and tested. Pollination devices are: blower fan with a conical tube that connects to a hopper of pollen mixture, (2) steel wire rotating into a center of conical tube, (3) steel brush rotating into a conical hopper, whose bottom has a sliding gate, and (4) conical tube with an air tube

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and manual blower. The best system consisted of a pollination device with a fan blower. It gave a maximum reach of 75 cm and lateral spread of 60 cm.

Yehia (2003) study the design and operation factors of this machine and concluded that: (1) the average machine productivity was 33 palm tree/h, (2) field efficiency of the designed machine was 76.8 % and (3) pollination cost for the designed machine was 0.12 LE/palm tree, whereas the pollination cost by a traditional method was 2.5 LE/palm tree.

The present research is to study the design factors of pollination device for date palm-trees.

2- Review of Literature

Mousa and Eliwa (2000) found that the mechanical pollination of Hiary (الحياني) palm-tree gave a high fruit set and total yield comparing to manual method.

Awady et al. (2003a) designed, constructed, and evaluated a self-propelled machine for pollination of date palm-trees, along with other services such as pest control and pruning. The designed machine consisted of 4-arm stand, telescopic tubes, and pollination or other devices. The main results were: (1) the average machine productivity was 21 palm tree/h, (2) pollination cost for the designed machine was 0.15 LE/palm tree, whereas, the pollination cost by a traditional method was 2.5 LE/palm tree, and (3) the optimum design of 4-arms stand consisted of straight arms with about 2 m width and 20.5 cm height which gave the best stability.

Awady et al. (2003b) designed, constructed, and evaluated a self-propelled machine for pollination of date palm trees. The designed machine consisted of a self-propelled chassis, telescopic tubes, and pollination or other devices. The main results were: (1) the average machine productivity was 10 palm tree/h, and (2) pollination cost for the designed machine was 0.74 LE/palm tree, whereas, the pollination cost by a traditional method was 2.5 LE/palm tree.

MATERIALS AND METHODS

The designed pollination device: consists of fan fixed on small electrical motor of 12 volt, that operates by a dry battery, pollination conical-hopper, a vibrated plastic roller (feeder) that moves by second small motor of 12 volt and conical tubes. The pollination grains drops from the bottom of the hopper on the fan and the fan air throws them to palm tree (fig. 1).



Fig. 1: The pollination device.

