

Evaluation of modified pollen dispenser and storage of dehisced pollen for effective pollination in apple

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ABSTRACT

Studies on evaluation of pollen dispenser on the basis of per cent foragers touching the floor of pollen dispenser with front strip of different sizes showed that the higher percentage of foragers (53.67) touched the floor of pollen dispenser with 2 cm height of front strip. The data regarding recovery of pollen from 100 flowers of Red Gold cultivar of apple varied from 28.2 to 34.2 mg with an average of 32.17 mg. Dehisced apple pollen grains can be stored up to 7 months at 4°C with optimum viability. The observations on the time taken to dispense pollen grains from pollen dispenser attached to the hive entrance indicated that *A mellifera* foragers dispensed 2 g of pollen in 1 to 2 h under open field conditions and in 3 to 4 h under caged conditions.

Keywords: Pollen dispenser; front strip; pollinizer variety; dehisced pollen;
Apis mellifera

INTRODUCTION

Pollen dispenser is the device fitted to the honey bee hive entrance and is so constructed that outgoing bee foragers are forced to walk through the pollen of compatible cultivars often collected by hand. Burrell and King (1932) devised the first pollen insert possibly more economical method of pollen distribution than hand pollination. Townsend et al (1958) developed the pollen dispenser that proved quite effective in pear

orchards. Similar types of pollen dispensers were developed and made available commercially to fruit growers along with dehisced pollen in USA for different crops in the US (Firman 1980). The dehisced pollen can be used for pollination of many crops through pollen dispensers. In view of the lack of adequate pollination especially in temperate fruits grown in North-West Himalayan states of India pollen dispensers were evaluated in Himachal Pradesh for achieving optimum pollination in apple.

MATERIAL and METHODS

Design of pollen dispenser

The pollen dispenser used in the study was essentially the Firman pollen dispenser modified to some extent to suit the local requirements. The modified pollen dispenser was 37.5 cm in length and 4.9 cm in breadth with 20 cm base (Plate 1a). Four variations (1, 2, 3 and 4 cm) with regard to the frontal strip were evaluated keeping in view the activity of *Apis mellifera* F foragers. The number of outgoing and incoming foragers was recorded for one minute (n= 10) at the hive entrance fitted with pollen dispenser during 1200-1300 h on four sunny days and the percentage of outgoing and incoming foragers touching the pollen grains placed in the pollen dispenser was worked out.

Dehiscence of pollen

Unopened/ balloon stage flowers of pollinizer variety of apple Red Gold were collected (Plate 1b) and the anthers from 100 flowers were removed by rubbing on the wire mesh and collected in labelled petri

dishes. These petri dishes were kept in an incubator at 24°C for overnight. The dehiscence pollen was then separated from the husk (Plate 1d) and the following observations were recorded:

Initial weight of anther: A
Weight of husk after dehiscence: B
Weight of dehiscence pollen: C (A-B)

The pollen collection for use in pollen dispensers was done following this method with large number of flowers.

Viability and storage of dehiscence pollen

The viability of fresh pollen was tested using acetocarmine stain test. For this two drops of acetocarmine (1%) were placed on a microscopic slide and the pollen grains were dusted on it. The pollen grains were then covered with the help of a cover slip and excessive strain was removed prior to examination. Deep stained pollen grains were counted as viable and weak or shrivelled ones as non-viable and pollen viability was worked out as under:

$$\text{Pollen viability (\%)} = \frac{\text{Number of stained pollen grains}}{\text{Total number of pollen grains}} \times 100$$

Three fields were observed in each slide to work out the average pollen viability. The viability of pollen was studied after 1, 2 and 3 h of placement in the pollen

dispenser. For storage study 2 g of dehiscence pollen was kept in a glass vial (closed tightly) and the vials were stored at 2-4°C in a refrigerator. The viability of stored pollen

grains was studied at 15 to 20 day interval for the initial two months and later at 25 to 30 day interval for the next 10 months.

