Guidelines
For the Conduct of Test for
Distinctiveness, Uniformity and Stability

On

Dragon Fruit
(*Selenicereus* sp.)

Protection of Plant Varieties and Farmers Rights Authority
(A Statutory Body created by an Act of Parliament)
Government of India, New Delhi

CONTENTS

I. Subject of Test Guidelines

These test guidelines shall apply to all varieties of Dragon fruit (*Selenicereus* sp.)

II. Material Required

1. The Protection of Plant Varieties and Farmers' Rights Authority (PPV & FRA) shall decide on the quantity and quality of the plant material required for testing the variety and when and where it is to be delivered for registration under the Protection of Plant Varieties and Farmers' Rights (PPV & FRA) Act, 2001. Applicants submitting such plant material from a country other than India shall make sure that all customs and quarantine requirements stipulated under relevant national legislations and regulations are compiled with.

2. The material is to be supplied in the form of cuttings (stem segment measuring 55 cm length sufficient to produce 2 plants) or one year old plant.

3. The plant material supplied should be visibly healthy, vigour, should be free from any important pest or disease.

4. The plant material should not have undergone any treatment, which would affect the expression of the characteristics of the variety, unless the competent authorities allow or request such treatment. If it has been treated, full details of the treatment must be given.

III. Conduct of Tests

1. The minimum period of DUS tests should generally be two distinct growth cycles. The plants must, in particular, yield a sufficient quantity of fruit throughout each of the two growth cycles.

2. The tests should be carried out under conditions ensuring satisfactory growth for the expression of the relevant characteristics of the variety and for the conduct of the examination. In particular, it is essential that the dragon fruit plant produce a satisfactory crop of fruit in each of the two growing cycles.

3. Test Plot Design

The design of the tests should be such that plants or parts of plants may be removed for measurement or counting without prejudice to the observations which must be made up to the end of the growing cycle.

The additional test protocol for special purposes may be established by PPV & FRA.

1.	Locations	1
2.	Number of replications	3
3.	Treatment unit	4 plants per pole/replication
4.	Spacing	10ft × 10ft
5.	Number of plants	16

On-site DUS Testing

- The applicant or his/her nominee on his/her behalf shall submit a request to the Authority for conducting a reliable trial according to Test Guidelines and the instructions from Authority before on-site examination of the candidate variety.
- The applicant or his/her nominee shall submit a request to the Authority for on-site examination prior to the start of the growing cycle as mentioned in Test Guidelines for site examination of the candidate variety. On-site testing may be conducted at the places specified by the applicant. The age of the trees at on-site shall be a minimum of 3 years.
- As a minimum, 4 poles installed in uniform spacing whereas each pole contain 4 plants, should be available for inspection and examination for 'on-site' DUS testing. The plants must be healthy, free from pests and diseases, and raised under standard management practices.
- For farmer's variety or landraces, the authority may notify suitable guidelines on the number of plant(s) and season(s), if any.
- On-site examination shall be arranged during the fruiting season when distinguishing characteristics of the candidate variety can most easily be seen. The characteristics of the candidate variety can be examined and compared with those of the comparative varieties as per the Test Guidelines.
- The Expert Committee constituted by the PPV & FRA, in consultation with the DUS Centre, shall be authorized to inspect on-site testing and recording the appropriate characters.
- The applicant shall supply the Expert Committee with a summary of distinct characteristics supported by photographs. The Expert Committee shall take notes and observations on distinctness and shall confirm preliminary data and/or summary of distinctness from the applicant.
- The Expert Committee shall submit an examination report to the authority.

IV. Methods and Observations

A. The characteristics described in the Table of Characteristics (see section VII) shall be used for testing varieties and hybrid for their DUS.

1. For the assessment of Distinctiveness and Stability, observations shall be made on 4 poles whereas each pole contain 4 plants in all the directions. In the case of parts of plants, the number to be taken from each of the plants should be 2.

2. For determination of the colour of young stem, newly emerged stem with less than 15 days old should be selected.

3. For recording data on the length of the cladode, margin of rib, spine colour and length of spine, matured stem should be selected for observation.

4. For determination of colour of flower bud, newly emerged 5 days old flower bud should be selected.

5. For recording data on the colour of flower, fully developed inflorescence/flower with visibly separated unopened flower at the day of flower opening should be selected.

6. Observations on length of pericarpel, perianth and whole flower; style length, no. of stigma lobes should be taken on the day of anthesis.

7. The fruit characters should be recorded from fully ripe fruits (ready for consumption).

8. Total Soluble Solids and Betalain content should be analyzed from the pulp of fully ripe fruits

B. The optimum stages of plant growth for assessment of each characteristic are given in the sixth column of the Table of characteristics are described below:

Growth Stages	Codes
Vegetative: Observations on the cladode should be made on mature cladodes not showing signs of active growth.	10
Flowering: Flower should be selected from the exposed regions of the plant. For recording data on colour of flower bud, length of pericarpel, length of perianth, colour of perianth from fully developed flower at the day of opening with visibly unopened flowers should be selected.	20
Fruit ripening: The ripe fruit is the stage where fruit is fully ready for consumption. This stage is reached when the peel colour turns to its varietal trait.	30
Seed: Observations on seed were made by removing seed from fruit.	50

V. Grouping of Varieties

1. The selection of varieties of common knowledge to be grown in the trial with the candidate varieties and the way in which these varieties are divided into groups to facilitate the assessment of distinctness are aided by the use of grouping characteristics.