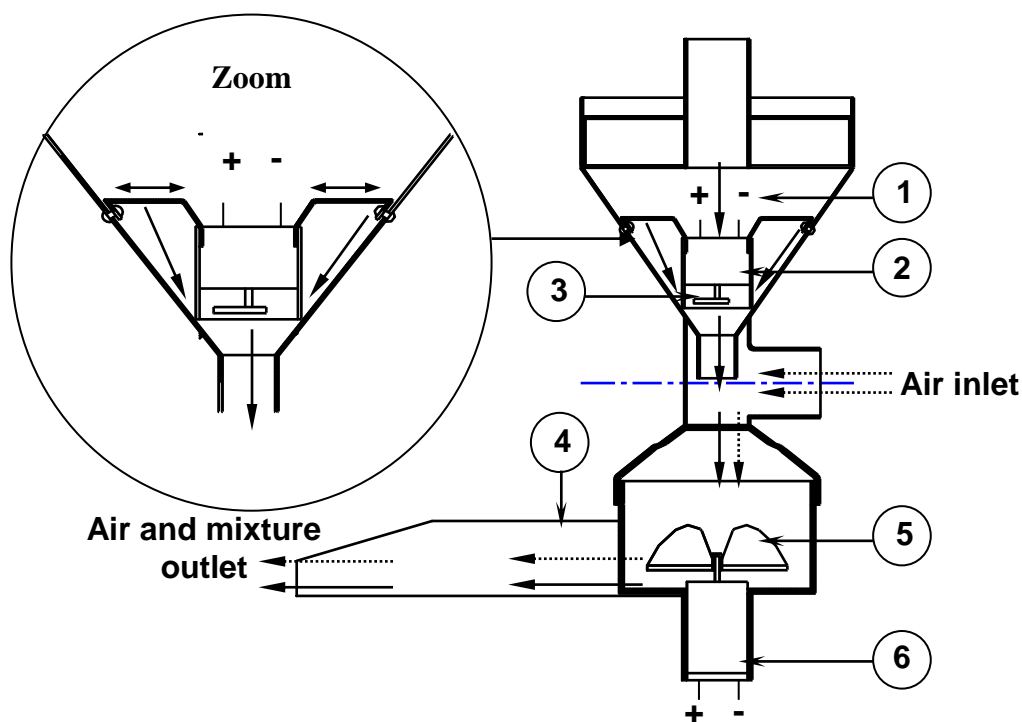


Fig. 2: Section of pollination device of palm tree.
 (1) pollination-grain hopper, (2) vibrated plastic-roller and 12 volt electrical motor, (3) eccentric mass, (4) conical tube, (5) fan, and (6) 12 volt electrical motor.

The portable pollination machine (Awady et al., 2003a):

The portable pollination machine consists of consists of 4-arm stand (with width of 200 cm and 20 cm height), five telescopic-tubes, and pollination. The total mass of the machine is about 20 kg with width of 2 m, minimum length of 2 m and maximum length of 14 m (fig. 3).

Fruit set: (Eliwa, et al., 2003)

Fruit set = Total No. of fruits per bunch / Total No. of flower per bunch (4)

Experimental soil and palm conditions:

The experiments were carried out in a special farm in Sharkiea Governorate in 2005. The conditions of the farm are as the following: (a) soil type: sndy silt, (b) palm tree variety: Zaghloul, (c) trees spacing: 4 - 9 m, (d) rows spacing: 6 m, (e) palm tree height: 7 - 14 m. All treatments were replicated five times to give more reliable averages.

Fig. 3: Sketch of the portable pollination-machine (Awady et al., 2003a).
(1) 4-arm stand, (2) 5-telescopic tubes, (3) 12-volt battery, (4) manual pulley, (5) electrical-wire pulley, (6) steel wire, (7) steel-wire roller, and (8) pollination device.

RESULTS AND DISCUSSION

1: Density of carrying materials.

The densities of flour, starch, bran, "flour + bran" with ratio of 1 :1 and "flour + bran" with ratio of 2 : 1 were 0.54, 0.47, 0.39, 0.41 and 0.42 g/cm³.

2: Effect of design factors of pollination device on discharge of pollination mixture:

(a) The gap between vibrating roller and hopper sides.

The best gap between vibrating roller and hopper sides was 0.5 mm. This gap gave a suitable mixture quantity (0.6 - 1 g/s flour) that can be carried by fan air. Meanwhile, clogging was caused with 0.75 and 1 mm gap.

(b) Air speed.

Figs. 4 and 5 show that the discharge ranges were 0.6 - 1, 0.2 - 1.24, 0.63 - 0.53, 0.27 - 0.33, and 0.26 - 0.34 g/s for flour, starch, bran, "flour + bran" with ratio 1 : 1 and "flour + bran" with ratio 2 : 1 respectively when air speed ranged between 1.5 - 1.8 m/s. The best air speed that gave a suitable and uniform discharge was 1.8 m/s.

(c) Carrying material.

Figs. 4 and 5 show that the best carrying material that gave a uniform flow was "flour + bran" with ratio of 1 : 1. The mixture discharge ranged between 0.27 - 0.33 g/s at different air speeds and mixture-height inside the hopper.

(d) Quantity of pollination mixture inside the hopper.

Figs. 4 and 5 show that the best quantity of pollination mixture inside the hopper, that gave a uniform flow, was 50 - 100 g (1/2, half, 3/4 and full hopper). The mixture discharge ranged between 0.27 - 0.33 g/s using "flour + bran" carrying material with ratio of 1 : 1 and at different air speeds and mixture-quantities inside the hopper.

