Role of DUS test and Functional characteristics

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July 26-29th ,2017

Contents

UPOV principles

Conditions for Protection

Article 5; 91 Act of the UPOV

[Criteria to be satisfied] The breeder's right shall be granted where the variety is

- **New**
- **Distinct**
- **Uniform**
- **Stable**

[*Other conditions*] …..denomination, fees

What is DUS?

D: must be distinguishable from any other varieties

What is DUS?

U: must be uniform

What is DUS?

S: **must be unchanged after repeated propagation**

Next generation

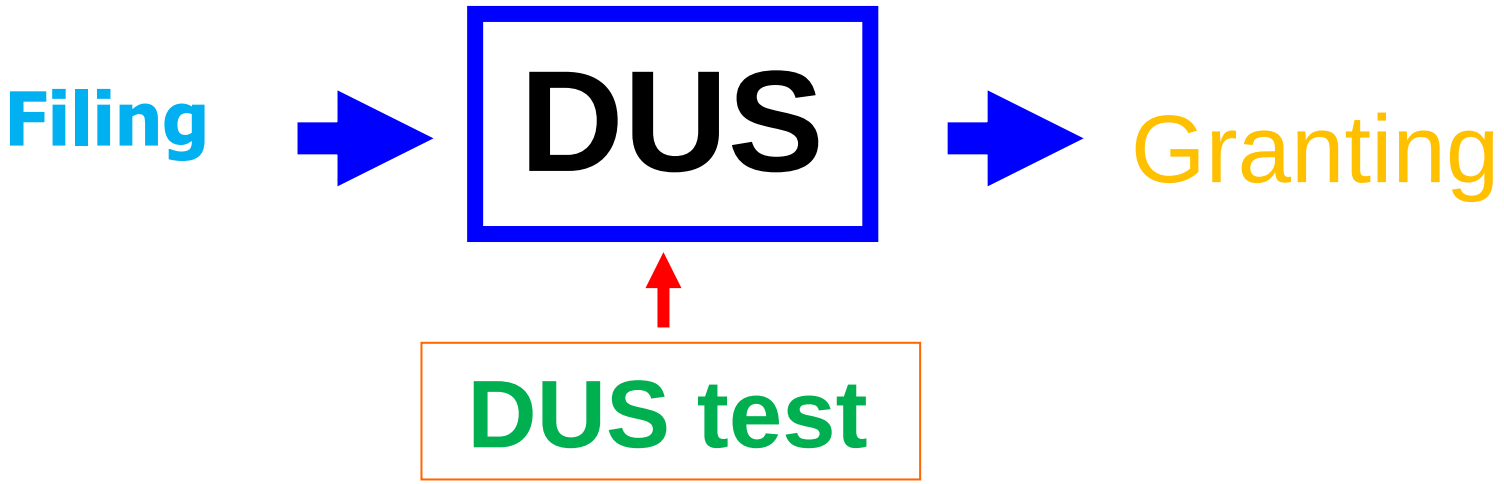
Next generation

UPOV principles

Examination of the Application

Article 12; 91 Act of the UPOV

Any decision to grant a breeder's right shall require an examination for compliance with the conditions under Articles 5 to 9.



Purpose of DUS test: to access whether the variety comply with the DUS requirements

What should we do in the DUS test?

Purpose of DUS test

- **Characteristics as the Basis for Examination of DUS** TG/1/3: 2.4

1. For any variety to be capable of protection it must first *be clearly defined.*
2. Only after a variety has been defined can it *be finally examined for fulfillment of the DUS criteria* required for protection.

3. UPOV convention have established that *a variety is defined by its characteristics and those characteristics are the basis on which a variety can be examined for DUS.*

purpose of DUS test

1. Definition of the variety by the expression of characteristics
2. Examination of the DUS

DUS test

1. Definition of a variety

by the expression of characteristics

Definition of a variety

Definition of a variety
by the expression of characteristics

To clarify the expression of characteristics , then make a variety description of the variety

example; variety description of tomato

Definition of a variety

TGs for tomato

■ Variety description

total 60 chars.

Char No.	Characteristics	States of Expression
1	Seedling: anthocyanin coloration of hypocotyl	9
2	Plant: growth type	1
3	Only determinate growth type varieties: Plant: number of inflorescences on main stem (side shoots to be removed)	5
4	Stem: anthocyanin coloration of upper third	3
5	Only indeterminate growth type varieties: Stem: length of internode (between 1st and 4th inflorescence)	
6	Leaf: attitude (in middle third of plant)	5
7	Leaf: length	5
8	.....	..

The variety description → defined by the expression of characteristics

Definition of a variety

TGs for tomato

	English	Note	Example varieties
1	**Seedling: anthocyanin coloration of hypocotyl**		
QL VG	absent	1	PT18, XH5
	present	9	CHX1, VR2

1

9

Definition of a variety

TGs for tomato

	English	Note	Example varieties
4	**Stem: anthocyanin coloration**		
QN VG	absent or very weak	1	PT18, XH5
	weak	3	Lai số 2
	medium	5	
	strong	7	CHX1
	very strong	9	

1

7

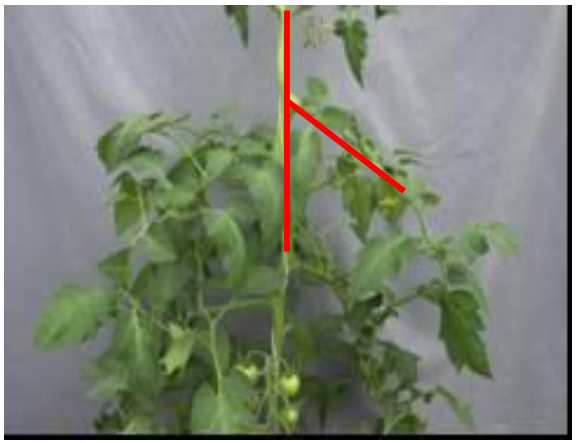
Definition of a variety

TGs for tomato

	English	Note	Example varieties
6	**Leaf: attitude**		
QN VG/ MS	semi-erect	3	
	horizontal	5	PT18, XH5
	semi drooping	7	Hồng Lan

3

5



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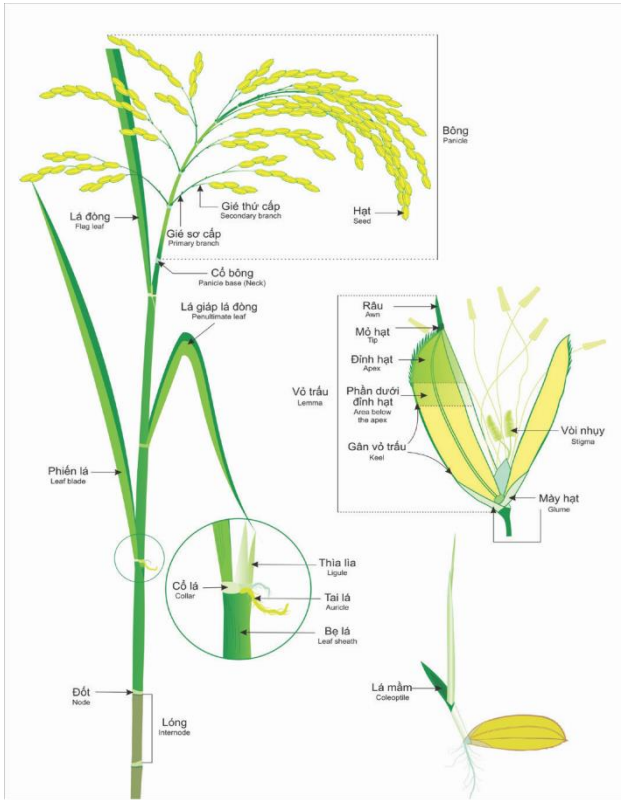
Definition of a variety

■ Variety description

total 65 chars.



