GUIDELINES
FOR THE CONDUCT OF TEST FOR DISTINCTIVENESS, UNIFORMITY AND STABILITY

On

Papaya

(Carica papaya L.*)*

Protection of Plant Varieties and Farmers' Rights Authority

(PPV & FRA)

Government of India

Contents

Papaya (*Carica papaya* L)

I. Subject

These test guidelines shall apply to all the varieties, hybrids and parental lines of papaya (*Carica papaya* L.)

II. Materials required

1. The Protection of Plant Varieties and Farmers' Rights Authority (PPV & FRA) shall decide when, where and in what quantity and quality the plant material is required for testing a variety applied for registration under the Protection Plant Varieties and Farmers' Rights Authority (PPV & FRA) act, 2001. Applicants submitting seed or plant material from a country other than India must make sure that all customs and phytosanitary requirements stipulated under relevant national legislations and pre and post quarantine regulations are complied with.

2. The seeds supplied should be visibly healthy, not lacking in vigour, nor affected by any pests or diseases. The seed material should meet the minimum requirements for germination capacity (60%), moisture content (7% for ambient storage), physical and genetic purity (>98% for varieties and >90% for hybrids). The minimum quantity of seed material, to be supplied by the applicant, should be 20 g in gynodioecious varieties and 40 g in dioecious varieties for both the seasons.

3. Tissue cultured plant materials of gynodioecious varieties if are to be tested, then healthy and well hardened fifty well rooted plants be supplied for each location along with the necessary phyto-sanitary certificate indicating their freedom from viruses or pests or any such systemic infections.

4. The seed/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 for such treatment(s). If it has been treated, full details of the treatment must be mentioned explicitly.

5. The seeds/ planting materials should be supplied afresh in each growing season and at the beginning of each of the growing cycle.

III Conduct of tests

1. The minimum duration of DUS tests for the new varieties shall normally be at least two independent growing cycles. Tests should be conducted in at least two places. The growing cycle is considered as the duration of a single growing season, beginning with vegetative growth, followed by flowering and fruit harvest.

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 plants produce a satisfactory crop of fruit in each of the two growing cycles.

3. If a crop cycle is affected due to natural circumstances and if any essential characteristic of the candidate variety is not expressed for visual observations at these locations, the variety shall be considered for further examination at appropriate test site or under special test protocol on expressed request of the applicant, for which additional quantity of seeds or planting materials shall be required.

4. The field tests shall be carried out under open field conditions favoring normal growth and expression of all the test characteristics.

5. The design of the tests should be such that it should result in observations from a total of 36 fruit bearing plants at 12 plants per replication) in each of the test locations for each entry in each of the growing cycles and should facilitate plants or parts of plants to be sampled for measurement or counting without prejudice to the observations which must be made up to the end of the growing cycle.

6. Test Plot Design: The test materials are required to be planted at a spacing of 1.8 m x 1.8 m with a minimum of three replications having 12 fruit bearing plants per replication (totaling to 36 plants) for taking observations. In dioecious varieties, apart from 12 fruit bearing trees, three male plants per replication has to be maintained for recording observation.

7. The fruit bearing plants mentioned in these guidelines refers to the hermaphrodite and female plants of gynodioecious varieties and female plants in dioecious varieties.

8. Plants of at least 25-30 cm in height, with a basal stem girth of 2.0 to 2.4 cm and having well developed root and healthy shoot systems with 9-12 leaves should be used for evaluation.

9. On-site testing: On- site testing will be considered when desirable traits fail to express to the fullest extent under a particular environment depending upon the number of entries.

IV. Methods and observations

1. The characteristics described in the table of characteristics (see section VII) shall be used for the testing of varieties and hybrids for their DUS characteristics.

2. For the assessment of distinctness and stability, observations should be recorded on all the 36 fruit bearing plants and or parts of 36 fruit bearing plants, which shall be divided among the three replications having 12 plants per replication. For the assessment of quantitative and qualitative traits, three parts from each of the 36 plants shall be sampled.