2. Grouping characteristics are those in which the documented states of expression, even were produced at different locations, can be used, either individually or in combination with other such characteristics: (a) To select varieties of common knowledge that can be excluded from the growing trial used for examination of distinctiveness; and (b) to organize the growing trial so that similar varieties are grouped together.

The following characteristics are to be used for grouping Dragon Fruit varieties:

a)	Young shoot reddish colour	Characteristic 1
b)	Distance between areole	Characteristic 4
c)	Stem Margin	Characteristic 5
d)	Flower Perianth colour	Characteristic 14
e)	Peel colour	Characteristic 27
f)	Pulp colour	Characteristic 28
g)	Betalain content	Characteristic 31
h)	TSS content	Characteristic 30

VI. Characteristics and Symbols

1. To assess Distinctiveness, Uniformity and Stability, the characteristics and their states as given in the Table of characteristics (Section VII) shall be used.

2. Notes (1 to 9) shall be given for each state of expression for different characteristics for the purpose of electronic data processing.

3. Legend (*) Characteristics that shall be observed during every growing season on all varieties and shall always be included in the description of the variety, except when the state of expression of any of these characters is rendered impossible by a preceding phenological characteristic or by the environmental conditions of the testing region. Under such exceptional situation, adequate explanation shall be provided.

   (+) See Explanation on the Table of Characteristics in Section VIII. It is to be noted that for certain characteristics. The plant parts on which observations to be taken are given in the explanation or figure(s) for clarity and not the colour variation.

4. Characteristics denoted with symbols QL and QN in the first column of the Table of characteristics shall be indicated as;

   QL: Qualitative characteristic

   QN: Quantitative characteristic

5. Type of assessment of characteristics indicated in column seven of table of characteristics is as follows:

   MG: Measurement by a single observation on a group of plants or parts of plants

   MS: Measurement of a number of individual plants or parts of plants

   VG: Visual assessment by a single observation on a group of plants or parts of plants

   VS: Visual assessment by observation of individual plants or parts of plants

List of Example Varieties

Selenicereus costaricensis	*Selenicereus undatus*	*Selenicereus meghalanthus*
26/1-Prg.	Thai White	Australian Golden Yellow
CHESH-D2	TLM White	ISIS Gold
Townsend Pink	Vietnam Giant	Palora
Physical Graffiti	Vietnam White	
Haleys Comet	Alice white	
Maria Rosa		
Delight		
Guatemalan Red		
Purple Haze		
Sri-BL		
Royal Red		
Da Hong		
Thailand Red		
Sugar Dragon		
CHESH-D1		
Zamorano		
Nam. C		
Edgar		
Natural Mystic		

VII. Table of characteristics

A. Descriptors for Dragon Fruit

Sl. No.	Characters	State	Note	Example varieties	Stage of observation	Type of assessment
1. * (+) QL	Young stem : reddish colour	a. Absent or weak (N144C-Green group)	3	ISIS Gold	10	VG
		b. Medium (152C-Yellow Green group)	5	Physical Graffiti		
		C. Strong (59C-Red purple group)	7	Zamorano		
2. * (+) QN	Stem: Length of segment	a. Short (< 40 cm)	3	Zamorano	10	VG/MS
		b. Medium (40-69.9cm)	5	CHESH-D1		
		C. Long (> 70cm)	7	Viet.W		
3. * (+) QN	Stem: width	a. Narrow (<5 cm)	3	Sri-BL	10	VG/MS
		b. Broad (>5 cm)	7	Viet. W		
4. * (+) QN	Stem: Shape	a. Triangular	1	Sri-BL	10	VG
		b. T Shape	2	CHESH-D1	10	
5. * (+) QL	Stem: no. of lobes	a. Few (<2)	3			
		b. many (>2)	7			
6. * (+) QN	Stem: distance between areole	a. Short (<2.75cm)	3	Zamorano	10	VG/MS
		b. Medium (>2.75-5.5cm)	5	Da Hong		
		C. Long (>5.5 cm)	7	Vietnam Giant		
7. * (+) QN	Stem: margin of rib	a. Concave	1	Palora	10	VG
		b. Straight	2	Thailand Red		
		c. Convex	3	Alice White		
8. * (+) QL	Areola: number of spines	a. Few (<3)	3	Physical Graffiti	10	VG
		b. Medium (>3 -5)	5	CHESH-D1		
		c. Many (>5)	7	Royal red, Zamorano		
9. * (+)	Spine: length	a. Short (<3 mm)	3	Sri-BL	10	VG/MS
		b. Long (>3 mm)	7	Zamorano		

QL						
10. * (+) QL	Spine: main colour	a. Grey (201B-Grey group)	1	CHESH-D1	10	VG
		b. Light brown (	3	Palora		
		c. Dark brown (200D-Brown group)	5	Zamorano		
11. * (+) QL	Flower bud : shape	a. Ovate	1	Guatemalan Red	20	VG
		b. Elliptic	2	Nam. C		
		c. Spheroid	3	Australian golden yellow		
		d. Oblate	4	Royal Red		
12. * (+) QN	Flower bud: shape of apex	a. Acute	2	CHESH-D1	20	VG
		b. Round	4	Royal Red		
13. * (+) QN	Flower bud: colour	a. Green (143B-Green group)	3	ISIS Gold	20	VG
		b. Pink (59A-Red purple group)	5	Connie Meyer		
		c. Red (N186C-Greyed purple group)	7	Palora, CHESH-D1		
14. * (+) QL	Flower bud: length of pericarp	a. Short (9.0 - 12.0 cm (> 9cm)	3	CHESH-D1	20	VG/MS
		b. Medium (12.1-17.0 cm (>12.1 cm)	5	Guatemalan Red		
		C. Long (17.1-28.0 cm (> 17.1 cm))	7	Palora		
15. * (+) QL	Flower bud: length of perianth	a. Short (6.0- 8.0 cm (>6 cm)	3	Palora	20	VG/MS
		b. Medium (8.1-13.0 cm (> 8.1 cm))	5	Guatemalan Red		
		C. Long (13.1-16 cm (>13.1 cm)	7	CHESH-D1		
16. * (+) QL	Flower: Length	a. Short (<20.0 cm)	3	Connie Meyer	20	VG/MS
		b. Medium (20.0-30.0 cm)	5	Guatemalan red		
		C. Long (>30.00 cm)	7	Palora		
17. * (+) QN	Flower: Diameter	a. Narrow	3	Connie Meyer	20	VG/MS
		b. Broad	7	CHESH-D1		