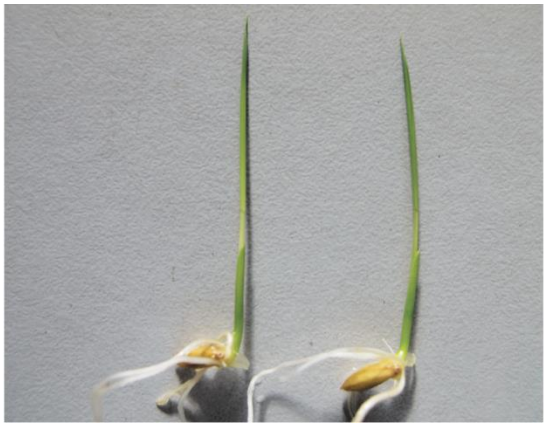
Char No.	Characteristics	States of Expression
1	Coleoptile anthocyanin coloration	9
2	Basal leaf: Sheath color	3
3	Leaf: íntensity of green color	5
4	Leaf: anthocyanin coloration	9
5	Leaf: distribution of anthocyanin coloration	2
6	Leaf sheath: anthocyanin coloration	9
7	Leaf sheath: intensity of anthocyanin coloration	5
8	Leaf blade: pupbescence of surface	5
..	.....	..

The variety description → defined by the expression of characteristics

Definition of a variety

TGs for Rice

	English	Stage	Note	Example varieties
1	**Coleoptile anthocyanin coloration**	**10**		
QN	absent or very weak		1	Khang dân 18
VS	weak		3	Trân châu lùn
	Strong		5	



1

3

Definition of a variety

TGs for Rice

	English	Stage	Note	Example varieties
2	**Basal leaf: Sheath color**	**40**		
PQ	green		1	Khang dân 18 Bắc thơm số 7
VS	Green with purple		2	
	light purple		3	Trân châu lùn
	Purple		4	Thảo dược Vĩnh Hòa 1

1

3

4

Definition of a variety

TGs for Rice

	English	Stage	Note	Example varieties
3	**Leaf: íntensity of green color**	**40**		
QN	light		3	ĐTL2
VG	medium		5	Bắc thơm số 7
	Dark		7	Q5

3

5

7

Definition of a variety

TGs for Rice

	English	Stage	Note	Example varieties
4	**Leaf: íntensity of green color**	**40**		
QL	absent		1	Khang dân, Bắc thơm số 7
VG	present		9	Trân châu lùn

1

9

Definition of a variety

TGs for Rice

	English	Stage	Note	Example varieties
5	**Leaf: distribution of anthocyanin coloration**	**40**		
PQ	on tips only		1	
VG	on margins only		2	Trân châu lùn
	in blotches only		3	
	even		4	

2

4

Definition of a variety

TGs for Maize

■ Variety description

total 41 chars.

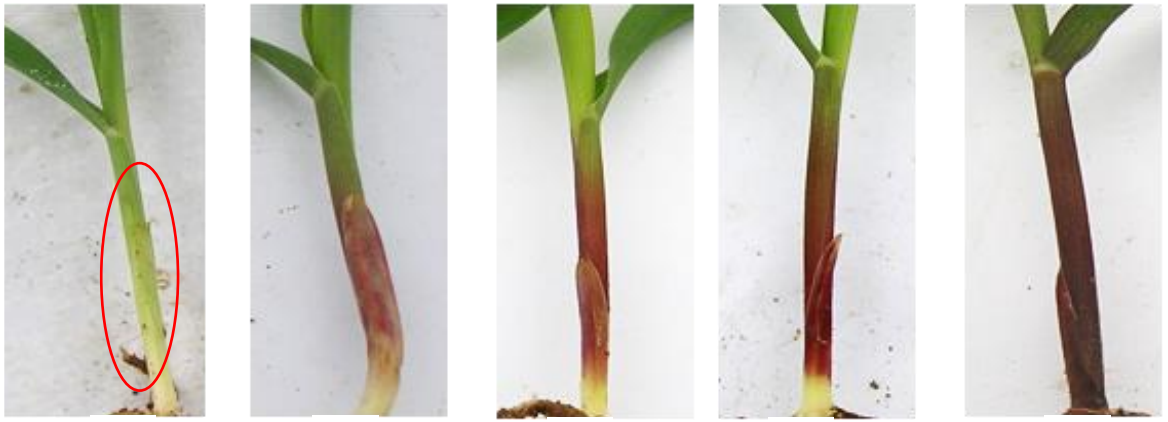
Char No.	Characteristics	States of Expression
1	Foliage: Intensity of green color	2
2	First leaf: Shape of tip	3
3	Foliage: Intensity of green color	2
4	Leaf: Undulation of margin of blade	2
5	Leaf: Angle between blade and stem (on leaf just above upper ear	3
6	Leaf: Attitude of blade (on leaf just above upper ear)	3
7	Stem: Degree of zig-zag	2
8	Tassel: Time of anthesis (on middle third of main axis, 50% of plants)	5
9	.....	..

The variety description → defined by the expression of characteristics

Definition of a variety

TGs for Maize

	English	Stage	Note	Example varieties
1	**First leaf: Anthocyanin coloration of sheath**	**12-14**		
QN	absent or very weak		1	Sugar 75
VG	weak		3	
	medium		5	
	strong		7	
	very strong		9	Fancy purple 212

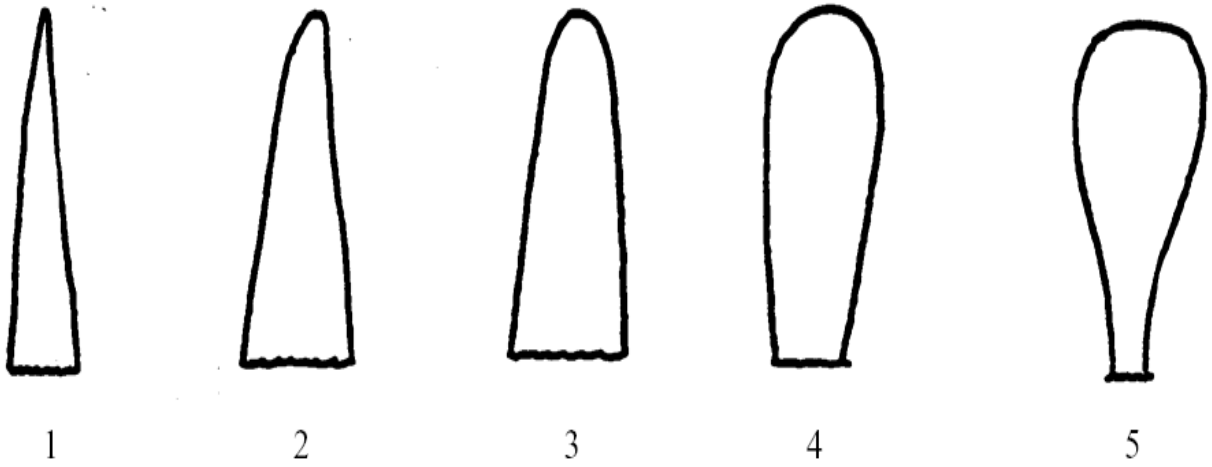


1 3 5 7 9

Definition of a variety

TGs for Maize

	English	Stage	Note	Example varieties
2	**First leaf: Shape of tip**	12-14		
PQ	pointed		1	
VS	pointed to rounded		2	
	rounded		3	
	rounded to spatulate		4	
	spatulate		5	



Definition of a variety

TGs for Maize

	English	Stage	Note	Example varieties
3	**Foliage: íntensity of green color**	**51-59**		
QN	light		3	
VG	medium		5	
	Dark		7	

Definition of a variety

TGs for Maize

	English	Stage	Note	Example varieties
4	**Leaf: undulation of margin of blade**	**51-59**		
QN	absent or very weak		1	
VG	intermediate		2	
	strong		3	

1

2

3

Definition of a variety

TGs for chrysanthemum

■ Variety description

Total 89 chars.

