**Evaluation of Self-incompatibility on fruit set and yield parameters of Dragon Fruit (*Hylocereus* spp.: Fam. Cactaceae)**

**ABSTRACT**

The study on evaluation of self-incompatibility in two types of dragon fruit *viz*., Vietnam royal white, *Hylocereus undatus* (Haw.) Britton and Rose and Vietnam royal pink, *Hylocereus polyrhizus* (Haw.) Britton and Rose was carried out on fruit yield parameters during 2021-22. The treatments *viz.,* hand cross-pollination of flower with pollen of same flower, pollen from other flower of same plant, pollen from flower of other plant and pollen from *H. polyrhizus* to *H. undatus* and *vice-versa* was compatible resulting in 100 per cent fruit set in both the types of dragon fruit. The fruit weight, pulp weight, peel weight, test weight, ash content and TSS of the fruits varied among treatments with a maximum when flowers of *H. undatus* was hand cross-pollinated with pollen from flowers of *H. polyrhizus.* Therefore, efficient pollination could be achieved by cross pollination of compatible clones. Hence, to avoid low fruit weight, mixed plantings with *H. polyrhizus* in *H. undatus* is recommended.

*Keywords*: Self-incompatibility, Fruit yield and Cross-pollination

1. **INTRODUCTION**

Dragon fruit, *Hylocerus* spp. is an exotic fruit crop belonging to the family Cactaceae, native to Central and South American rainforests. It has been well established as a new crop in various tropical countries due to its precocious yielding ability and its acceptability in the market. Dragon fruit has been introduced to India during late 1990s. In India, it is cultivated in Karnataka, Kerala, Tamil Nadu, Maharashtra, Gujarat, Orissa, West Bengal, Andhra pradesh and Andaman and Nicobar Islands in a small area of less than 400 ha (Karunakaran *et al.,* 2019).

Unlike other cacti, which are from desert origin, dragon fruit has its origin from areas with sufficient rainfall ranging from 1730-2540 mm/year. An average yearly rainfall of 500-1500 mm is required for healthy plant growth. Excessive rain may cause the flowers to drop and sometimes the fruit rots. The crop can also be cultivated organically using locally available organic manures and compost. The demand for nitrogen is less compared to most other fruit crops. It can be grown in a well-drained red, yellow podzolic, lateritic and reddish-brown soil at an altitude up to 1700m, with a temperature ranging from 20-30 oC (Gunasena *et al*., 2006).

Currently, it is being cultivated in 22 countries of the tropics including Australia, Cambodia, China, Colombia, Ecuador, Guatemala, Hawaii, Indonesia, Israel, Japan, Laos, Malaysia, Mexico, New Zealand, Nicaragua, Peru, Philippines, Spain, Sri Lanka, Taiwan, Thailand, South Western USA and Vietnam. Historical evidence indicates that the French introduced the crop to Vietnam about 100 years ago and it was grown for the King. Later, it became popular among the wealthy families of the entire country. Vietnam has favourable climatic conditions for growing tropical fruits, mainly in the southern parts of Mekong Delta and in the southeast areas (Karunakaran *et al.,* 2019).

. It is a perennial, fast growing, climber, with triangular or rarely, four or five sided stems. The stems are fleshy, vine like with many branched segments. Each segment has three wavy wings or ribs with corneous margins and 1-3 spines or sometimes spineless. These form aerial roots that adhere to the support and keep the plant erect. These roots enable the vine to climb over rocks, trees or cling to walls and form dense masses. There are 2-5 short sharp spines in each areole. The stem may reach 6 m or more depending on the growing conditions. In *H.undatus*, the stomata are sunken in the epidermis and the stem tissues contain a considerable volume of parenchyma. However, they do not have a wax layer. Therefore, its drought tolerance is lower as compared to *H. polyrhizus* (Nerd *et al.*, 1999).

The flowers of *Hylocereus polyrhizus* (Haw.) Britton and Rose are large, white in colour with nocturnal anthesis, accompanied by strong floral emission. The extension of floral anthesis also indicated mixed pollination syndromes of nocturnal and diurnal pollinators. Self-incompatibility of the plant is evidenced by spatial segregation of the sexual organs with approach herkogamy and dry-type stigma and numerous stigma lobes positioned above the anthers creating a large area that enhances a large amount of pollen deposition (Cho *et al*., 2021).