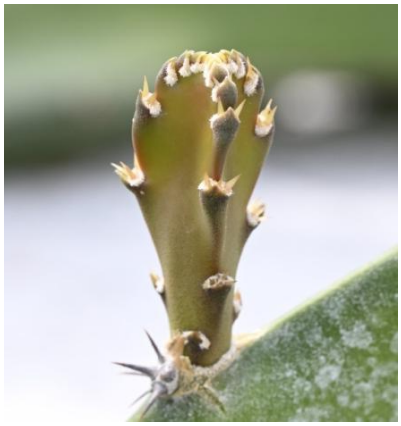
18. * (+) QN	Flower: Perianth colour	a. Weak (146B-Yellow Green group)	1	TLM White	20	VG
		b. Medium (144C-Yellow Green)	2	CHESH-D1		
		C. Strong (59A-Red Purple group)	3	Connie Meyer		
19. * (+) QL	Petal (Petaloid tepal): colour	a. White (NN155B-White group)	2	Purple Haze, CHESH-D1	20	VG
		b. Purple (N74A-Red purple)	4	Connie Meyer		
20. * (+) QN	Sepal (Sepaloid tepal): main colour	a. Green (144C-Yellow green group)	2	Australian golden yellow	20	VG
		b. Red (59A- Red purple)	4	Connie Meyer		
21. * (+) QL	Flower: length of style	a. Short (<20 cm)	3	Connie Meyer	20	VG/MS
		b. Long (>20 cm)	7	Palora		
22. * (+) QL	Flower: number of stigma lobes	a. Few (<20)	3	Connie Meyer	20	VG
		b. Medium (20-28)	5	Maria Roza, Physical graffitti		
		c. Many (>28)	7	Sugar Dargon		
23. * (+) QN	Flower: colour of stigma lobe	a. Cream (NN155A-White group)	1	Connie Meyer	20	VG
		b. Green (149A-Yellow Green group)	3	Palora		
24. * (+) QN	Flower: position of anther in relation to stigma	a. Short (>1.0 cm)	3	Connie Meyer	20	VG
		b. Medium (0 cm)	5	Nam. C., CHESH-D1		
		c. Long (0.5-0.8 cm)	7	Sugar Dragon		
25. * (+) QL	Flower: Spines on pericarp	a. Present	2	Palora	20	VG
		b. Absent	4	CHESH-D1		
26. * (+) QN	Fruit: Shape	a. Oval	1	Nam. C	30	VG/MS
		b. Globose	2	CHESH-D1		
		c. Oblate	3	Guatemalan Red		

27. * (+) QL	Fruit: number of bracts	a. Low (< 20)	3	Haleys Comet	30	VG
		b. Medium (21-30)	5	Edgar		
		c. High (>30)	7	CHESH-D2, Da Hong		
28. * (+) QL	Fruit: length of apical bract	a. Short (<5 cm)	3	Haleys Comet	30	VG/MS
		b. Medium (>5- 7 cm)	5	Zamorano		
		C. Long (>7 cm)	7	Da Hong, CHESH -D2		
29. * (+) QL	Fruit: colour of fruit bract	a. Green (143A-Green group)	2	Makisupa, Alice White,	30	VG
		b. Pink (58C-Red purple group)	4	CHESH-D2,		
		c. Red (59B-Red purple group)	6	Zamorano		
30. * (+) QL	Fruit: thickness of peel	a. Thin (<5 mm)	3	Thai White	30	VG/MS
		b. Thick (>5 mm)	7	Guatemalan Red		
31. * (+) QN	Fruit: colour of peel	a. Green (141C-Green group)	2	Connie Meyer	30	VG
		b. Yellow (2B-Yellow group)	4	Israel Yellow		
		c. Dark pink (58B-Red purple group)	6	Da Hong, CHESH-D2		
		d. Red (61B- Red Purple group)	8	Natural Mystic		
32. * (+) QL	Fruit: colour of Pulp	a. White (NN155B-White group)	2	Viet.W, TLM white	30	VG
		b. Pink (68A-Red purple group)	4	Townsend pink, Da Hong		
		c. Red (67C-Red purple group)	6	Royal Red, CHESH-D3		
33. * (+) QL	Fruit: Bract	a. Absent	2	CHESH-D1	30	VG
		b. Present	4	Palora		
34. * (+) QL	Fruit: Spines on fruit	a. Absent	2	CHESH-D1	30	VG
		b. Present	4	Palora		
35. * (+) QL	Seed Hardness	a. Soft	2	CHESH-D1	40	MS
		b. Hard	4	Palora		