Char No.	Characteristics	States of Expression
1	Plant: height	5
2	Plant: type	1
3	Only bushy varieties: Plant: growth habit	2
4	Only bushy varieties: Plant: density of branching	5
5	Stem: color	4
6	Stipule: size	5
7	Petiole: attitude	5
8	.....	..

The variety description → defined by the expression of characteristics

Definition of a variety

TGs for Cucumber

■ Variety description

Total 51 chars.

Char No.	Characteristics	States of Expression
1	Cotyledon: bitterness	9
2	Plant: growth type	1
3	Plant: total length of first 15 internodes	5
4	Leaf blade: attitude	5
5	Leaf blade: length	5
6	Leaf blade: ratio length of terminal lobe/length of blade	5
7	Leaf blade: shape of apex of terminal lobe	1
8	.....	..

The variety description → defined by the expression of characteristics

DUS test

2. Examination of the DUS

Distinctness

- A variety may be considered to be clearly distinguishable if the difference in characteristics is:

  (a) consistent

  (b) clear differences

Candidate Variety **VS** Common knowledge

Uniformity

- The uniformity requirement for a variety will be different for
  - ✓ truly self-pollinated varieties
  - ✓ mainly self-pollinated varieties
  - ✓ inbred lines of hybrid varieties
  - ✓ vegetative propagated varieties

  and
  - ✓ cross-pollinated varieties
  - ✓ mainly cross-pollinated varieties
  - ✓ synthetic varieties
  - ✓ hybrid varieties

Stability

- In practice, test of stability is not performed.

  - ✓ when a variety has shown to be uniform, it can be considered to be stable.
  - ✓ where appropriate, stability may be tested by growing a further generation

Characteristics

- ✓ **Type of Expression of characteristics**
- ✓ **Method of Observation / Type of Record**

Type of Expression

QL

Qualitative

Characteristics

Type of Expression

QN

Quantitative

Characteristics

Type of Expression

PQ

Pseudo Qualitative

Characteristics

Type of Expression: QL

- ✓ **are expressed in discontinuous states**
- ✓ **As a rule, the characteristics are not influenced by environment.**

Panicle: awns

Absent 1

Present 9

Stem: anthocyanin coloration of nodes

Absent 1

Present 9

Type of Expression: QL

36.	VG	Ear: type of grain	Example varieties	Note
QL		flint		1
		flint-like		2
		intermediate		3
		dent-like		4
		sweet		5
		pop		6
		waxy		7
		flour		8

1 2 3 4 5 6

Type of Expression: QL

TG/61/7 _CUCUMBER, GHERKIN

28.	VG	Fruit: sutures	Example varieties	Note
QL	**(a)**	absent	Corona, Hana	1
		present	Nabil, Silor	9

Type of expression

States of expression

Notes

Type of Expression: QN

- ✓are measurable on a one-dimensional scale and show continuous variation
- ✓length, height, width, thickness, weight, Intensity…

Leaf sheath: intensity of anthocyanin coloration

1

3

5

7

Type of Expression: QN

Ear: length of peduncle

3

5

7

Stem: anthocyanin coloration of brace roots

1

3

5

7

9

Type of Expression: QN

"1-9" scale

notes	states
1	very small (or: absent or very small)
2	very small to small
3	**small**
4	small to medium
5	**medium**
6	medium to large
7	**large**
8	large to very large
9	very large

notes	states
1	very weak (or: absent or very weak)
2	very weak to weak
3	**weak**
4	weak to medium
5	**medium**
6	medium to strong
7	**strong**
8	strong to very strong
9	very strong

Type of Expression: QN

- Limited range

"1-5" scale

Stem: attitude

note	states
1	erect
3	semi-erect
5	prostrate

"1-4" scale

leaf blade: angle of apex

note	states
1	acute
2	Right-angled
3	moderately obtuse
4	strongly obtuse

"1-3" scale

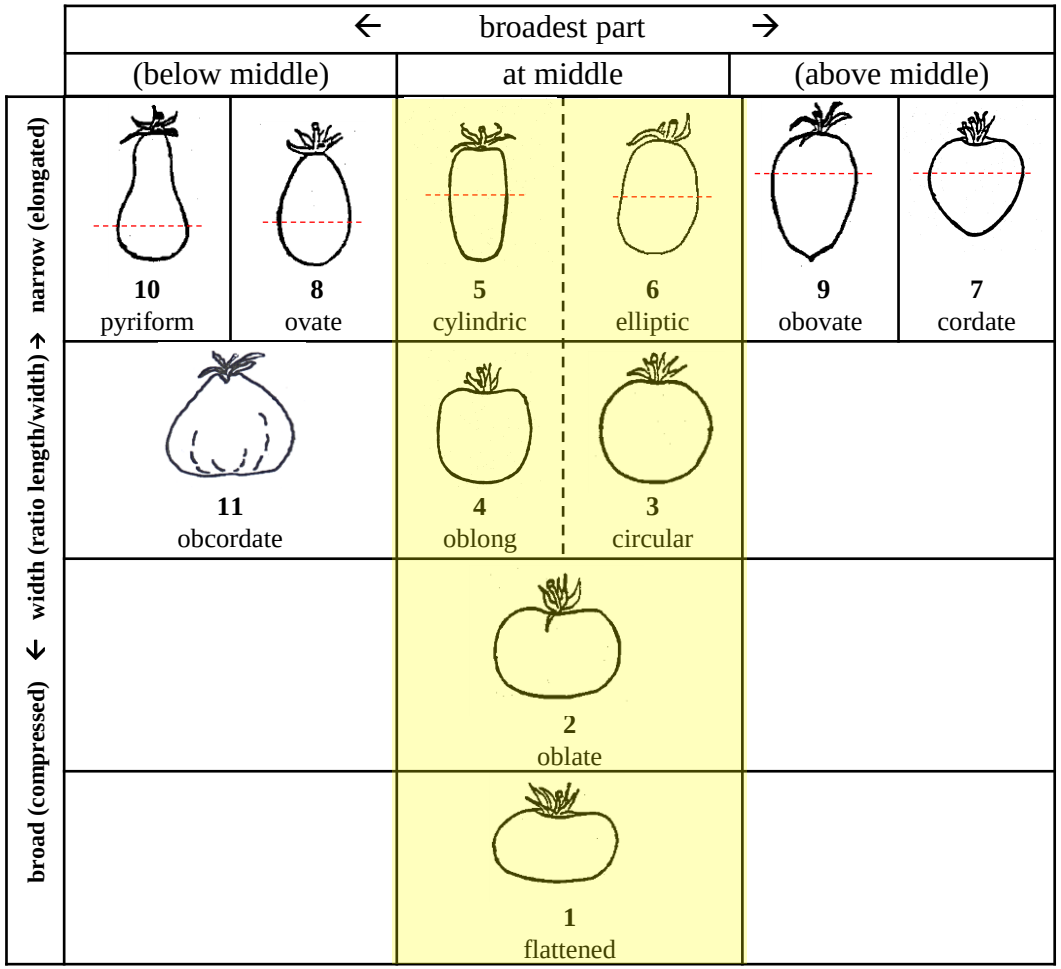
Flower: fragrance

note	states
1	Absent or very weak
2	weak
3	strong

Type of Expression: PQ

- ✓ **range of expression is at least partly continuous, but varies in more than one dimension**

