

(up on gentle pressing feeling soft compared hard in unmaturred buds).

Emasculation method: By slightly piercing both thumbs inside bulge part of the flowers and cut the flower longitudinally by bending the each half of corolla column parts opposite side without damaging the central gynoecium part (Fig. 2).



Fig 2. Right bud stage for emasculation and steps for emasculation process in dragon fruit

Pollination method 1: Pollens from flower can be collected in petri dish or container and using camel brush dust on stigma. Ensure sufficient pollen on stigma by visual observation.

Pollination method 2: open the flower longitudinally and place below the stigma and rub gently to anthers 2-3 times. Ensure sufficient pollen on stigma by visual observation

Benefits

- This technology improves the fruit size and quality
- Cross pollination reduces the fruit maturity period by one week compared to fruits formed through natural pollination.
- Farmers can be benefitted through maximizing the yield per unit area and also getting a premium price for big size and better-quality fruits.
- Thus, it helps in doubling farmers income if adopted appropriately even under aberrant rains during flowering or anthesis period.

Benefit cost ratio:

- ◆ Hand self-pollination (with emasculation): 2.0
- ◆ Hand self-pollination (without emasculation): 2.50
- ◆ Hand cross-pollination: 3.0

Precaution with the Technology

- ◆ Besides phenological stages of flowering and fruiting, one should know the basics of pollination aspects such as anthesis and active pollination period, duration of pollen viability and stigma receptivity, method of emasculation and pollination.
- ◆ It is suggested to identify and use healthy (free from pest and disease) flowers and best pollen parent for getting good size and better-quality fruit upon pollination.



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Enhancing the Productivity of Dragon Fruit Through Supplementary Pollination



- Emasculation
- Pollination



- Increasing size
- Early maturity



- Yield
- Quality



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Introduction

Though dragon fruit was introduced in India during 1990s itself but, it is being popularized and cultivated commercially since last decade only. Due to its adaptation to diverse agro-ecologies, resilient to abiotic stresses, less water requirement and easy maintenance it is now growing marginal, degraded lands and even arid regions of the country. But the productivity in India is very low mainly due to non-availability of quality and authentic planting materials, and lack of region-specific crop management practices. Like any other newly introduced crop, understanding the floral biology and pollination requirement of dragon fruit is pre-requisite to start breeding programme and develop management practices. In this context, a series of experiments were conducted at ICAR-NIASM during fruiting seasons of two years 2020 and 2021 to study the floral biology, know the mode of pollination in two species of dragon fruit and effect of different pollination methods on fruit size and quality.

Phenology of reproductive phases

In general, the flowering in dragon fruit is begin after one and half year of planting. Flowering mainly affected by the photo period, which requires 10–13 h of light. The phenology of reproductive stages such as floral bud initiation, anthesis and fruit development is varies from species to species. We observed that in *Hylocereus undatus* (white flesh type) the blooming period starts from April and ends in October with 5-6 major cycles and 2-3 blooms with few sparse flowers. Whereas in red type blooming starts from May ends in September. In both the species it takes 14-15 days for anthesis from floral bud stage and fruit matures 30-35 days after anthesis (DAA). The anthesis starts at 6.30 PM in the evening, completely blooms between 9.00 PM-12.00 AM, starts closing 7.00 AM onwards, partially closes at 9.00 AM and starts withering 10.30 AM as sunshine increases.

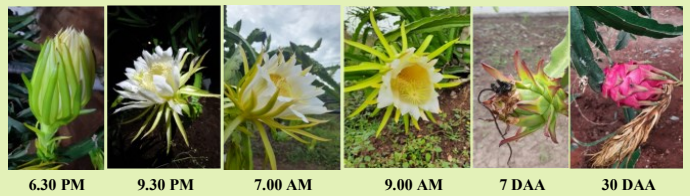


Fig 1. Flowering and fruiting phenological stages.