36. * (+) QL	Fruit: sweetness	a. Low (9 -12 °B)	3	Zamorano, Royal red	30	MS
		b. Medium (13-16°B)	5	CHESH-D1, Siam Red		
		c. High (17- 20 °B)	7	Palora, Haleys Comet		
37. * (+) QL	Betalaine (mg BCE)	a. Low/absent (0)	1	TLM White, Hirehalli white	30	MS
		b. High (15-23)	2	Sugar dragon		

VIII. Explanation for table of characteristics

Strong



Medium

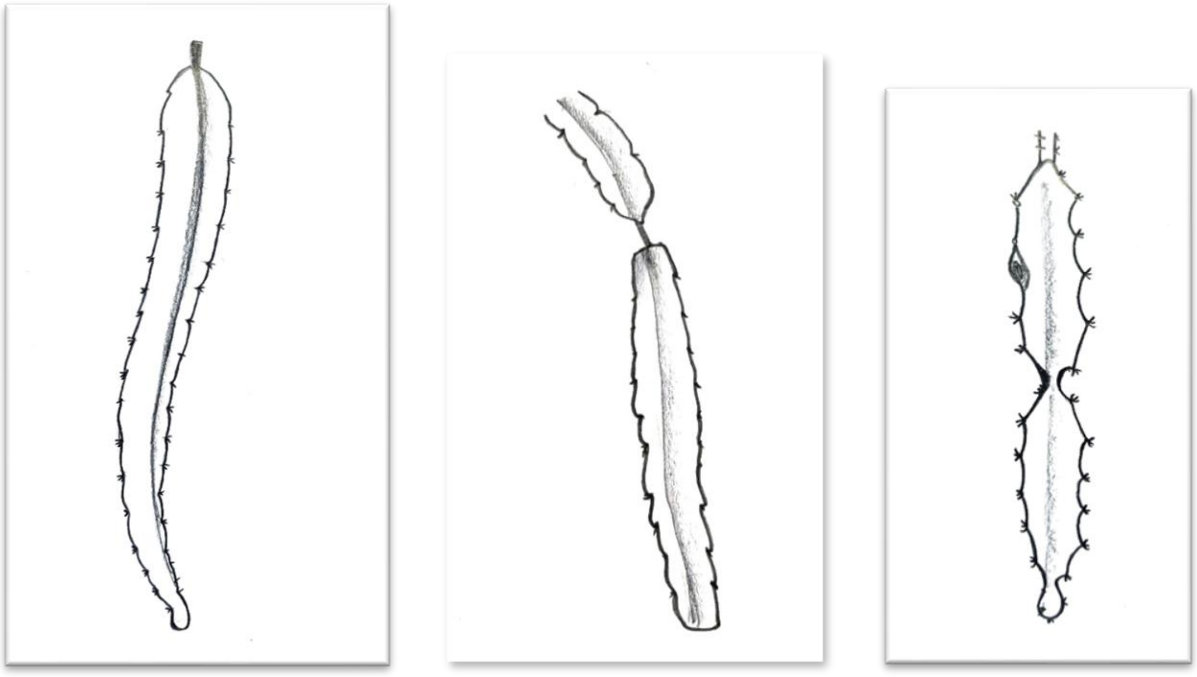
Absent/ Low

Characteristic 1. Young stem: Reddish colour

Long

Medium

Short

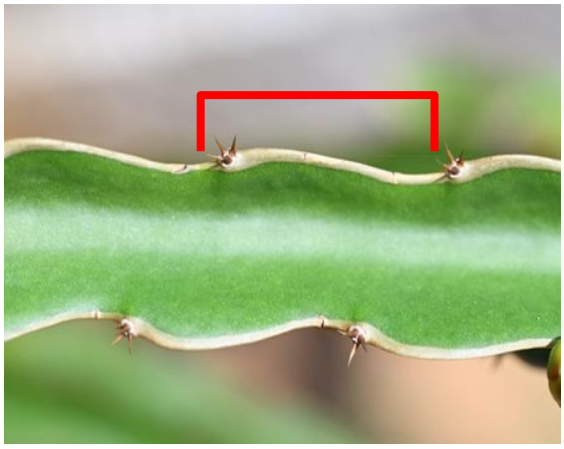


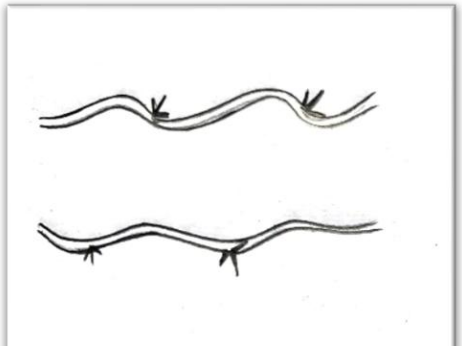
Characteristic 2. Stem: Length of segment

