

SHORT COMMUNICATION

FLOWER BUD POLLINATION DURING DAYTIME FOR HIGHER FRUIT SET IN RED-FLESHED DRAGON FRUIT (*Hylocereus spp*)

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INTRODUCTION

The dragon fruit (*Hylocereus spp.*) is a vine type cactus fruit popular in local as well as in the export fresh-fruit market. This plant was first cultivated as an ornamental plant but later gained popularity as a fresh fruit due to distinct fruit qualities. This attractive fruit in the family Cactaceae has a bright red outer skin with green scales and white or red-fleshed with tiny black seeds. The flower of the dragon fruit blooms at night and thus, called as “Queen of the night”. The juicy flesh of the fruit is delicious and nutritious, which can be consumed fresh or as salads, juice, sherbets, jam, syrup, ice cream, yoghurt, jelly and candy (Gunasena *et al.*, 2006). Vietnam is the leading exporter of this fruit and Taiwan, Malaysia, Israel, China, Australia and Nicaragua are other exporters. The cost of establishment of this crop is high due to durable trellises, the high returns will recover the cost during first 2-3 years of cultivation. The plants will continue to yield about 20 or more years thus earns greater profits in the long term (Mizrahi *et al.*, 1997; Mizrahi and Nerd, 1999). Dragon fruit contains medicinal properties, and they are rich in antioxidants that help neutralizing toxic substances such as heavy metals, and preventing development of cancer, diabetes, etc. This property also helps to control high sugar levels, and bleeding and health of the teeth. The fruit is also rich in vitamin C, phosphorous and calcium, which helps to develop bones, teeth and skin, and therefore is called as a “healthy fruit”.

Dragon fruit was introduced to Sri Lanka in 1997 and has gained popularity across the island within a short time period. The information from the main planting material producers and fruit exporters indicates that the cultivated extent at present is about 1200 ha. This crop was originated from tropical and sub-tropical forest regions of Mexico and Central and South America. Currently the fruit crop is cultivated in more than 20 countries in the tropics (Mizrahi and Nerd, 1999). After introduction of the crop, it was cultivated at small scale in the Low Country Wet Zone of the Sri Lanka. Later, with the publicity received and the attractive fruit qualities have attracted the farmers, Dragon fruit was also named as the “miracle fruit of the 19th century” in the country. The current trend is to cultivate this crop in the homegardens as well as in commercial scale orchards. Unlike other cacti,

Dragon fruit has originated from rainforest areas and thus, can be grown successfully in wet regions where sufficient rainfall is available. It needs about 500-2000 mm annual rainfall and an atmospheric temperature of 20-30 °C. It grows well up to the altitude of 1700 m and needs well drained soils with pH range of 5.5-6.5 (Pusphakumara *et al.*, 2007).

The vine cacti species belongs to two different genera namely, *Hylocereus* and *Selenicereus*, depending on the nature of vine habits, skin and pulp colour. Three species namely, *H. undatus* (white flesh with red skin), *H. polyrhizus* (red flesh with red skin) and *S. megalanthus* (white flesh with yellow skin) are cultivated in the world (Gunasena and Pusphakumara, 2006). The first two types are cultivated in Sri Lanka at present. This *Hylocereus spp.* possess a weakened self-incompatible mechanism. Therefore, efficient pollination with compatible clones by cross pollination is vital to achieve a higher fruit set (Lichtenzweig *et al.*, 2000; Nerd and Mizrahi, 1997; Weiss *et al.*, 1994). Low fruit set (about 30-50 %) has been observed especially in the red-fleshed type, in many cultivated areas even under manual pollination with the same type. Farmers have also complained regarding on the same limitation in the red-fleshed Dragon fruit, however, there were no such complaints reported for the white-fleshed type. Cross pollination of red-fleshed type flowers with pollens from white flesh type is one available option to increase the fruit set in the red-fleshed type. Therefore, it is better to cultivate both types as a mixed cultivation as it facilitates successful cross pollination. However, there is a necessity to find a solution for the Dragon fruit fields that have been cultivated only to the red-fleshed type. The receptivity of flowers only during night time has also created a limitation for manual pollination of the crop. Therefore, this study was conducted to identify an alternative method pollination of red-fleshed Dragon fruit.

MATERIALS AND METHODS

This study was conducted at the fruit orchard of the Horticultural Crops Research and Development Institute, Gannoruwa, Peradeniya, Sri Lanka during July-August 2011. The red-fleshed Dragon fruit vines used were about 3 years old and were in the second bearing season. The crop was managed as recommended by the Department of Agriculture. Experiment was conducted as an observational study with three replicates. Since the night time pollination is a tedious process for farmers, pollination capabilities of the crop was evaluated from the early morning of the following day after flowering. Pollination treatments were practiced from 6.00 am at one hour intervals up to 11.00 am. The flower buds of the red-fleshed variety from the pre-bloom stage were used to extract pollens for the pollination of the flower opened during the previous night. Ten flowers per replicate were used for each pollination treatment. Pollens from a plant of the red-fleshed variety were used

for the pollination of flowers in another plant. Different coloured tags were used to identify different hours of pollination. Percentage fruit set at two weeks after pollination and mean fruit weights at harvest were recorded. The data were analyzed using SAS computer software package.