Time taken to dispense pollen

The data on the time taken by *A mellifera* foragers to dispense the measured quantity (2 g) of dehisced pollen of apple were recorded under caged and open conditions by making visual observations at 30 min interval till all the pollen in the dispenser was exhausted.

RESULTS and DISCUSSION

Evaluation of pollen dispenser

The data revealed that among the outgoing and incoming foragers the mean number touching the floor of pollen dispenser was 36.88 per cent in the former and 43.07 per cent in the latter. The data also showed that the percentage of foragers touching the floor of pollen dispenser with different sizes of front strip indicated that significantly higher percentage of foragers (53.67) touched the floor of the pollen dispenser fitted with 2 cm front strip followed by 3 cm (44.99%), 4 cm (37.35%) and 1 cm (23.90%) (Table 1).

The data further reveal that the proportion of incoming and outgoing bees was also higher in the case of pollen dispenser with 2 cm front strip being 58.71 and 48.63 per cent (Table 1). Townsend et al (1958) developed pollen dispenser in which the entrance strip was kept at 1 to 3

cm. Also Jaycox and Owen (1965) reported that this type of pollen dispenser was quite effective in apple pollination.

Dehiscence of pollen

The data regarding recovery of pollen from 100 flowers of Red Gold cultivar of apple varied from 28.2 to 34.2 mg with an average of 32.17 mg (Table 2). These results find support from Church and Williams (1983) who reported that pollen production from 100 flowers varied during different years in different pollinizer varieties of apple viz Winter Gold (50-100 mg), Golden Hornet (90-100 mg) and Golden Delicious (102-104 mg). The observed variation in the amount of pollen collection could be explained on the basis of observation that a few anthers tended to shrivel instead of dehisce. Similar phenomenon was also reported by Church and Williams (1983).

Viability of dehisced pollen

The data on viability of dehisced pollen stored at 2-4°C at different intervals revealed that freshly dehisced pollen had 94.25 per cent viability when recorded on 20 April 2009 which on storage up to 7 May, 25 May, 10 June and 27 June 2009 was 89.25, 88.88, 87.45 and 86.10 per cent respectively all being statistically on a par (Table 3). The viability however was reduced significantly thereafter to 70.10 and 65.34 per cent on 6 November and 9 December 2009 respectively and further to 42.65 per cent on 17 March 2010 ie after

Table 1. The proportion of outgoing and incoming foragers of *A mellifera* touching the floor of pollen dispenser with front strips of different sizes

Particulars	Percentage of foragers touching the floor of pollen dispenser with indicated size of front strip				
	1cm	2 cm	3 cm	4 cm	Mean
Outgoing foragers	22.02 (27.94)	48.63 (41.21)	42.75 (40.82)	34.13 (35.73)	36.88 (37.17)
Incoming foragers	25.79 (29.49)	58.71 (50.04)	47.23 (43.41)	40.57 (39.55)	43.07 (40.62)
Mean	23.90 (28.71)	53.67 (47.13)	44.99 (42.11)	37.35 (37.64)	

CD_{0.05}: Foragers= 2.42, Height= 3.42, Interaction= NS

Figures in parentheses are the arc sine transformed values

Table 2. Amount of dehisced pollen collected from 100 flowers of Red Gold, a pollinizer variety of apple

Replication	Weight of anthers (mg)	Weight of husk (mg)	Weight of dehisced pollen (mg)
1	1980	1946.1	33.9
2	1940	1907.6	32.4
3	1910	1875.8	34.2
4	1790	1761.8	28.2
Mean	1905	1872.82	32.17

one year of storage (Table 3). These results are in general agreement with Bian (1987) who reported that storage of pollen at 0-5°C in a refrigerator resulted in slight

reduction in its viability. On the contrary Anjum and Khan (2008) reported that at 4°C pollen viability was reduced to 9.1 per cent after 48 weeks of storage.