*Hylocereus undatus*, possesses a weakened self-incompatible mechanism. Therefore, efficient pollination could be achieved by cross pollination of compatible clones. Hence, to avoid low fruit set, mixed plantings with several genotypes is recommended. The crossability among different taxa of different species may provide information about their close genetic relationships despite their classification as independent botanical taxons (Weiss *et al*., 1994; Nerd *et al.*, 1999; Lichtenzveig *et al.,* 2000).

The *H. undatus* species is independent of biotic pollination to set and produce large sized and well-shaped fruits but *H. polyrhizus* shows limited self-pollination and requires biotic pollination to set fruits and also to produce larger sized fruits (Muniz *et al.,* 2019).

*Hylocereus undatus* possess a weakened self-incompatible mechanism. Therefore, efficient pollination could be achieved by cross pollination of compatible clones. Hence, to avoid low fruit set, mixed plantings with several genotypes is recommended. The crossability among different taxa of different species may provide information about their close genetic relationships despite their classification as independent botanical taxons. This indicates that different species may be considered as members of the same genepool.

In Karnataka the information on the evaluation of Self-incompatibility and fruit yield parameters of Dragon Fruit is limited. Many scientists stated that the weakened self-incompatible mechanism in *Hylocereus undatus* and *H. polyrhizus* and recommended mixed planting of several genotypes to avoid low fruit set. In view of all these scientific facts the present study aims to document the fruit set and other yield parameters through hand cross pollination.

**2.** **MATERIAL AND METHODS**

**2.1 Study Area**

The Self-incompatibility of two types of dragon fruit *viz*., Vietnam royal white, *Hylocereus undatus* (Haw.) Britton and Rose and Vietnam royal pink, *Hylocereus polyrhizus* (Haw.) Britton and Rose was studied to record the fruit set and yield parameters during 2021-22 in a farmer’s field at Suradenupura (13o 12’08’’N and 77o 33’50’’E), Yelahanka (Tq.), Bengaluru Urban.

**2.2 Self-incompatibility studies**

Dragon fruit types, *Hylocereus undatus* (white flesh) and *Hylocereus polyrhizus* (pink flesh), were selected to study the self-incompatibility, through hand pollination (Plate 1). The experiment had four treatments and five replications, laid out in randomized complete block design (RCBD), with following treatments during the flowering period of 2021-22 in the farmer’s field at Suradenupura, Yelahanka (Tq.), Bengaluru Urban.

**T1: Pollination of flower with pollen from same flower**

**T2: Pollination of flower with pollen from other flower of same plant**

**T3: Pollination of flower with pollen from flower of other plant**

**T4: Pollination of flower with pollen from other dragon species**

In T1, on the previous day of flower opening, floral buds which were ready to open (n=10) were selected in four different directions of the plant and were tagged and bagged by using pollinator exclusion nylon (1mm size) bags. On the next day morning (6 am), bags were removed. Pollen of same flower was collected and hand pollinated by using separate pollen brush. The flowers were bagged immediately after pollination to prevent the floral visitors. The same procedure was replicated five times in both the varieties of dragon fruit.

In T2, on the previous day of flower opening, the fully matured floral buds (n=10) were selected in four different directions of the plant. The selected floral buds were emasculated before anther dehiscence (at 01:00pm) and were tagged and bagged. Similarly, another set of four flowers in the same plant were selected and bagged for collection of pollen. On, next day morning (6 am), bags were removed. Pollen of the tagged flowers in the same plant were collected and hand pollinated by using separate pollen brush. The flowers were bagged immediately after pollination to prevent the floral visitors. The same procedure was replicated five times in both varieties of dragon fruit.

In T3, on the previous day of flower opening, the fully matured floral buds (n=10) were selected in four different directions of the plant. The selected floral buds were emasculated before anther dehiscence (at 01:00pm) and were tagged and bagged. Similarly, another set of four flowers in the other plant were selected and bagged for collection of pollen. On, next day morning (6 am), bags were removed. Pollen of tagged flowers in another plant were collected and hand pollinated by using separate pollen brush. The flowers were bagged immediately after pollination to prevent the floral visitors. The same procedure was replicated five times in both varieties of dragon fruit.