Fruit: shape in longitudinal section



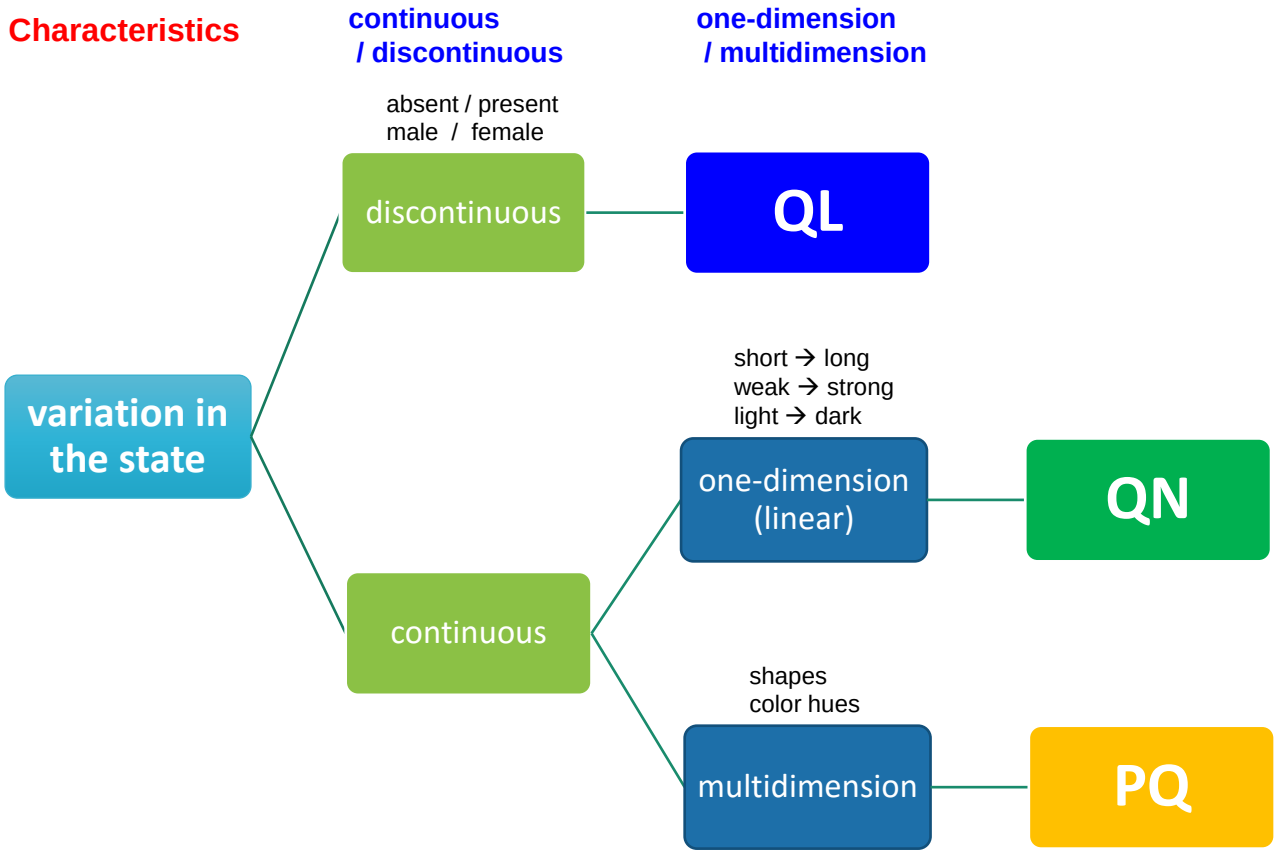
Type of Expression: PQ

TG/44 Tomato

28. (*) (+)	VG MS	Fruit: shape in longitudinal section	Example Varieties	Note
		oblate	Liebesapfel	**1**
PQ	(b)	circular	Cherry Sweet	**2**
		cordate	Daniel	**3**
		square	Delphin, Yolo Wonder	**4**
		rectangular	Clovis, Nocera rosso	**5**
		trapezoidal	Delta, Marconi	**6**

Types of expression

Decision making chart



Method of observation & Type of record

Method of observation:

M (measurement) : using a ruler/weighing scales, dates, counts, etc.

V (visual) : visual observation includes smell, taste and touch

Type of record:

G (Group) : single record for a variety, or a group of plants or parts of plants

S (Single) : records for a number of single plants or parts of plants

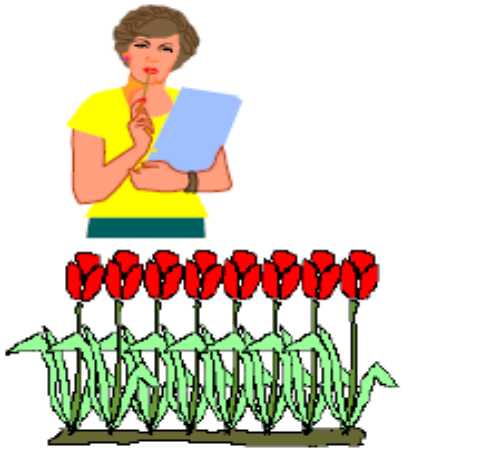
Type of Assessment

Method of observation + Type of record

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

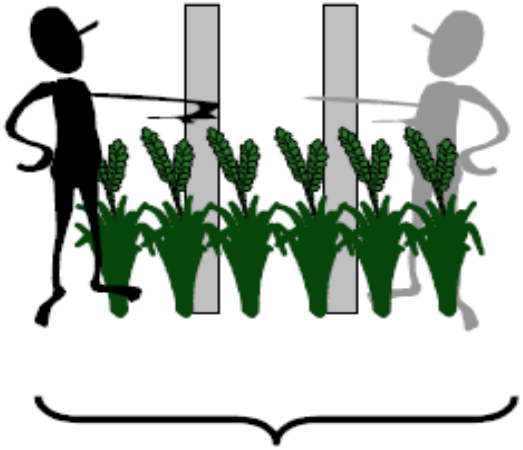
MG : **Measurement by a single observation of a group of plants or parts of plants.**

Example (VG): Flower: type
(tulip: vegetatively propagated)



single variety record

Example (MG): Plant: height
(wheat: self-pollinated)



single variety record

Type of Assessment

16.	**VG**	**Leaf sheath: intensity of anthocyanin coloration**		
QN		**very weak**	**Khang dân 18**	**1**
		weak	**BM9962**	**3**
		medium	**Trân trâu lùn**	**5**
		strong	**Thảo dược vĩnh hòa 1**	**7**