3. The assessment for uniformity of characteristics shall be undertaken on simple visual observations of a group of plants or parts of plants. During such observation, the entry shall be deemed uniform when the number of aberrant or odd plants or parts of plant shall not exceed one in 12. A population standard of 1.0% with an acceptance probability of at least 95% should be applied. In the case of a sample size of 36 plants, the number of off types should not be more than one per replication.

4. The seedlings are transplanted at 30-45 days after germination in the main field. In case of dioecious varieties, five plants are planted per pit, so that early flowering males are removed, to maintain one male plant for every 12-15 female plants.

5. The number of nodes to first flower should be observed from the ground level up to the node at which the first flower emerges.

6. The length of the middle inter node (distance between two successive nodes) should be recorded at half the plant height, after taking the full plant height from the soil level to the growing tip of the plant at first flowering stage.

7. The height to first fruiting should be recorded from the ground level to first fruit set at the fruiting stage.

8. All the observations pertaining to leaf parameters shall be recorded on the fully expanded 5th leaf marked from the just expanded first terminal leaf on the main stem.

9. All the observations on inflorescence and number of nodes to first flower should be made at the time of flowering. Flowering is considered to begin when the first flower on the inflorescence has fully opened and observations on the flower shall be made on the most recently opened flower on the inflorescence before fading of colour.

10. Fruits are to be harvested when streaks of yellow pigmentation appear on the pericarp of mature fruits on the plant. The fruits after harvest can be kept for natural ripening under ambient condition for proximate analysis.

11. The fruit characters shall be recorded at full maturity / edible ripeness stage from the fruits harvested at periodical intervals from each test plant. The fruit ridges are to be observed in the transverse section and the central cavity diameter recorded at the broadest part. The fruit cavity index shall be calculated as the ratio of the fruit cavity volume to fruit volume and expressed in percentage.

12. For the assessment of colour characteristics, Royal Horticultural Society (RHS) colour chart shall be used wherein the specific colour groups shall be mentioned with distinctiveness.

13. A code number in the sixth column of the Table of characteristics indicates the optimum stage for the observation of each characteristic during the phenological stages of the plant growth and development. The relevant growth stages corresponding to these code numbers are described below:

Sl. No.	**Stage of observation**	**Decimal coding**
1	At flowering	10
2	After fruit set and before the harvest of first fruit	20
3	At the time of first fruit harvest	30
4	At edible stage of ripe fruit after harvest	40

V. Grouping of varieties

a. The candidate varieties for DUS testing shall be divided into groups in order to facilitate the assessment of distinctiveness. Characteristics, which are suitable for grouping purpose, are those which are known from experience not to vary or to vary only slightly, within a variety and in their various states are fairly evenly distributed across all the varieties in the collection.
b. The following characteristics are proposed for the grouping of varieties:
    a. Plant: Sex type (Characteristic 4)
    b. Plant: Height to first fruit(Characteristic 6)
    c. Fruit : Shape (Characteristic 9)
    d. Fruit : Pulp Colour (Characteristic 11)
    e. Fruit: Shape of central cavity (Characteristic 20)

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 for the colour variation.

4. Characteristics denoted with symbols **QL, QN** and **PQ** in the first column of the Table of characteristics shall be indicated as;
   QL: Qualitative characteristic
   QN: Quantitative characteristic
   PQ: Pseudo-qualitative characteristic

5. Type of assessment of characteristics indicated in column 7 of table of characteristics is as follows;
   MG: Measurement by a single observation of 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 of a group of plants or parts of plants
VS: Visual assessment by observations of individual plants or parts of plants