Narrow/Triangular

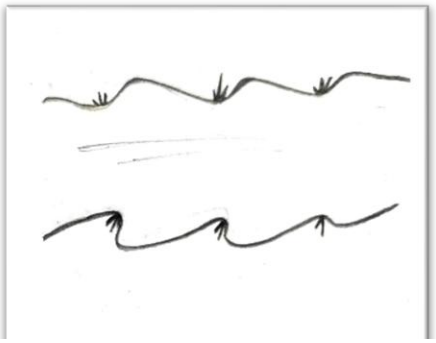
Broad/T-Shape

Characteristic 3, 4 &5. Stem: width, Shape & no. of lobes

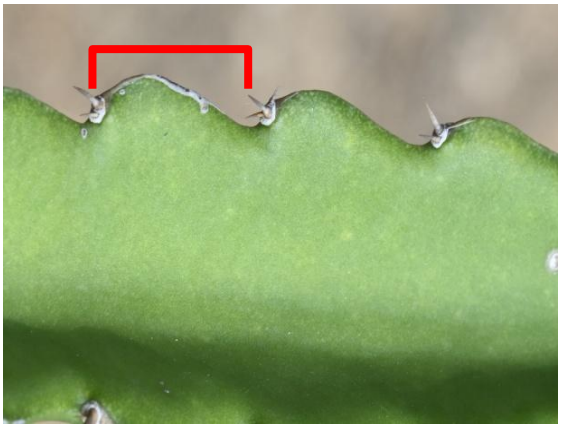


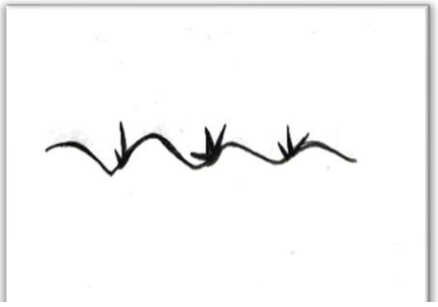


Long



Medium

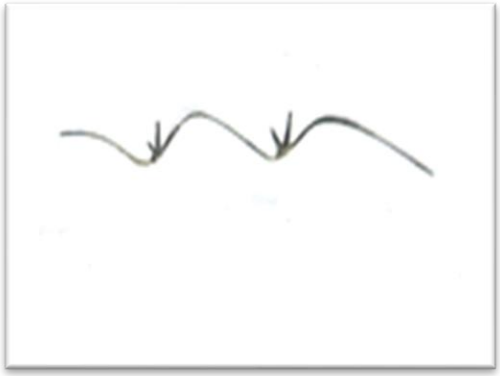




Short

Characteristic 6. Stem: Distance between areole

Concave



Convex

Straight

Characteristic 7. Stem: Margin of rib

Few

Medium

Many

Characteristic 8. Areola: Number of spines

Short

Long

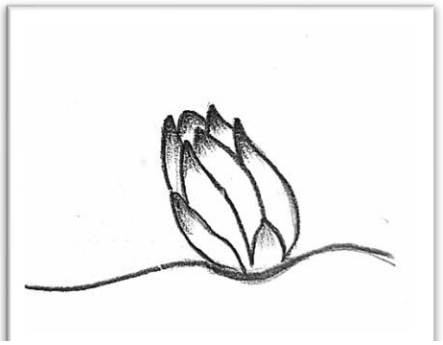
Characteristic 9. Spine: Length

Grey