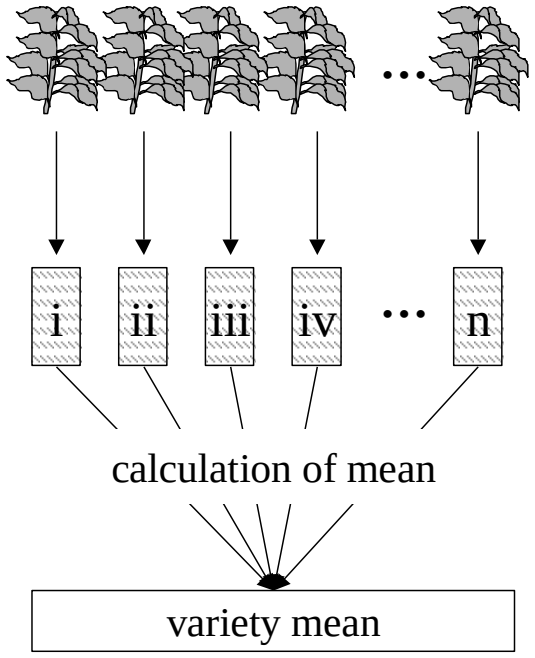
8.	**MG**	**Tassel: time of anthesis**		
PQ	**(c)**	**very early**	**Jazon, White Mirabell**	**1**
		very early to early	**Goldene Königin, Yellow Pear**	**2**
		early	**Sungold**	**3**
		early to medium	**Aichi First**	**4**
		medium	**Daniela, Ferline, Montfavet H 63.5**	**5**
		medium to late	**Ozyrys**	**6**
		late	**Green Grape, Green Zebra**	**7**
		late to very late	**AM1513**	**8**
		very late		**9**

Type of Assessment

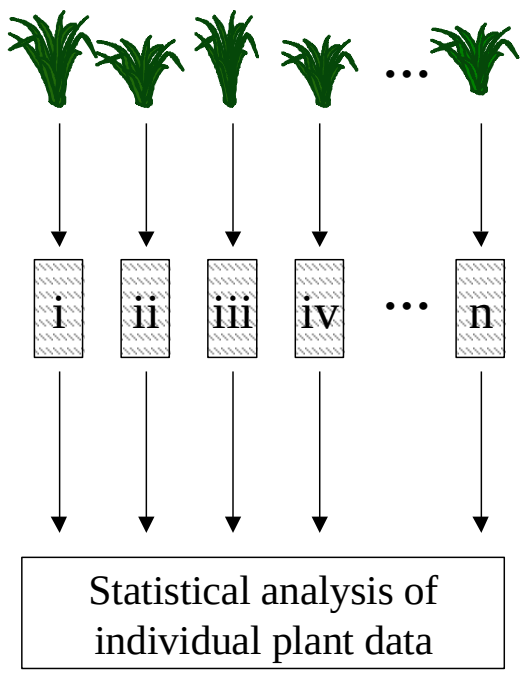
MS : Measurement of a number of individual plants or parts of plants.

VS : Visual assessment by observation of a number of individual plants or parts of plants.

Section 4.3.3.1
Example (MS): Leaflet: length
(pea: self-pollinated)



Section 4.3.3.2
Example (MS): Plant: natural height
Example (VS): Plant: growth habit
(ryegrass: cross-pollinated)



Type of Assessment

26.	**MS**	**Non-prostrate verieties only: Stem length (excuding panicle)**		
QN		**very short**		**1**
		short	**Koshihikari kazusa 2 gou**	**3**
		medium	**Bắc thơm số 7**	**5**
		long	**BM9962**	**7**
		very long		**9**

Type of Assessment

- Type of assessment in Tomato TGs

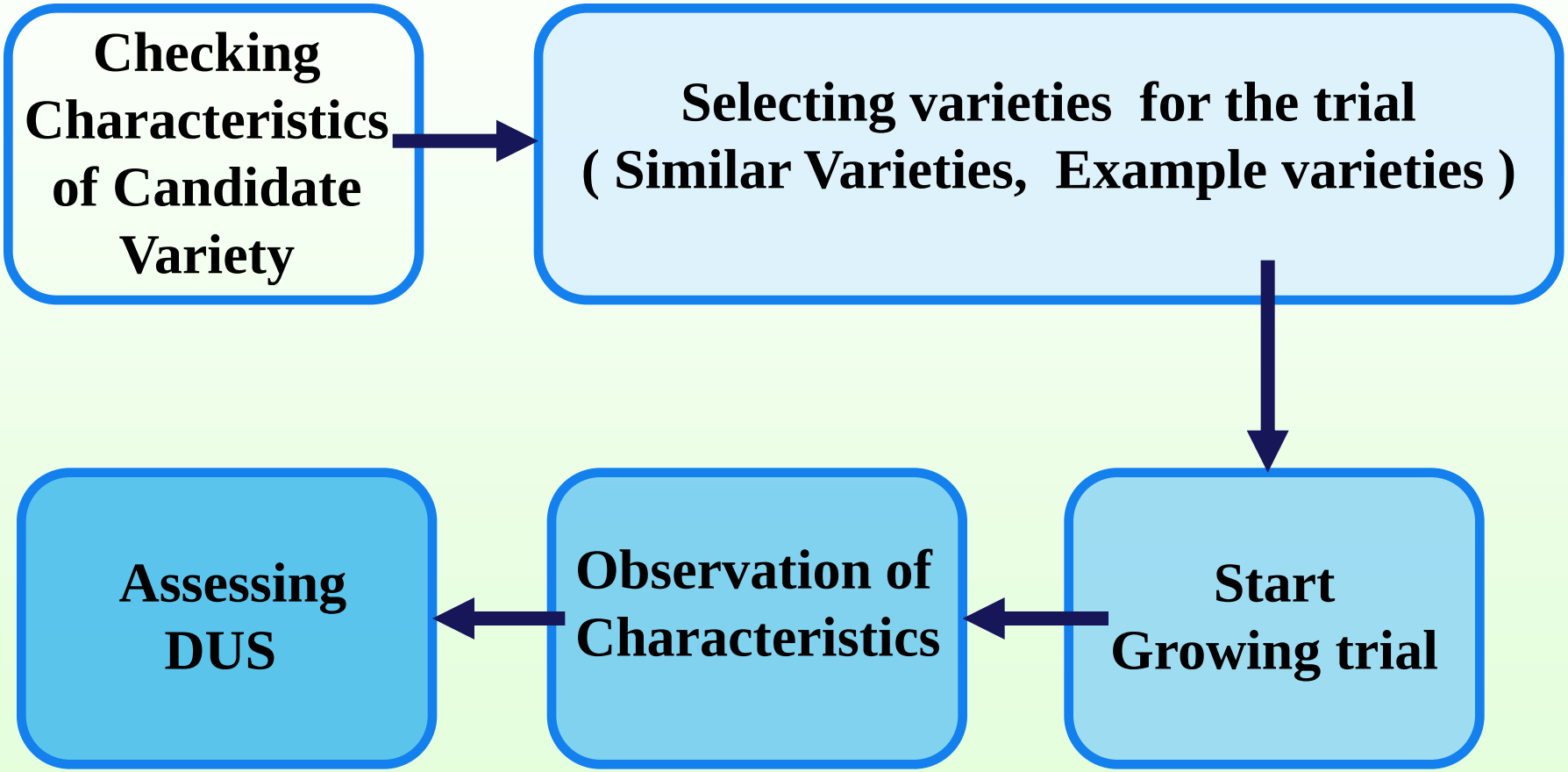
	QL	PQ	QN	Total
VS	0	0	0	0
VG	25	3	19	47
VG/MS	0	1	11	12
MS	0	0	1	1
MG	0	0	1	1
	25	4	32	61