In T4, on the previous day of flower opening, the fully matured floral buds (n=10) were selected in four different directions of the plant. The selected floral buds were emasculated before anther dehiscence at 01:00pm, were tagged and bagged in *Hylocereus undatus* (white flesh). Similarly, another set of four flowers in *Hylocereus* *polyrhizus* (pink flesh) were selected and bagged for collection of pollen. On, next day morning (6 am), bags were removed. Pollen of tagged flowers in *Hylocereus* *polyrhizus* (pink flesh) were collected and hand pollinated *Hylocereus undatus* (white flesh) flowers by using separate pollen brush. The flowers were bagged immediately after pollination to prevent the floral visitors. The entire procedure is vice versa for the *Hylocereus* *polyrhizus* (pink flesh) pollination by *Hylocereus* *undatus* (white flesh) and same procedure was replicated five times in both varieties of dragon fruit.





**A: Emasculation B: Emasculated flower C: Bagging of emasculated flower**



**D: Collection of pollen from other flower E: Hand pollination**

**..**



**F**: **Bagging the flower after hand pollination**

**Plate 1: Different steps of emasculation and hand pollination imposed in *Hylocereus undatus* (white flesh) and *Hylocereus polyrhizus* (pink flesh) during 2021-22**

### 2.3 Fruit yield and its attributing parameters

Fruit yield and its attributing parameters such as fruit set, fruit weight, pulp weight, peel weight, fruit diameter, peel thickness, pulp (%), number of seeds per fruit, weight of seeds per fruit and test weight of seeds were recorded in all the treatments and replications.

**Fruit set (%)**

##### Total number of flowers that set fruits in all the treatments and replications were counted at fully ripened stage before harvest and per cent fruit set was calculated by using the following formula:

|  |  |  |
| --- | --- | --- |
| **Fruit set (%) =** | **Number of flowers that were set flowers** | **× 100** |
| **Total number of flowers tagged** |

#### Fruit weight (g)

#### Ripened fruits were selected from all the treatments and replications and were weighed with the help of digital weighing balance and mean weight per fruit was computed and expressed in grams.

**Pulp weight, peel weight (g) and pulp percentage per fruit (%)**

The pulp and peel of four randomly selected fruits from all the treatments and replications were removed and weighed with the help of digital weighing balance and mean pulp and peel weight was computed and expressed in grams. Per cent pulp in fruit was calculated by using the following formula:

|  |  |  |
| --- | --- | --- |
| **Pulp (%) =** | **Weight of pulp** | **× 100** |
| **Total weight of fruit** |

#### Fruit diameter (cm)

Ripened fruits were selected from all the treatments and replications and their diameter was measured with the help of Vernier calliper and expressed in cm.

##### **Seeds per fruit and test weight of seeds (g)**

The four selected ripened fruits from all the treatments and replications were squeezed manually. Seeds were separated through sieving and were sun dried. Total numbers of seeds present per fruit were counted manually and test weight of 100 seeds was recorded.

**2.4 Fruit quality parameters**

The observations on fruit quality and its associated parameters such as total soluble solids, pH of fruits and ash content was recorded.

**Total soluble solids (TSS)**

Total soluble solids, in the juice of representative samples from all the treatments and replications were determined by using a hand refractometer and the data was expressed in Brix.

**pH of fruits**

pH of the fruit juice of representative samples from all the treatments and replications was recorded with the help of digital pH meter.

**Ash content of fruit**

Ash content was estimated by using 10g of sample from each treatment and replications were weighed accurately in a crucible and were heated in low flame until the sample charred, followed by heating in a muffle furnace for about 4 to 5hrs at 600 0C, then crucibles were cooled in a desiccator and weight was recorded. It was done until getting constant weight and the ash was almost white or grayish white in colour.

|  |  |  |
| --- | --- | --- |
| **Ash content (g/ 100g) =** | **Weight of ash (g)** | **× 100** |
| **Sample weight (g)** |

**Analyses of data**

The data was analysed statistically and descriptive statistics were done using SPSS 12.0 (SPSS Inc., an IBM Company, Chicago, USA) and graphs were generated using Sigma Plot 7 (Systat Software Inc., Chicago, USA).