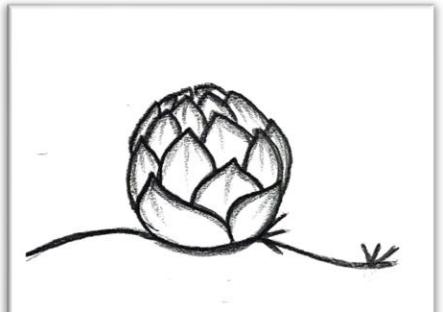
Light Brown

Dark Brown

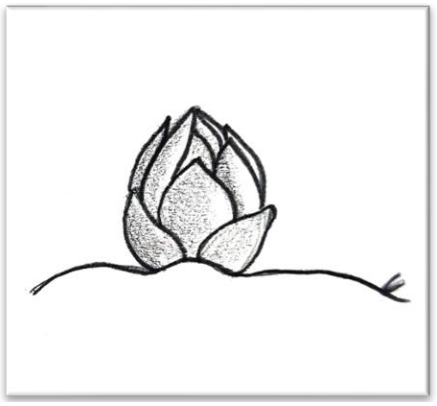
Characteristic 10. Spine: Main colour



Elliptic



Oblate

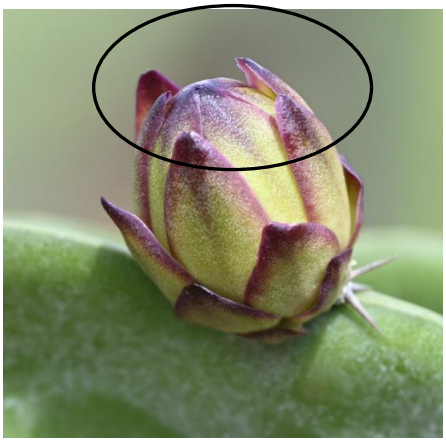


Circular

Ovate

Characteristic 11. Flower bud: Shape

Acute



Round

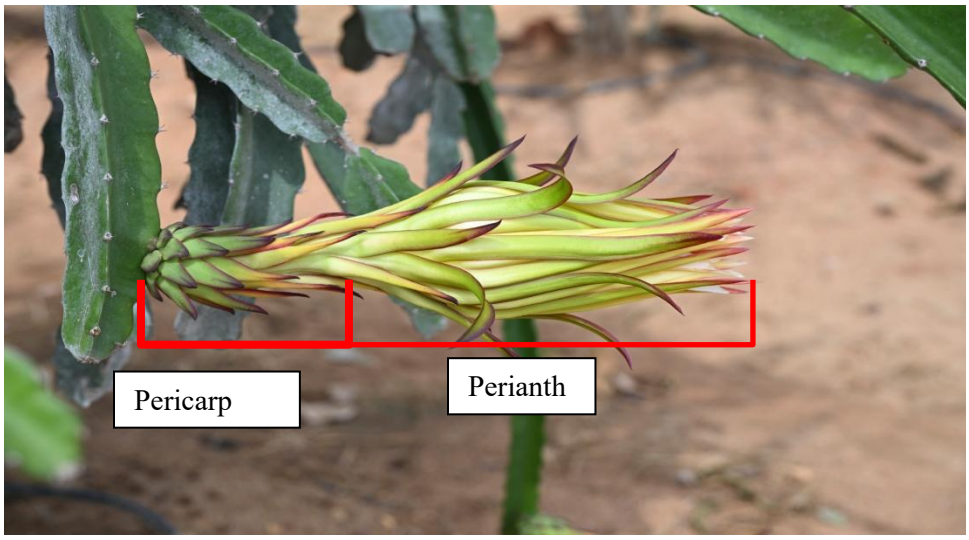
Characteristic 12. Flower bud: Shape of apex

Green

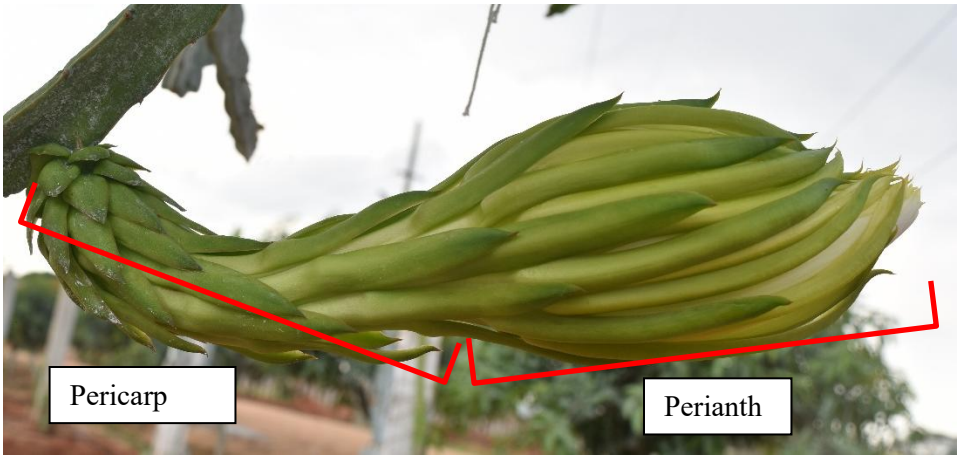
Pink

Red

Characteristic 13. Flower bud: Colour



Low



Medium

High

Characteristic 14, 15&16. Flower bud: Length of Pericarp, Perianth and whole flower bud