Mode of pollination in two species of dragon fruit

In general, most of the clones of dragon fruit are self-pollinated, however reported cross pollination in some clones irrespective of species mainly due to self-incompatibility. In order to identify the mode of pollination in the two species of dragon fruit,

different methods of pollinations were imposed. Based on the observed fruit set (Table 2) it is concluded that in the *H. undatus* clone is self-pollinated and whereas the *H. costaricensis* (red flesh) clone is cross pollinated because of self-incompatibility. Therefore, it is very essential to know the mode of pollination or cross compatibility of planting materials prior to selection and planting. The planting materials that have self-incompatibility should be planted alternatively with self-compatibility clones to ensure the fruit set.

Table1. Fruit set upon different pollination methods

Pollination treat-ment	Fruit set (%)	
	<i>H. undatus</i>	<i>H. costaricensis</i>
Open pollination	100	0.00
Selfing (bagging)	100	0.00
Hand self-pollination	100	0.00
Cross pollination	100	100

Pollen viability and stigma receptivity

The pollen viability in *H. undatus* through aceto carmine test showed that pollen viable up to 18 hours after anthesis. This is also confirmed by fruit set up on pollination using the pollens collected from different aged flowers (after anthesis). However, pollen grains up to 14 hours of after anthesis is highly viable and thus pollination before 10 AM in the morning is best to obtain to good fruit set. In vivo pollination of varying aged stigma (before and after anthesis) and subsequent fruit set indicates that stigma become receptive 24 hours before anthesis and retains its receptive up to 36 hours after anthesis. But fruit size reduced as age of stigma increased. Hence, stigma before and after 24 hours can be a can be used for pollination for better results.

Enhancing the fruit size and quality of dragon fruit through supplementary pollination

The fruit size of some of the varieties/clones of dragon fruit particularly of white flesh type comparatively a small and even sometimes not marketable compared to red type. This is mainly because of insufficient pollination due to the floral morphology i.e differential position of stamens and stigma (pinnate type), lack of sufficient insect pollinators, and pollen washout due to rainfall occurs during anthesis and pollination period. Marketing the smaller and under size fruits is major challenge for Dragon fruit farmers and associated stake holders. ICAR-

NIASM, Baramati developed a technology to improve the fruit size and quality in dragon fruit through supplementary hand pollination.

The technology comprises hand self and cross pollination depending on the availability of labour and suitable pollen source.

A. **Self-pollination:** Pollinating the stigma of the flower using pollens from the same /different flower from same plant or other plant of same clone. It can be done **with emasculation** during evening hours even 3-4 hours before anthesis or **without emasculation** in the early morning hours.

a) **With emasculation:** After confirmation of anther dehiscence in the evening on the day of anthesis, emasculate the flower and pollinate using the pollens from removed floral part (dusting the pollens of same flower to the stigma). Stamen column of one flower can be used for pollinating 8-10 flowers

b) **Without emasculation:** Hand self-pollination can be done on the next day early morning hours of anthesis without emasculation.

B. **Cross pollination:** Pollinating the stigma (female) of the flowers using pollens (male) from the flowers of different clone/ variety. For instance, pollinating white type flower's stigma with pollens from red one. Emasculate the female flowers before anthesis or well in advance even forenoon/afternoon hours (to save time and pollinate more number of flowers) and pollinate emasculated flowers using fresh pollens of different variety. Cover the stigma of emasculated flower with butter paper if days are hot and brighter. However, emasculation and pollination can be done simultaneously. But identification of best pollen source/male parent is very important.

Table 1. Effect of pollination fruit size and quality

Pollination mode	Fruit weight (gm)	Increment (%)
Hand self-pollination	350	50
Hand cross-pollination	510	120
Natural self-pollination	230	-

The right stage for emasculation to attempt cross pollination can be identified by visual observation (appearance of white coloured petals at tip as shown in Fig. 2a) and also by touching