**3. RESULTS AND DISCUSSION**

**3.1 Effect of self-incompatibility (Hand cross-pollination) on fruit set and yield attributing characters of *Hylocereus undatus***

Self-incompatibility of *Hylocereus undatus* was assessed by imposing four treatments with five replications and the results are as detailed below.

**3.1.1 Number of flowers tagged and fruit set**

Totally 50 floral buds, 10 each in five replications, which were ready to open on the next day morning were randomly selected in all the treatments and bagged with pollinator exclusion nylon (1mm size) bags. On next day morning, the bags were removed and hand cross-pollination was done between 0600-0700 hrs with respect to four treatments and were bagged immediately. In the hand cross-pollinated treatments all the 50 flowers showed fruit set (100%).

**3.1.2 Fruit weight, pulp weight and peel weight (g)**

The fruit, pulp and peel weight varied significantly among the treatments. Significantly maximum fruit (573.80 g), pulp (432.40 g) and peel weight (152.55 g) was recorded in fruits obtained from flowers hand cross-pollinated with pollen of *H. polyhizus* followed by hand cross-pollination of flowers with pollen from flowers of other plant (420.0, 302.5 and 122.85 g), flowers hand cross-pollinated with pollen from other flower of same plant (380.0, 279.0 and 112.9 g) and the lowest (272.60, 182.30 and 92.25 g) was recorded in fruits obtained from flowers hand cross-pollinated with pollen of the same flower (Table 1 and plate 2).

**3.1.3 Peel thickness, fruit weight, pulp diameter (cm) and percentage of pulp**

Significantly maximum peel thickness (0.79 cm), fruit diameter (10.30 cm), pulp (9.52 cm) diameter and percentage of pulp (76.30%) was recorded in fruits obtained from flowers hand cross-pollinated with pollen of *Hylocreus polyhizus* followed by hand cross-pollination of flowers with pollen from flowers of other plant (0.67, 8.79, 8.14 cm and 72.21 %), flowers hand cross-pollinated with pollen from other flower of same plant (0.63, 8.15, 7.54 cm and 68.10 %) and the lowest (0.50, 7.20, 6.73 cm and 66.05 %) was recorded in fruits obtained from flowers hand cross-pollinated with pollen of the same flower. However, the diameter of fruit obtained from cross pollination of flower with pollen from flower of the other plant (8.79 cm) was on par with diameter (8.15 cm) of fruit obtained from the pollination of the flower with pollen from other flower of same plant (Table 1).

**3.1.4 Number of seeds per fruit, weight of seeds per fruit and test weight of seeds (g)**

Significantly maximum number of seeds per fruit (3257.2) and weight of seeds per fruit (5.60 g) was recorded in fruits obtained from flowers hand cross-pollinated with pollen of *Hylocereus polyrhizus*,followed by hand cross-pollination of flowers with pollen from flowers of other plant (2558.0 and 3.73 g), flowers hand cross-pollinated with pollen from other flower of same plant (1583.2 and 2.55 g) and the lowest (748.00 and 1.25 g) was recorded in fruits obtained from flowers hand cross-pollinated with pollen of the same flower. Test weight of seeds in fruits obtained from hand cross-pollination of flower with pollen from flower of same flower (0.17 g) was significantly maximum compared to other treatments. The lowest test weight of seeds (0.15 g) was recorded in fruits obtained from pollination of flowers with pollen from flowers of *H. polyrhizus.* However, the test weight of seeds (0.16 g) in fruits obtained from hand cross-pollination of flower with pollen from other flower of same plant was on par with test weight of seeds (0.16 g) in fruits obtained from hand cross-pollination of flower with pollen from other flower of other plant (Table 1a).