VII . Table of Characteristics

Sl. No	Characteristics	States	Note	Example varieties	Stage of observation	Type of assessment
1	2	3	4	5	6	7
1 (*) **QN**	Number of nodes to first flower	Low (<30)	3	Pusa Nanha	10	**MS**
		Intermediate (>30 but<40)	5	Arka Prabhath, Arka Surya, CO.2, CO.5, CO.7, TNAU PAPAYA CO.8		
		High (>40)	7			
2 **QN**	Length of middle internode on tree (cm)	Short (<3)	3	Pusa Nanha	10	**MS**
		Intermediate (>3.0 but <4.5)	5	Arka Prabhath, Arka Surya, CO,2, CO.7, CO.8		
		Long (> 4.5)	7	CO.5, Washington		
3 **PQ**	Colour of mature leaf petiole	Green	3	CO.2, CO.6	10	**VG**
		Green with light purple tinge	5	CO.4, CO.7, Sunrise Solo, Arka Prabhath		
		Purple	7	CO.5, Washington		
4 (*) **PQ**	Sex type	Dioecious	1	Pusa Nanha, CO.2, CO.5, CO6, TNAU PAPAYA CO.8	10	**VS**
		Gynodioecious	2	Arka Surya, Arka Prabhath, CO.3, CO.7		
5 **PQ**	Colour of inflorescence stalk	Green	1	Arka Prabhath, CO.2, CO.6	10	**VG**
		Purple/Pink	2	CO.5,Washington		

6 (*****) **QN**	Height to first fruit(m) (Bearing height)	Low (<1.0)	3	Pusa Nanha	20	**MS**
		High (> 1)	5	CO.2, CO.5, CO.7, CO.8 Arka Prabhath, Surya		
7 **(***) **QN**	Number of fruits on trunk at first harvest	Low <30	3	Pusa Dwarf, Pusa Nanha CO.1	30	**MS**
		Intermediate (>30 but <40)	5	Arka Prabhath, Surya		
		High (>40)	7	CO.2 CO.7, CO.8		
8 **PQ**	Stem colour of adult plant	Greenish or Greyish brown	1	Pusa Nanha, CO.2, Arka Surya	30	**VG**
		Green with shades of red – purple (pink)	2	CO.5, Washington		
9 (*****) **PQ** (+)	Fruit shape	Pear shaped (Pyriform)	1	Arka Surya, Sunrise Solo (Hermaphrodite)	40	**VG**
		Lengthened cylindrical	2	Arka Prabhath (Hermaphrodite)		
		Oblong-ellipsoid	3	CO.7		
		Globular to high round	4	Arka Surya (Female), Pusa Nanha, CO.1	40	**VG**
		Oblong-Ovate	5	CO.2, CO.8		
10 (*****) **PQ** (+)	Fruit Apex (Stylar tip)	Blunt	1	Arka Surya (Female), CO.4	40	**VG**
		Depressed	2	Arka Surya (Hermaphrodite), Arka Prabahth		
		Prominent	3	Arka Prabhath (Female), CO.2, CO.8		
11 (*****) **PQ**	Fruit pulp colour (As per RHS colour chart)	Yellow	3	CO1, CO.4	40	**VG**
		Yellow orange	5	Pusa Nanha		
		Orange red	7	Arka Surya,		

				Arka Prabhath CO.7, CO.8		
12 **PQ** (+)	Fruit shape of stalk end (stylar base)	Depressed	1	Pusa Nanha	40	**VG**
		Flattened	2	Arka Prabhath, Surya, CO.7		
		Inflated	3	CO.3		
13 **QL**	Ridging on Fruit surface	Absent	3	Washington, CO.4	40	**VG**
		Present	5	CO.8, Arka Surya (Female)		
14 (*****) **QN**	Fruit weight (kg)	Low (<0.5)	3	Sunrise Solo	40	**MS**
		Intermediate (>0.5 but <1.0)	5	CO.3 , Arka Surya		
		High (>1.0)	7	CO.6, TNAU PAPAYA CO.8, Arka Prabhath		
15 (*****) **QN**	Fruit length (cm)	Short (<15)	3	CO.3, Sunrise Solo, Arka Surya (Female)	40	**MS**
		Intermediate (>15 but <25)	5	CO.7, CO.4 , Arka Prabhath		
		Long (>25)	7	CO.2, CO.8		
16 (*****) **QN**	Fruit diameter (cm)	Low (<10)	3	CO.3, Sunrise Solo, Arka Surya	40	**MS**
		Intermediate (>11but <13)	5	CO.7, Arka Prabhath		
		High (>13)	7	CO.2, CO.8		
17 (*****) **QN**	Pulp thickness (cm)	Thin (< 2.5)	3	CO.3, CO.7	40	**MS**
		Thick (>2.5)	5	Arka Prabhath, CO.3, CO.2, CO.8		
18 **QN** (+)	Central cavity diameter (cm)	Low (<7)	3	Sunrise Solo	40	**MS**
		Intermediate (>7 but <9)	5	Arka Prabhath, Pusa Nanha		
		High (>9)	7	CO.2, CO.4		
19 (*****) **QN**	Fruit cavity index (%)	Low (<25)	1	CO.7, Arka Prabhath	40	**MS**
		High (>25)	2	CO.2,CO.4, CO.8		