Type char Excel

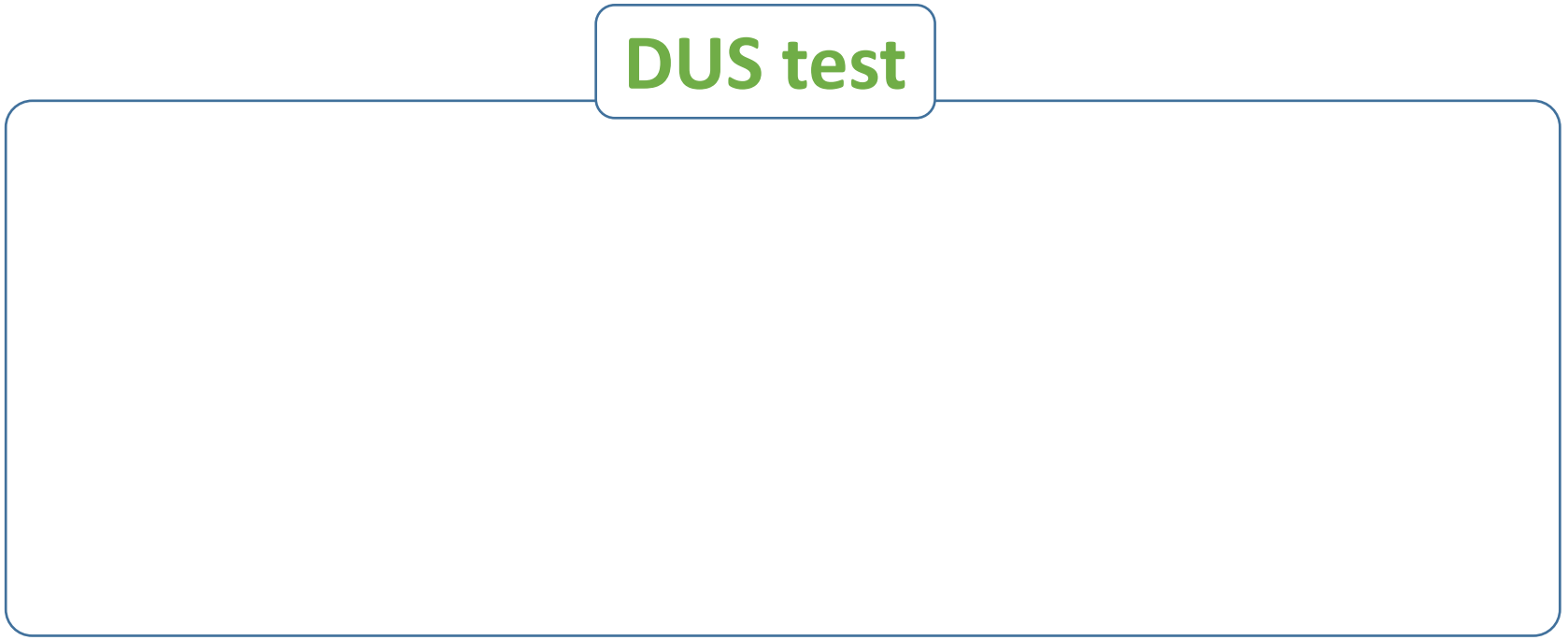
DUS

Examination

Workflow of the DUS test



DUS test



Similar varieties: Varieties very close to the candidate varieties in morphological, physiological characteristics

Example varieties: Varieties to clarify the states of expression of a characteristic, then to assist with preparation of the description

D

Distinctness examination

Distinctness

Requirement:

Article 7; 91 Act of the UPOV

- a variety must be **clearly distinguishable** from any other variety whose existence is a matter of common knowledge.

clearly distinguishable => 1. Consistent

2. Clear

Clearly Distinguishable

from any other varieties ?

"it is necessary to examine distinctness in relation to all varieties of common knowledge."

VS

Compare Candidate variety VS Existing varieties

Selection of Similar Varieties

Where a candidate variety is sufficiently different from particular group of varieties,

VS

No need to compare the candidate variety with different group of varieties

Selection of Similar Varieties

VS

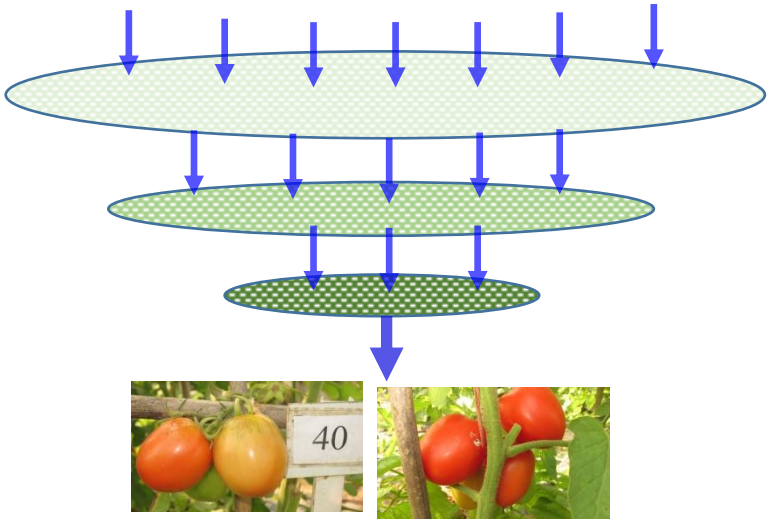
No need to compare candidate variety with different group of varieties

How to select different group of varieties?

Selection of Similar Varieties

Selecting the similar varieties

Candidate varieties



Grouping characteristics

Similar varieties

Selection of Similar Varieties

Not be necessary for comparing with all varieties, where a candidate variety is different from a particular group of varieties

Cylindric 5

VS

Oblong 4

Compare ***Candidate variety*** **VS** ***Similar varieties***

Selection of Similar Varieties

Candidate varieties

≠

≠

≠

Similar varieties

the candidate variety is considered to be distinguished to all existing varieties