**Table 1:** **Self-incompatibility studies (Hand cross pollination) on fruit set and yield attributing parameters of dragon fruit type *Hylocereus undatus* (White flesh) at Suradenupura, Bengaluru urban during 2021-22**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Hand cross pollination of flowers** | **Flowers tagged (No.)** | **Fruit set**  **(%)** | **Fruit weight (g)** | **Pulp weight (g)** | **Peel weight (g)** | **Diameter (cm)** | | **Peel thickness (cm)** | **Pulp (%)** |
| **Fruit** | **Pulp** |
| **Pollen of same flower** | 50 | 100 | 272.60d | 182.3d | 92.25d | 7.20c | 6.73d | 0.50d | 66.05d |
| **Pollen from other flower of same plant** | 50 | 100 | 380.00c | 279.0c | 112.9c | 8.15b | 7.54c | 0.63c | 68.10c |
| **Pollen from flower of other plant** | 50 | 100 | 420.00b | 302.5b | 122.85b | 8.79b | 8.13b | 0.67b | 72.21b |
| **Pollen from flower of *H. polyrhizus*** | 50 | 100 | 573.80a | 432.4a | 152.55a | 10.30a | 9.52a | 0.79a | 76.30a |
| **Mean** | **-** | **-** | **411.60** | **299.1** | **120.1** | **8.61** | **7.98** | **0.65** | **70.6** |
| **F test** | **-** | **-** | **\*** | **\*** | **\*** | **\*** | **\*** | **\*** | **\*** |
| **S.Em±** | **-** | **-** | **6.31** | **1.27** | **1.54** | **0.06** | **0.03** | **0.01** | **0.46** |
| **CD @5%** | **-** | **-** | **19.44** | **3.93** | **4.75** | **0.19** | **0.09** | **0.02** | **1.40** |
| **CV** | **-** | **-** | **3.43** | **0.95** | **2.87** | **1.62** | **0.84** | **2.31** | **1.44** |

NB**; \*:** Significant at p=0.05

Means followed by the same letter in a column do not differ significantly by DMRT

** **

**T2: Hand pollination with pollen from other flower of same plant**

**T1: Hand pollination with pollen of same flower**

** **

**T3: Hand pollination with pollen from flower of other plant**

**T4: Hand pollination with pollen from *H. polyrhizus*(pink flesh)**

**Plate 2: View of fruits obtained from self-incompatibility studies imposed in *Hylocereus undatus* (white flesh) at Suradenupura, Bengaluru Urban during 2021-22**

**3.1.5 TSS (Brix), pH and ash content (g)**

Total soluble solids (15.73 Brix), pH (4.5) and ash content (4.22 g) was significantly maximum in fruits obtained from hand cross-pollination of flowers with pollen from flower of *H. polyrhizus* followed by fruits obtained from hand cross-pollination of flower with pollen from flower of the other plant (14.37 Brix, 3.8 and 3.45 g), fruits obtained from hand cross-pollination of flower with pollen from other flower of same plant (13.52 Brix, 3.3 and 3.17 g) and lowest (13.26 Brix, 3.4, 2.18 g) was recorded in fruits obtained from flowers hand cross-pollinated with pollen of the same flower (Table 1a).

The fruit set and seed attributing characters of *Hylocreus undatus* were comparatively maximum in fruits obtained from flower hand cross-pollinated with pollen from flowers of *H. polyrhizus.* It might be due to pollination of flower with pollen from flower of other type of dragon fruit belong to same genus. However, there is no effect on fruit set between four treatments of self-incompatibility studies. These reasons are supported by earlier workers Lichtenzveig *et al.,* (2000), Nerd *et al.,* (1999) and Weiss *et al*., (1994) in central America who stated that, *Hylocereus undatus*, possesses a weakened self-incompatible mechanism. Therefore, efficient pollination could be achieved by cross pollination of compatible clones. Hence, to avoid low fruit set, mixed plantings with several genotypes is recommended.

**3.2 Effect of self-incompatibility (Hand cross-pollination) on fruit set and yield attributing characters of *Hylocereus polyrhizus***

Self-incompatibility of *H. polyrhizus* was assessed by imposing four treatments with five replications and the results are detailed below.