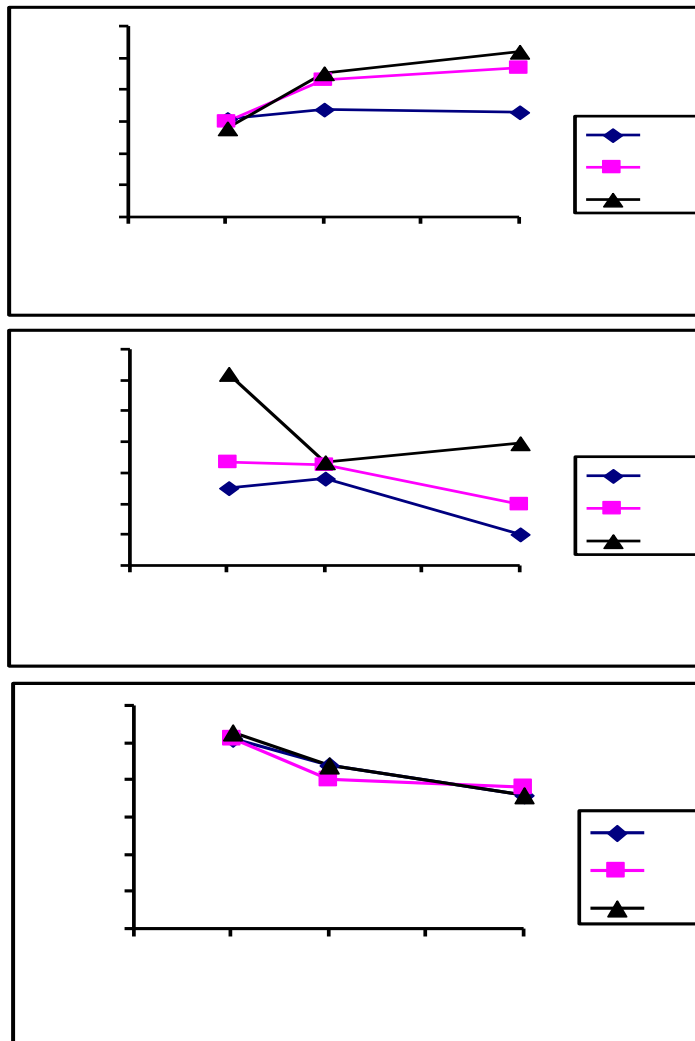


Fig. 4: Air speed vs. discharge of pollen mixture at different mixture height inside the hopper for flour, starch and bran.

3: Effect of design factors of pollination device on throw of pollination mixture:

(a) Air speed.

Fig. 6 shows that the throw spread increased from 60 to 110, from 70 to 80, from 70 to 90, from 90 to 100 and from 90 to 95 cm by increasing air speed from 1.5 to 1.8 m/s for flour, starch, bran, "flour + bran" with ratio 1 : 1 and "flour + bran" with ratio 2 : 1 respectively. Meanwhile, there is no effect of air speed on lateral spread

(b) Carrying material.

Fig. 6 shows that the maximum throw (90 - 100 cm) and lateral (40 cm) spread was obtained by using "flour + bran" with ratio 1 : 1.

(c) Mixture height inside the hopper.

There is no effect of mixture height of pollination mixture inside the hopper.

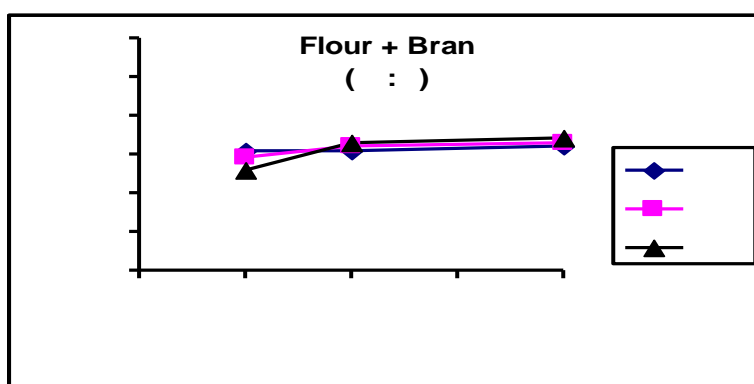


Fig. 5: Air speed vs. discharge of pollen mixture at different mixture height inside the hopper for "flour + bran" with ratio of 1 : 1 and 2 : 1.

4: Fruit set:

It was found that the highest fruit set of 64.2 and 69.4% were obtained by using designed pollination-device one and three times respectively. Whereas, the fruit set was about 51.2 % by using manual pollination method. The increasing of set fruit by using mechanical pollination methods is due to the easily to repeat the pollination process by the machine.

5: Pollination time and machine performance:

The pollination time per tree ranged between 64 and 128 s, when number of bunches ranged between 8 and 16. Meanwhile, the average of machine performance was 28 tree/h (222 tree/day).