20 (*) **PQ** (+)	Shape of central cavity	Star shaped	1	Arka Surya	40	**VG**
		Angular	2	CO.8		
		Circular or round	3	CO.1 ,CO.2,		
		Irregular	4	Washington		
21 (*) QN	TSS (°Brix)	Low (<11)	1	CO.1	40	**MS**
		High (>11)	2	ArkaPrabhath, Arka Surya, CO.2, CO.7, CO.8		
22 (*) **QN**	Pulp firmness at edible stage (kg/cm ^{2})	Low (<3)	3	CO.1	40	**VG**
		Intermediate (>3 but <5)	5	CO.2, CO.5, CO.6, Arka Surya, CO.7		
		High (>5)	7	Arka Prabhath		

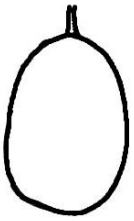
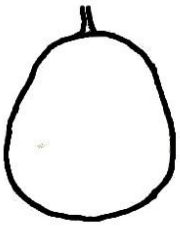
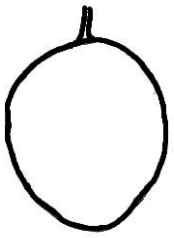
Note

19. Fruit cavity index is calculated as the ratio of fruit cavity volume to fruit volume and expressed in percentage.

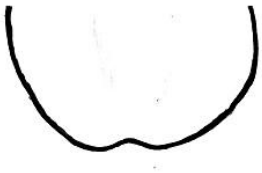
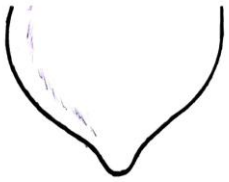
22. Pulp firmness at edible ripeness is recorded using a penetrometer and expressed as kg/cm ^{2}

VIII . Explanation for the Table of Characteristics

Characteristic 10. Fruit : General shape

				
Pear shaped	Lengthened cylindrical	Oblong ellipsoid	Globular to round	Oblong Ovate

Characteristic 11. Fruit: Apex (stylar tip)

		
Blunt	Depressed	Prominent

Characteristic 13. Fruit: Shape of stalk end (stylar base)

		
Depressed	Flattened	Inflated

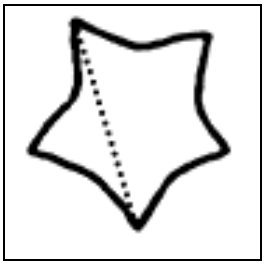
Characteristic14. Ridging on fruit surface

To be observed in transverse section

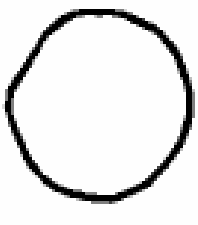
	
Absent	Present

Characteristic 18. Fruit : Central cavity diameter

The width of the central cavity should be recorded at the broadest part



Characteristic 21. Fruit : Shape of central cavity

			
Star shaped	Angular	Circular or absent	Irregular

IX. Working Group details

The test guidelines were developed by the Principal Investigators at the Nodal centre at Indian Institute of Horticultural Research, Hessaraghatta, Co-nodal centre at Tamil Nadu Agricultural University and the Task Force (8/2011) constituted by the PPV&FRA . Technical input was also provided by Dr. Manoj Srivastava, Registrar, PPV&FRA.

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XI. Name of DUS Test Centres:

Nodal DUS Centre	Co-Nodal Centre
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