Table 3. Viability of dehisced pollen of Red Gold variety of apple after storage at 2-4°C for different periods

Date of observation	Number of days in storage	Pollen viability (%)
20 April 2009 (freshly dehisced)	0	94.25 (76.17)
7 May 2009	17	89.25 (70.90)
25 May 2009	35	88.88 (70.58)
10 June 2009	51	87.45 (69.30)
27 June 2009	68	86.10 (68.22)
10 July 2009	81	82.77 (65.49)
8 August 2009	110	79.16 (62.89)
7 September 2009	140	78.69 (62.55)
10 October 2009	173	75.75 (60.55)
6 November 2009	200	70.10 (57.03)
9 December 2009	233	65.34 (54.02)
8 January 2010	263	56.40 (48.70)
10 February 2010	296	48.12 (43.92)
17 March 2010	331	42.65 (40.76)
CD _{0.05}		(4.96)

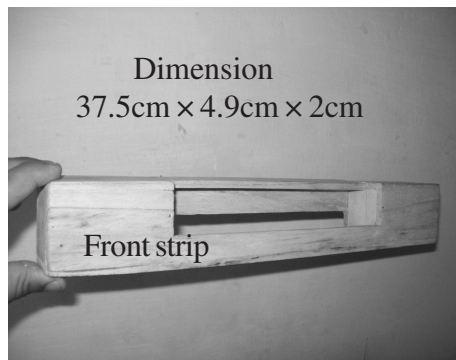
Figures in parentheses are the arc sine transformed values

Viability of pollen in pollen dispenser

The viability of fresh pollen after placement in pollen dispenser was recorded at hourly interval for three hours and it was found that fresh pollen had 94.25 per cent viability which was reduced significantly to 87.13 per cent after one hour and to 85.60 and 82.88 per cent after 2 and 3 h respectively the latter two being on a par statistically. These results are in agreement with earlier workers who reported viability of fresh pollen ranging from 66.36 to 98.85 per cent (Bhartiya 1980), 81.92 to 90.15 per cent (Bist and Sharma 1986) and 85.13 to 89.24 per cent (Anand 2003).

Time taken to dispense pollen

The time taken by bee foragers to dispense the pollen (2 g) from the pollen dispenser (mixed with equal amount of dried and ground husk of anther) was recorded at 30 min interval. It was revealed that *A mellifera* foragers dispensed the pollen in 1 to 2 h under open field conditions and in 3 to 4 h under caged conditions. Earlier Griggs et al (1952) advocated refilling of pollen dispensers twice a day. However longer periods of replenishment were also suggested by some workers (Antles 1953, Karmo 1958). Comparatively longer time taken to dispense



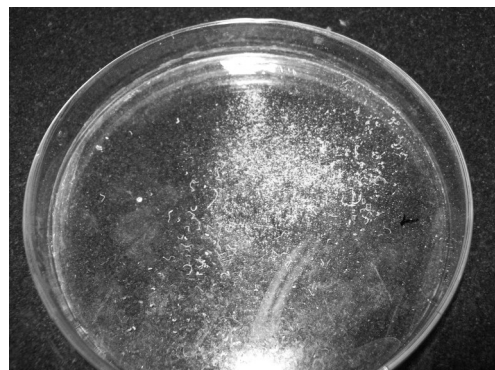
a



b



c



d

Plate 1. (a) Modified pollen dispenser
(b) Collection of flower at balloon stage
(c) Anthers kept for dehiscence in an incubator at 24°C
(d) Dehisced pollen grains

the same quantity of pollen under caged conditions may be attributed to the fact that the caged colony had fewer number of frames (4 frame strength) than the colony under open field conditions (10 frames).

The present study thus indicates that pollen dispenser with front strip of 2 cm height was the most efficient in dispensing apple pollen by foragers of *A mellifera*. Also the dehisced pollen grains could be stored up to seven months at low temperature of 2-4°C without affecting pollen viability to a great extent. Adequate pollination of apple cultivars could be ensured by dispersing dehisced pollen through this device attached to the hive entrance. Another practical utility of this method was to collect pollen from plants of pollinizer varieties grown at different altitudes (whose flowering may coincide with the main variety grown elsewhere) and utilize the same at another altitude where flowering in pollinizer varieties may not coincide with that of the main variety.

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