RESULTS AND DISCUSSION

Success of bud-pollination

The flowers of the red-fleshed Dragon fruit variety was observed from the pre-bloom stage (Figure 1) and the pollens shed before opening of the flower. Therefore, sufficient pollen was not available at the stigmas at the night time. Though the stigma was receptive during night time, the non-availability of pollen has resulted in the prevention of self-pollination in this variety. Even though pollens were available in un-opened flowers, self-pollination did not take place as the stigma was not receptive at that stage. This was the reason for preventing self-pollination in the red-fleshed variety of the Dragon fruit. The flower bud, which is ready to open in the next day can be identified with the size and colour of sepals and petals and can be easily split-open by hand (Figure 2). Then the anthers could be removed and collected to a container for pollination of the flower opened in the same day (Figure 3). Therefore, the bud pollination is a successful method for solving difficulties in self-pollination of the red-fleshed Dragon fruit.



Figure 1. Matured bud to collect pollens for pollination



Figure 2. Opened bud to collect nollen

This method has not been reported previously and information pertaining to this technique is not found in literature or even in the Internet. With the adoption of the proposed technique, there is no necessity to grow white-fleshed Dragon fruit variety together with the red-fleshed variety to facilitate fruiting through manual pollination as per advice extended to farmers previously by the DOA. With the proposed method, farmers are in a position to obtain more fruits from the red-

fleshed Dragon fruit variety (Figure 4), which has higher consumer demand and price.



Figure 3. Bloomed flower and the style and anthers



Figure 4. Fruit set after pollination

Percentage fruit set after pollination

About 4-5 days after pollination, the flower petals turned yellowish in colour and wilted after hand pollination. Simultaneously the enlargement of the ovary indicated fruit development. Unsuccessful pollination resulted in yellowish fruitlets, which falls soon. The fruits started growing and ripened following the ordinary pattern. Pre-mature fruit drop during the fruit growth and development stage was not observed in the treatments. The percentage fruit set significantly varied among the treatments (Table 1).

Table 1. Percentage fruit set by manual pollination in red flesh dragon fruit variety

<i>Pollination time of the day</i>	<i>Percentage fruit set</i>
6.00 am	99 ± 0.67 a
7.00 am	84 ± 0.58 c
8.00 am	91 ± 1.53 b
9.00 am	89 ± 0.67 b
10.00 am	58 ± 1.53 d
11.00 am	58 ± 2.08 d
CV %	12.62

Within the column, the means followed by the same letter are not significantly different at $p=0.05$

Results showed a negative relationship between the success of pollination with the time of hand pollination, with the red-fleshed Dragon fruit variety showing the highest success rate when hand pollinated at 6.00 am, and the lowest after 10.00 am. However, in contrary to the previous findings, the red-fleshed Dragon fruit variety showed a higher rate of fruit set when pollinated even in the morning of the following day of flower opening. More than 50 % fruit set was found in this study when hand pollination starting from 6.00 am to 11.00 am.

Weight of the fruits developed after pollination

The average fruit weight from different pollination treatments did not vary significantly ($p>0.05$) (Figure 5). However, the highest fruit weight was recorded when the flowers pollinated at 6.00 am (152 g) and the lowest fruit weight (88 g) was recorded when pollinated at 7.00 am.

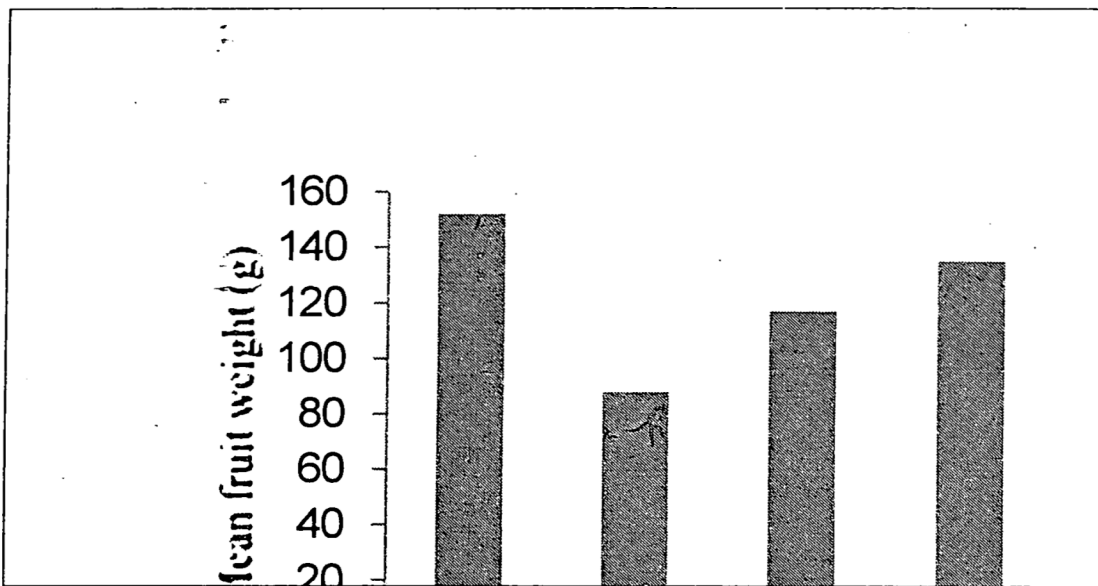


Figure 5. Mean fruit weight in dragon fruit by flower bud pollination at different time periods

CONCLUSIONS

Cross pollination using mature and un-opened flower buds of red-fleshed Dragon fruit was a novel and successful technique to increase fruit set. Pollination in the morning of the following day of flowering was successful and could be practiced by the farmers to obtain higher yields. The most effective time of pollination during the day time was between 6.00 am to 9.00 am. Weight of the fruits was not influenced by time of pollination.

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