Grouping characteristics

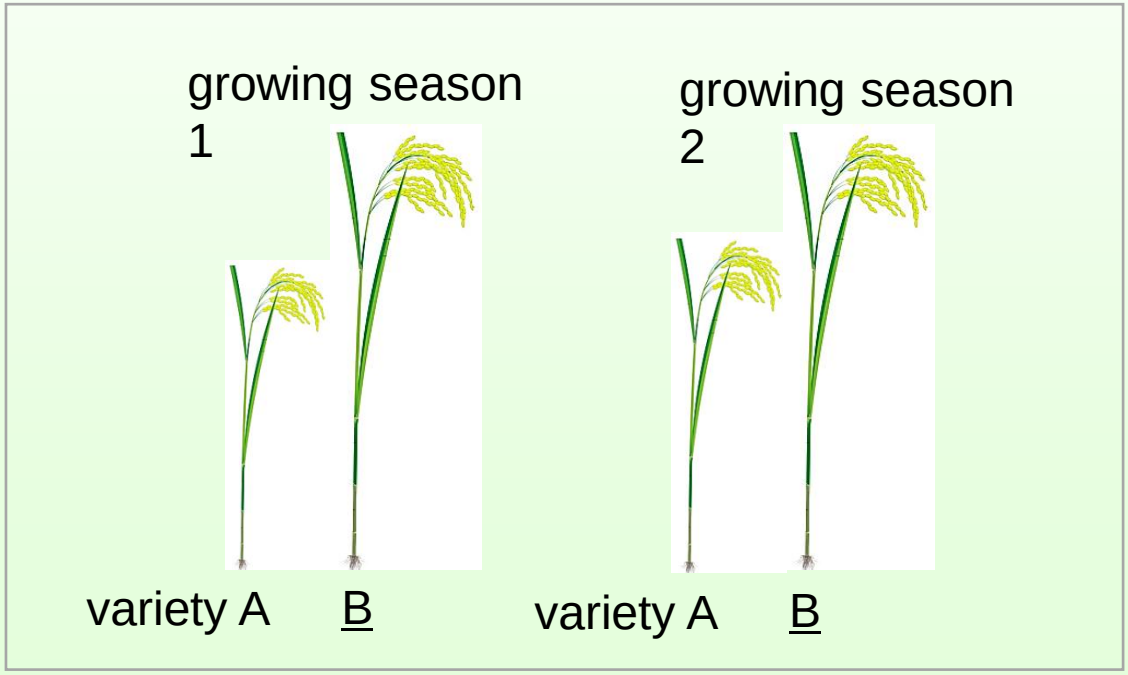
Grouping characteristics: tomato

Plant: growth type (characteristic 2)
Leaf: type of blade (characteristic 10)
Peduncle: abscission layer (characteristic 19)
Fruit: green shoulder (before maturity) (characteristic 21)
Fruit: size (characteristic 26)
Fruit: shape in longitudinal section (characteristic 28)
Fruit: number of locules (characteristic 36)
Fruit: color (at maturity) (characteristic 37)
Resistance to *Meloidogyne incognita* (Mi) (characteristic 46)
Resistance to *Verticillium* sp. (Va and Vd) – Race 0 (characteristic 47)
Resistance to *Fusarium oxysporum* f. sp. *lycopersici* (Fol) – Race 0 (ex 1) (characteristic 48.1)
Resistance to *Fusarium oxysporum* f. sp. *lycopersici* (Fol) – Race 1 (ex 2) (characteristic 48.2)
Resistance to Tomato mosaic virus (ToMV) – Strain 0 (characteristic 51.1)
Resistance to Tomato spotted wilt virus (TSWV) - Race 0 (characteristic 58)

Distinctness

1.Consistent difference:

To ensure sufficient consistent is to examine the characteristics in at two independent growing cycles.



Each time, variety B is taller than variety A

Distinctness

2.Clear differences:

Determining whether a difference between two varieties is clear depends on the **type of expression of the characteristics**.

QL: Qualitative

QN: Quantitative

PQ: Pseudo-Qualitative

Distinctness

Clear difference

QL characteristics:

TG/1/3: 5.3.3.2.1

Requires:

- the difference between two varieties may be considered clear if one or more characteristics have expressions that **fall into two different states in the Test Guidelines**

Different ”states” can be considered to be Distinct

Distinctness

Clear difference

QL characteristics:

pinnate - 1

bipinnate 2

Different ”states” can be considered to be Distinct

Distinctness

Clear difference

QN characteristics:

TG/1/3: 5.3.3.2.2

- For QN, **a difference of two Notes often represents a clear difference**, but that is not an absolute standard for assessment of distinctness. Depending on factors, such as the testing place, the year, environmental variation or range of expression in the variety collection, a clear difference may be more or less than two Notes. Guidance is provided in document TGP/9, 'Examining Distinctness'."

✓ **"Two Notes" rule**

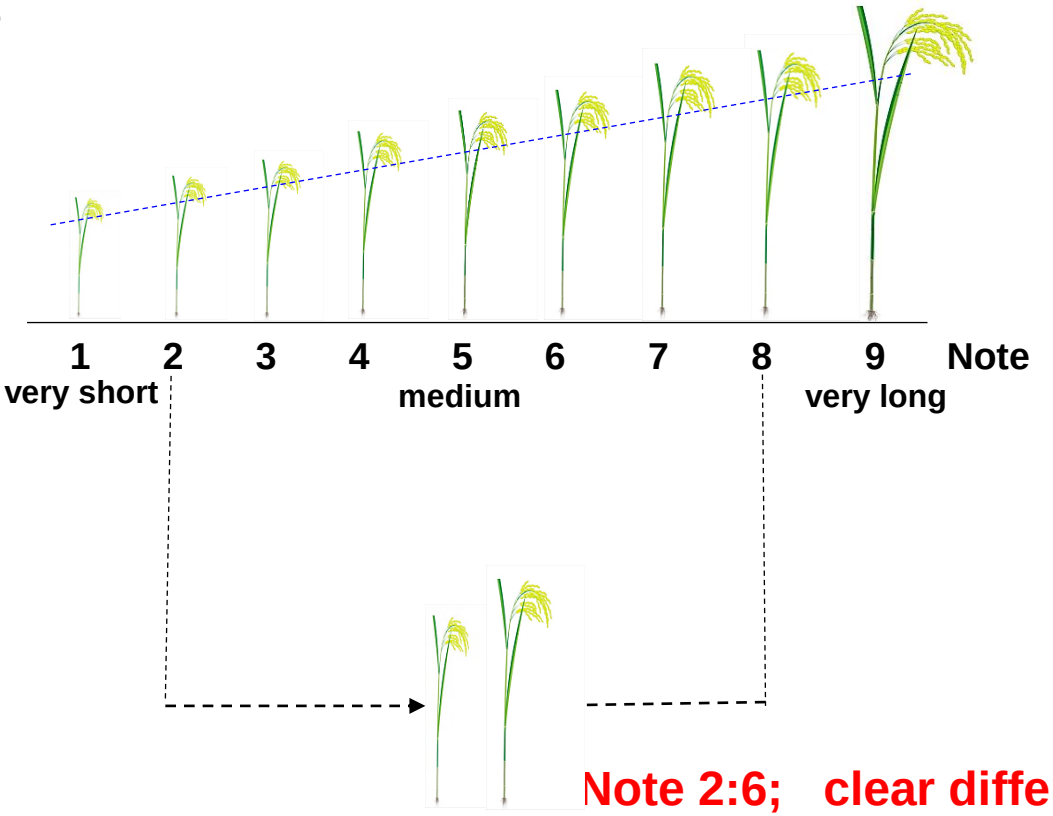
Distinctness

Clear difference

QN characteristics:

clear difference

(stem: Length)