Narrow

Broad

Characteristic 17. Flower: Diameter

Green

Intermediate

Purple

Characteristic 18. Flower: Perianth colour

White

Purple

Characteristic 19. Flower: Petal (Petaloid tepal) colour

Red

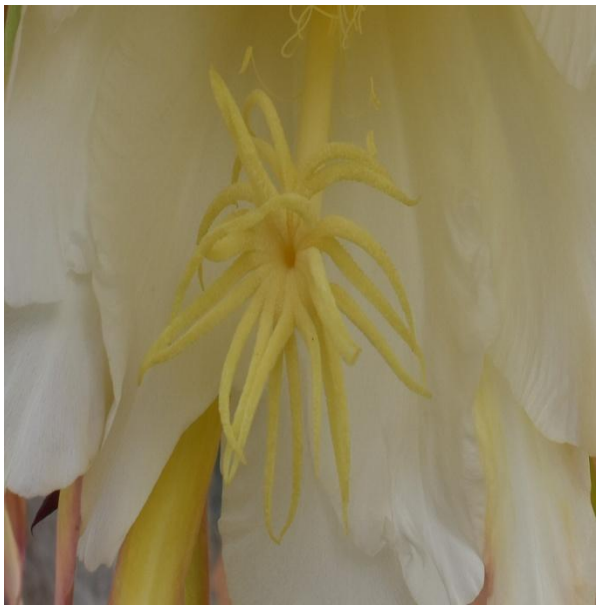
Green

Characteristic 20. Flower: Sepal (Sepaloid tepal) colour

Short

Long

Characteristic 21. Flower: Length of Style

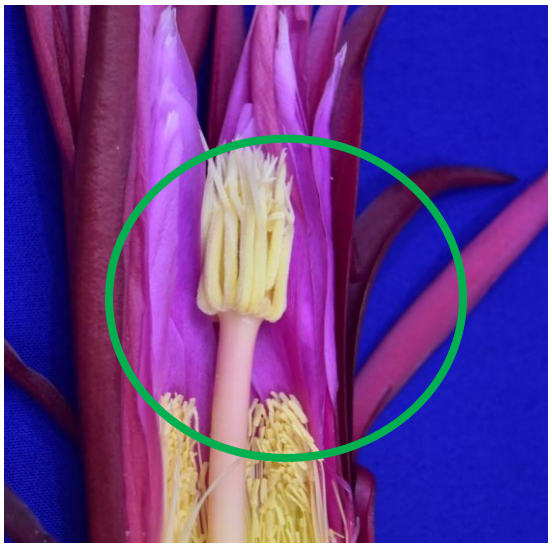


Many

Medium

Low

Characteristic 22. Flower: Number of stigma lobes

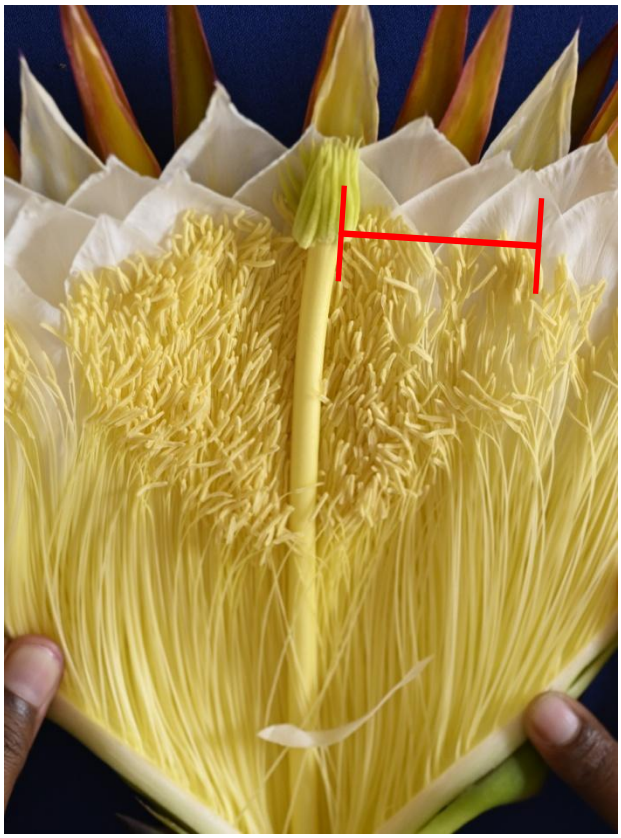


Cream

Green

Characteristic 23. Flower: Colour of stigma lobes

Short



Medium

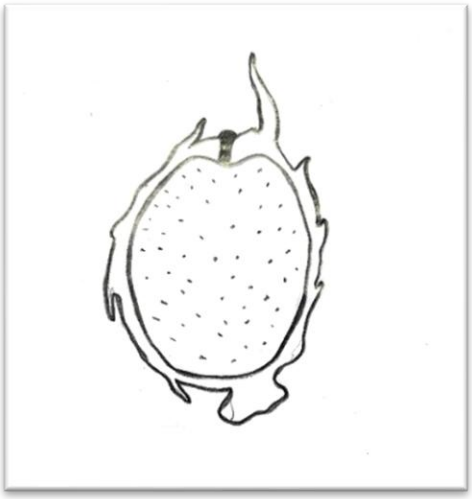
Long

Characteristic 24. Flower: Position of anthers in relation to stigma

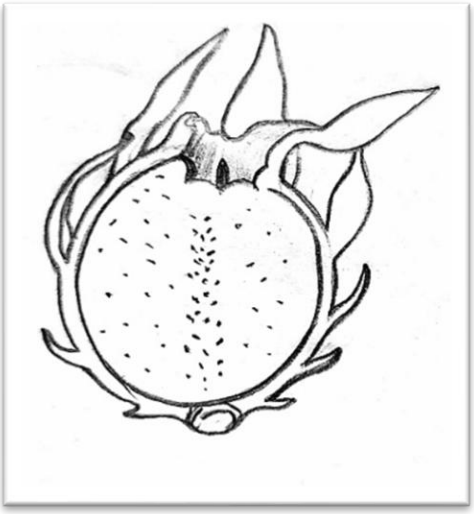
Spines present

Spines absent

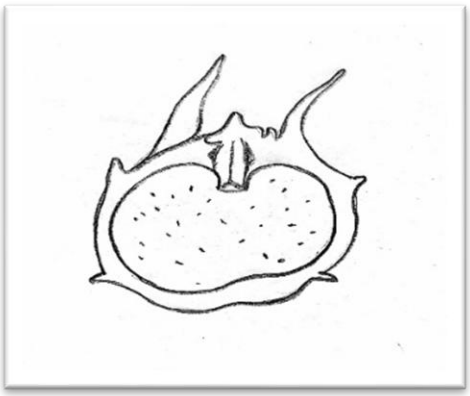
Characteristic 25. Flower: Spines on Pericarp