**3.2.1 Number of flowers tagged and fruit set**

Totally 50 floral buds in a treatment, 10 each in five replications, which are ready to open in the next day morning were randomly selected in all the treatments and bagged with pollinator exclusion nylon (1mm size) bags. On next day morning bags were removed and hand cross-pollination was done between 0600-0700 hrs with respect to four treatments and were bagged immediately. After hand cross-pollination, all the 50 flowers were set (100%) the fruits in all the treatments.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Hand cross pollination of flowers** | **Number of seeds/fruit** | **Weight of seeds/fruit (g)** | **Test weight of seeds (g)** | **TSS (Brix)** | **pH** | **Ash content (g)** |
| **Pollen of same flower** | 748.00d | 1.25d | 0.17c | 13.26d | 3.4d | 2.18d |
| **Pollen from other flower of same plant** | 1583.2c | 2.55c | 0.16b | 13.52c | 3.3c | 3.17c |
| **Pollen from flower of other plant** | 2558.0b | 3.73b | 0.16b | 14.37b | 3.8b | 3.45b |
| **Pollen from flower of *H. polyrhizus*** | 3257.2a | 5.60a | 0.15a | 15.73a | 4.5a | 4.22a |
| **Mean** | **2036** | **3.28** | **0.16** | **14.21** | **3.89** | **3.26** |
| **F test** | **\*** | **\*** | **\*** | **\*** | **\*** | **\*** |
| **S.Em±** | **10.70** | **0.01** | **0.01** | **0.05** | **0.01** | **0.02** |
| **CD @5%** | **32.99** | **0.04** | **0.00** | **0.15** | **0.03** | **0.06** |
| **CV** | **1.18** | **0.98** | **1.87** | **0.76** | **0.64** | **1.31** |

**Table 1a:** **Self-incompatibility studies (Hand cross pollination) on fruit set and yield attributing parameters of dragon fruit type *Hylocereus undatus* (White flesh) at Suradenupura, Bengaluru urban during 2021-22**

**NB; \*:** Significant at p=0.05

Means followed by the same letter in a column do not differ significantly by DMRT

**3.2.2 Fruit, pulp and peel weight (g)**

The fruit, pulp and peel weight varied significantly among the treatments. Significantly maximum fruit (465.80 g), pulp (363.40 g) and peel weight (103.20 g) was recorded in fruits obtained from flowers hand cross-pollinated with pollen from flowers of other plant followed by fruits obtained from hand cross-pollination of flowers with pollen from other flowers of same plant (446.40, 254.40 and 96.06 g), flowers hand cross-pollinated with pollen from flower of *H. undatus* (305.40, 234.60 and 75.22 g) and the lowest (262.40, 188.40 and 71.58 g) was recorded in the fruits obtained from flowers hand cross-pollinated with pollen of the same flower (Table 2 and plate 3).

**3.2.3 Peel thickness, fruit, pulp diameter (cm) and percentage of pulp**

The peel thickness (0.82 cm), fruit (8.92 cm), pulp (8.17 cm) diameter and percentage of pulp (78.33 %) was significantly maximum in the fruits obtained from flowers hand cross-pollinated with pollen from flowers of other plantfollowed by fruits obtained from hand cross-pollination of flowers with pollen from other flowers of same plant (0.73, 8.23, 7.58 cm and 73.41 %), with the exception of percentage of pulp in the fruits obtained from flowers hand cross-pollinated with pollen from flowers of *H. undatus* (76.40 %)*,* fruits obtained from flowers hand cross pollinated with pollen from flowers of *H. undatus* (0.61, 7.80, 7.21 cm and 76.40 %) and the lowest (0.52, 7.44, 6.88 cm and 71.55 %) was recorded in fruits obtained from flowers hand cross-pollinated with pollen of the same flower (Table 2).

**3.2.4 Number of seeds per fruit, weight of seeds per fruit and test weight of seeds (g)**

Significantly maximum number of seeds per fruit (3853.2) and weight of seeds per fruit (4.82 g) was recorded in fruits obtained from flowers hand cross-pollinated with pollen from flowers of other plantfollowed by fruits obtained from flowers hand cross-pollinated with pollen from other flower of same plant (3283.4 and 3.42 g), hand cross-pollination of flowers with pollen from flowers of *H. undatus* (3040.8, 3.13 g)) and the lowest (1664.2 and 2.33 g) was recorded in fruits obtained from flowers hand cross-pollinated with pollen of the same flower. Test weight of seeds in fruits obtained from hand cross-pollination of flower with pollen from flower of same flower (0.14 g) was significantly maximum followed by test weight of seeds in the fruits obtained from hand corss-pollination flowers with pollen from flowers of *H. undatus* (0.12).