6: Operation cost of using the designed pollination-device:

The operation cost of pollination by the designed pollination-device attached to a portable pollination machine (Awady et al., 2003a) was about 0.53 LE/palm tree for one time, whereas the manual pollination cost is about 5 LE/palm tree.

The advantages of the designed pollinator compared with last pollinator are: (1) precision of discharge, (2) giving low discharge, (3) very light and (4) giving high throw.

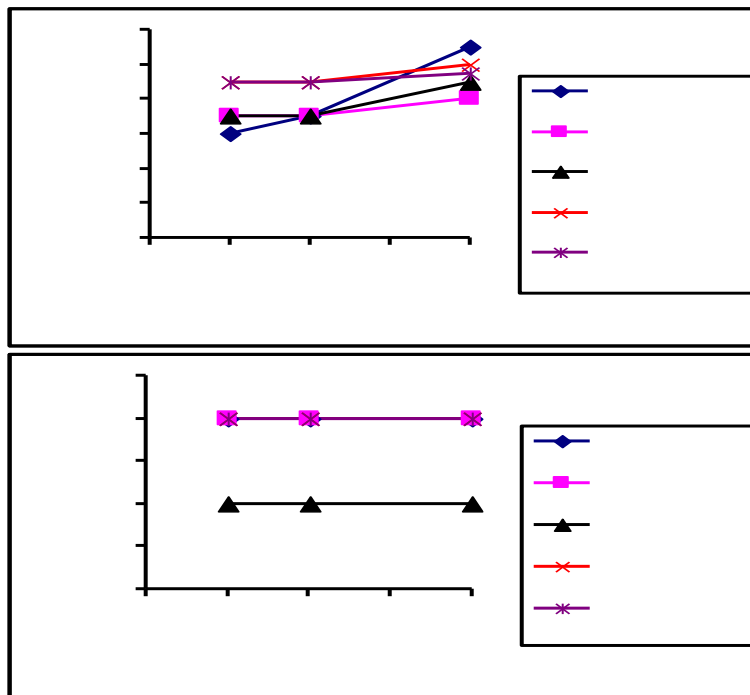


Fig. 6: Air speed vs. throw and lateral spread at different mixture with different carrying-materials.

CONCLUSION

The best conditions which gave the best performance were carried material of "flour + bran" with ratio of 1 : 1, air speed of 1.8 m/s, and quantity of mixture inside the hopper of 50 - 100 g (all sizes). It gave a maximum advance of 10 cm, lateral spread of 40 cm and mixture discharge of 0.3 - 0.33 g/s.

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عوامل تصميم جهاز تلقيح لنخيل البلح

إبراهيم يحيى

معهد بحوث الهندسة الزراعية (مركز بحوث الهندسة الزراعية)، مصر.

يهدف هذا البحث إلى تصميم جهاز تلقيح نخيل البلح، مع دراسة العوامل المؤثرة على أدائه. ويتكون الجهاز التلقيح من صندوق خليط اللقاح، جهاز تلقيح عبارة عن محرك هزاز، مروحة هواء.

* ووجد أن أنسب ظروف تعطى أفضل أداء لجهاز التلقيح هي: المادة الحاملة "دقيق + ردة" بنسبة 1 : 1، سرعة الهواء 1.8 م/ث، ارتفاع خليط اللقاح داخل صندوق اللقاح 3.2 – 8 سم (مملوء تماماً أو أى كمية). وتم الحصول على النتائج الآتية عند أنسب ظروف: معدل التصريف لجهاز التلقيح 0.3 - 0.33 ج/ث، القذف الأمامى لخليط اللقاح 100 سم، الانتشار العرضى 40 سم.

* تم الحصول على أعلى نسبة عقد (64.2، 100 %) عند التلقيح بالجهاز المصمم مرة واحدة وثلاث مرات على الترتيب، بينما تم الحصول على أقل نسبة عقد (51.2 %) عند التلقيح بالطريقة اليدوية.

* تراوح زمن التلقيح بين 64 إلى 28 ثانية بتغيير عدد العراجين من 8 إلى 16. ووجد أن متوسط معدل أداء آلة التلقيح هو 28 نخلة/ساعة.

* متوسط تكاليف التلقيح باستخدام الجهاز معلقاً على آلة متنقلة حوالى 0.53 جنيهها/نخلة للمرة الواحدة، بينما التلقيح بالطريقة اليدوية حوالى 5 جنيهها/نخلة.