Oval



Globose



Oblate

Characteristic 26. Fruit: Shape

Many/Long

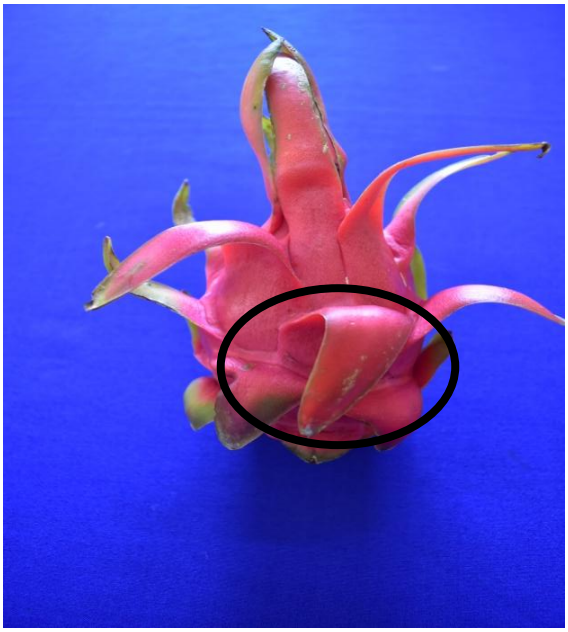
Medium/Medium

Low/Short

Characteristic 27 & 28. Fruit: Number of bracts & length of apical bract

Green

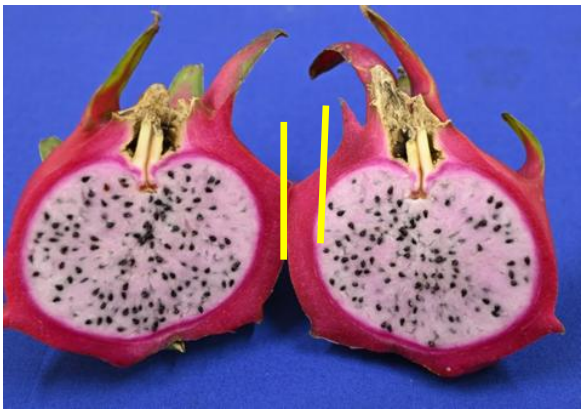
Red



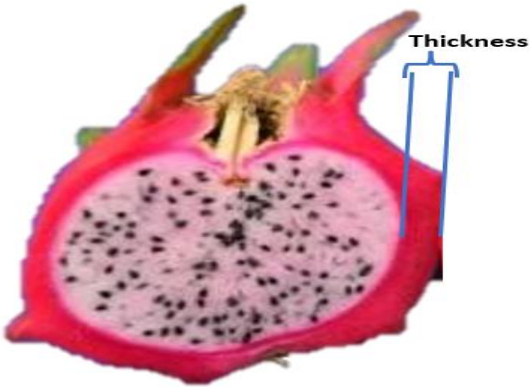
Pink

Characteristic 29. Fruit: Colour of fruit bract

Thin



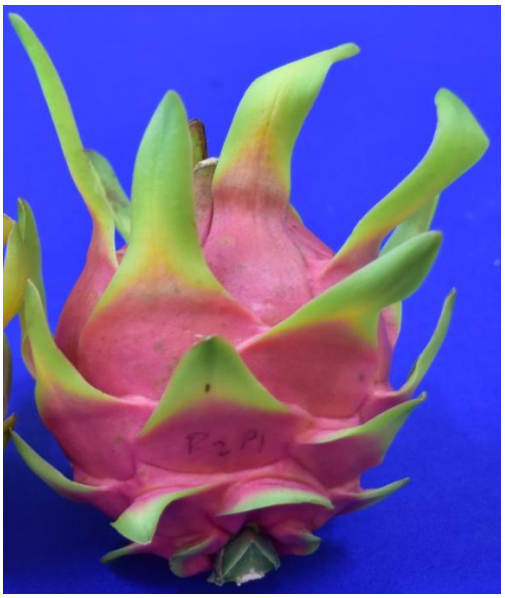
Thick



Characteristic 30. Fruit: Thickness of peel

Green

Yellow

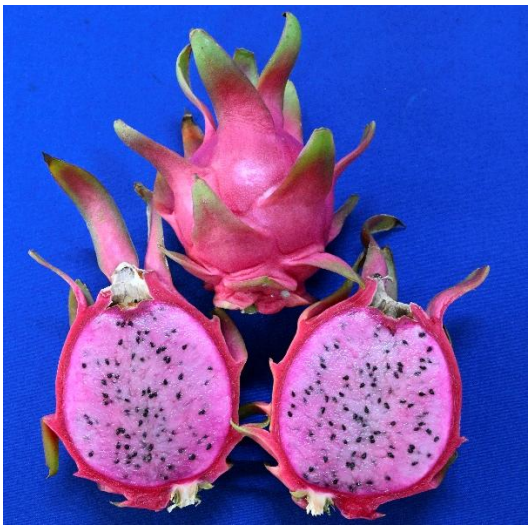


Medium pink

Red

Characteristic 31. Fruit: Colour of peel

White



Pink

Red

Characteristic 32. Fruit: Colour of Pulp

Bract Present/Spine absent

Bract absent/Spine present

Characteristic 33&34. Fruit: Bract & Spines on fruit

Hard

Soft

Characteristic 35. Seed: Seed Hardness

IX. Working Group details

The DUS test guidelines developed by the Task force constituted by the PPV&FRA Authority for Dragon fruit (*Selenicereus* sp.) in ICAR-IIHR Experimental Farm, Hirehalli, Tumakur, Karnataka. Technical inputs also provided by the PPV&FRA Authority.

Sl.no.	Name & Designation	Role
1	Dr. Dinesh M.R., Director (Retd), ICAR- Indian Institute of Horticultural Research, Bengaluru-560089, Karnataka Email: drmrdinesh@gmail.com Mobile: 9448064198	Chairman
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4	Dr. Prakash Patil, Project coordinator, AICRP on Fruits, ICAR-Indian Institute of Horticultural Research, Bengaluru-560 089, Karnataka Email: pcfruits@gmail.com Mobile:9449065722	Member
5	Dr. U K Dubey Joint Registrar, Plant Authority Bhawan Protection of Plant Varieties and Farmers' Rights Authority, New Delhi Email: uk.dubey@gov.in Mobile: 7217633991	Member Secretary
6	Dr Karunakaran G, Principal Scientist, Division of Fruit Crops, ICAR-Indian Institute of Horticultural Research, Bengaluru-560 089, Karnataka Email: karanstg@gmail.com Mobile: 9483233804	PI of Project

X. Nodal Officer

PI

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XI. Name of DUS Test Centre

Nodal Centre (DUS Test)
ICAR- IIHR Experimental Farm, Hirehalli, Tumkur- 572168, Karnataka
Collaborating Centre (DUS Test)
ICAR-National Bureau of Plant Genetic Resources, Regional Station, Hyderabad