**Table 2: Self-incompatibility studies (Hand cross pollination) on fruit set and yield attributing parameters of dragon fruit type *Hylocereus polyrhizus* (pink flesh) at Suradenupura, Bengaluru urban during 2021-22**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Hand cross pollination of flowers** | **Flowers tagged (No.)** | **Fruit set**  **(%)** | **Fruit weight (g)** | **Pulp weight (g)** | **Peel weight (g)** | **Diameter (cm)** | | **Peel thickness (cm)** | **Pulp (%)** |
| **Fruit** | **Pulp** |
| **Pollen of same flower** | 50 | 100 | 262.40d | 188.4d | 71.58d | 7.44d | 6.88d | 0.52d | 71.55d |
| **Pollen from other flower of same plant** | 50 | 100 | 346.40b | 254.0b | 93.06b | 8.23b | 7.58b | 0.73b | 73.41c |
| **Pollen from flower of other plant** | 50 | 100 | 465.80a | 363.4a | 103.2a | 8.92a | 8.17a | 0.82a | 78.33a |
| **Pollen from flower of *H. undatus*** | 50 | 100 | 305.40c | 234.6c | 75.22c | 7.80c | 7.21c | 0.61c | 76.40b |
| **Mean** | **-** | **-** | **345.00** | **260.1** | **85.79** | **8.10** | **7.46** | **0.67** | **74.92** |
| **F test** | **-** | **-** | **\*** | **\*** | **\*** | **\*** | **\*** | **\*** | **\*** |
| **S.Em±** | **-** | **-** | **3.245** | **2.430** | **0.502** | **0.017** | **0.021** | **0.008** | **0.15** |
| **CD @5%** | **-** | **-** | **10.00** | **7.488** | **1.547** | **0.052** | **0.064** | **0.026** | **0.46** |
| **CV** | **-** | **-** | **2.103** | **2.089** | **1.309** | **0.470** | **0.619** | **2.793** | **0.45** |

NB**: \*:** Significant at p=0.05

Means followed by the same letter in a column do not differ significantly by DMRT

****

**T4: Hand pollination with pollen from *H. polyrhizus*(pink flesh)**

**T1: Hand pollination with pollen of same flower**

**T2: Hand pollination with pollen from other flower of same plant**

****

**T3: Hand pollination with pollen from flower of other plant**

**Plate 3: View of fruits obtained from self-incompatibility studies imposed in *Hylocereus polyrhizus* (pink flesh) at Suradenupura, Bengaluru Urban during 2021-22**

However, the test weight of seeds (0.16 g) in fruits obtained from hand cross-pollination of flower with pollen from other flower of same plant was on par with test weight of seeds (0.16 g) in fruits obtained from hand cross-pollination of flower with pollen from other flower of other plant (Table 3).

**3.2.5 TSS (Brix), pH and ash content (g)**

Significantly maximum total soluble solids (15.14 Brix), pH (4.26) and ash content (3.61 g) was recorded in fruits obtained from hand cross-pollination of flowers with pollen from flower of other plant followed by fruits obtained from hand cross-pollination of flower with pollen from other flower of the same plant (14.69 Brix, 3.79 and 3.09 g), fruits obtained from hand cross-pollination of flower with pollen from flowers of *H. undatus*  (13.81 Brix, 3.62 and 2.57 g) with the exception of total soluble solids (14.50 Brix) recorded in fruits obtained from flowers pollinated with pollen of same flower. Lowest (14.50 Brix, 3.59 and 2.11 g) was recorded in fruits obtained from flowers hand cross-pollinated with pollen of the same flower (Table 2a).

The fruit and seed attributing characters of *Hylocreus polyrhizus* were comparatively maximum in fruits obtained from flower hand cross-pollinated with pollen from flowers of other plant of same species*.* It is proved that, the pollination agents were very much required to bring the pollen from flower of other plant of same type to another flower of same type, which enhanced the maximum fruit weight, other fruit and seed attributing parameters. However, there is no effect on fruit set between four treatments of self-incompatibility studies.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Hand cross pollination of flowers** | **Number of seeds/fruit** | **Weight of seeds/fruit (g)** | **Test weight of seeds (g)** | **TSS (Brix)** | **pH** | **Ash content (g)** |
| **Pollen of same flower** | 1664.2d | 2.33d | 0.14a | 14.50d | 3.59d | 2.11d |
| **Pollen from other flower of same plant** | 3283.4b | 3.42b | 0.10b | 14.69b | 3.79b | 3.09b |
| **Pollen from flower of other plant** | 3853.2a | 4.82a | 0.10c | 15.14a | 4.26a | 3.61a |
| **Pollen from flower of *H. undatus*** | 3040.8c | 3.13c | 0.12c | 13.81c | 3.62c | 2.57c |
| **Mean** | **2960** | **3.43** | **0.11** | **14.53** | **3.81** | **2.85** |
| **F test** | **\*** | **\*** | **\*** | **\*** | **\*** | **\*** |
| **S.Em±** | **18.45** | **0.021** | **0.01** | **0.058** | **0.04** | **0.02** |
| **CD @5%** | **56.85** | **0.065** | **0.04** | **0.180** | **0.14** | **0.08** |
| **CV** | **1.394** | **1.378** | **2.321** | **0.899** | **2.70** | **2.02** |

**Table 2a: Self-incompatibility studies (Hand cross pollination) on fruit set and yield attributing parameters of dragon fruit type *Hylocereus polyrhizus* (pink flesh) at Suradenupura, Bengaluru urban during 2021-22**

NB**: \*:** Significant at p=0.05

Means followed by the same letter in a column do not differ significantly by DMRT

1. **CONCLUSION**

The four treatments such ashand cross-pollination of flower with pollen of same flower, pollen from other flower of same plant, pollen from flower of other plant and pollen from *H. polyrhizus* to *H. undatus* and *vice-versa* were compatible resulting in 100 per cent fruit set in both the types of dragon fruit. Among the four treatments imposed to test the self-incompatibility of *H. undatus,* hand cross-pollinated with pollen from flowers of *H. polyrhizus* resulted in maximum fruit weight and other parameters. Similarly out of four treatments imposed to test the self-incompatibility of *H. polyrhizus,* hand cross-pollinated with pollen from flowers of other plant of same speciesresulted in maximum fruit weight and other parameters. Therefore, efficient pollination could be achieved by cross pollination of compatible clones. Hence, to avoid low fruit weight, mixed plantings with *H. polyrhizus* in *H. undatus* is recommended.

**DISCLAIMER (ARTIFICIAL INTELLIGENCE)**

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

**REFERENCES**

Cho, Joanna Lee Ying and Phebe Ding, (2021). Floral Morphology and Pollination Process of Red-fleshed Dragon Fruit (*Hylocereus polyrhizus*) Grown in an Open Field, 277-293.

Gunasena, H. P. M., Pushpakumara, D. K. N. G. and. Kariyawasam, M., (2006). Dragon Fruit: *Hylocereus undatus* (Haw) Britton and Rose-A fruit for the future." *Diunduh dari http://www. worldagroforestry. org/dow nloads/Publications/PDFS B* 14784.

Karunakaran, G., Arivalagan, M. and Sriram, S., (2019). Dragon Fruit Country Report from India. Dragon Fruit Network: Marketing and the Whole Value Chain and Steering Committee Meeting.

Lichtenzveig, J., Abbo, S., Nerd, A., Tel‐Zur, N. and Mizrahi, Y., (2000). Cytology and mating systems in the climbing cacti *Hylocereus* and *Selenicereus*. *American Journal of Botany*, **87**(7): 1058-1065.

Muniz, J. P. D. O., Bomfim, I. G. A., Correa, M. C. D. M., and Freitas, B. M., (2019). Floral biology, pollination requirements and behavior of floral visitors in two species of pitaya1. *Revista Ciencia Agronomica*, **50**: 640-649.

Nerd, A., Gutman, F. and Mizrahi, Y., (1999). Ripening and postharvest behaviour of fruits of two *Hylocereus* species (Cactaceae). *Postharvest Biology and Technology*, **17**(1): 39-45.

Weiss, J., Nerd, A. and Mizrahi, Y., (1994). Flowering behavior and pollination requirements in climbing cactus with fruit crop potential. *Hort. Science*, **29**:1487-1492.