Note 2:6; clear difference

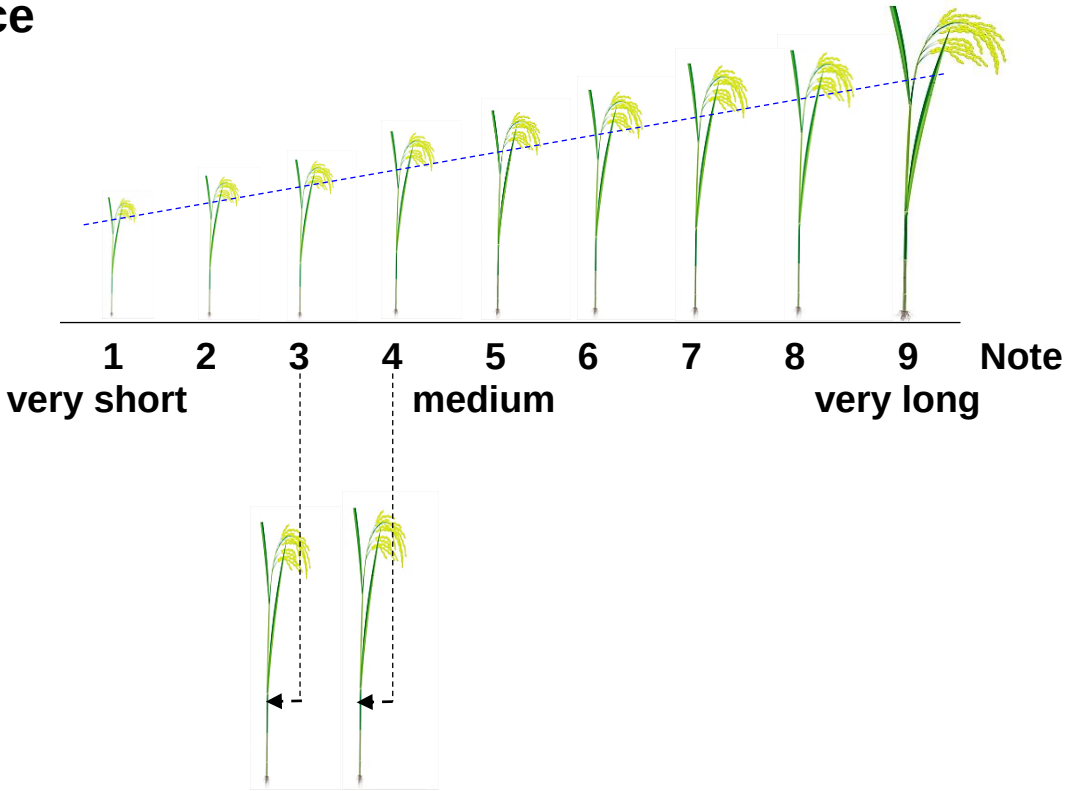
Distinctness

Clear difference

QN characteristics:

(stem: Length)

clear difference



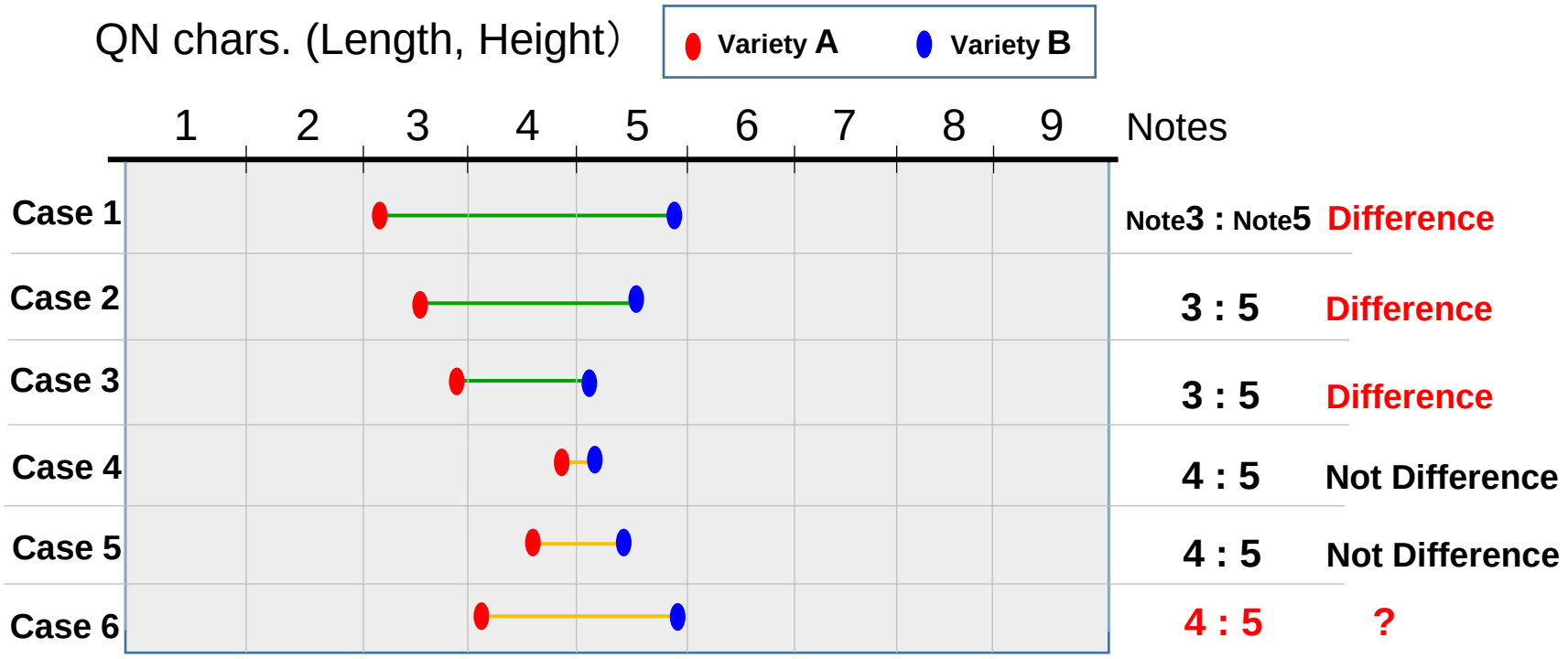
Note 3:4; may not be a clear difference

Distinctness

Clear difference

“a difference of two Notes often represents a clear difference”

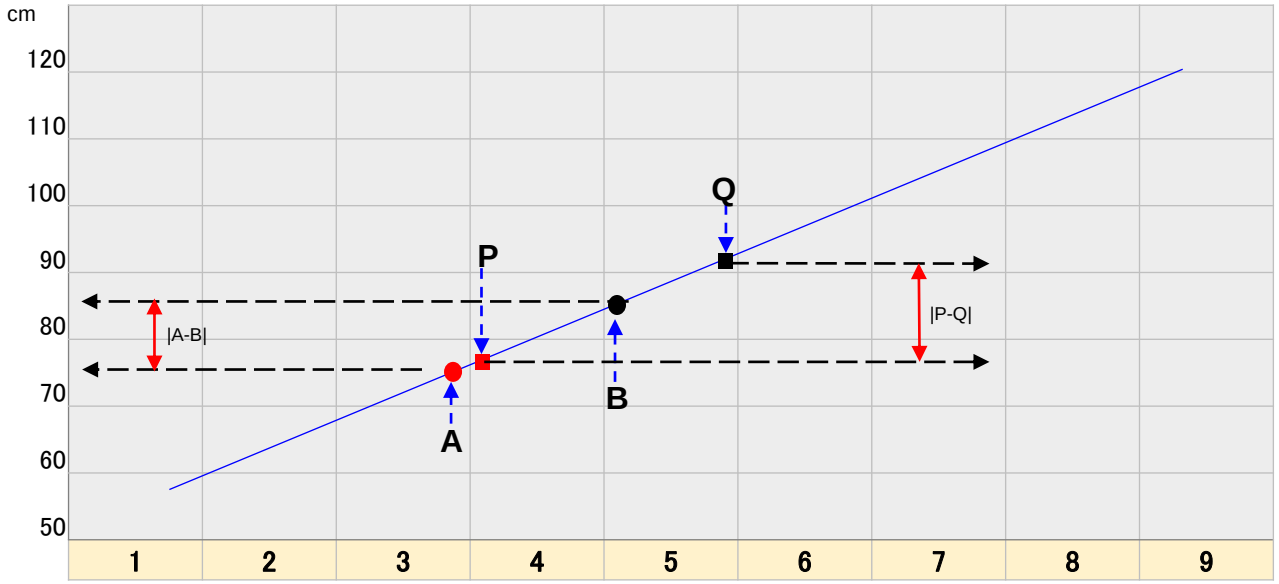
“Two Note” rule



Distinctness

Clear difference

QN: Stem: Length



	length: cm	Notes
A	75.0	3
B	85.0	5
A – B	10.0	2
P	77.0	4
Q	92.0	5
P –Q	15.0	1

two note 3:5 |A-B| 10 cm

one note 4:5 |P-Q| 15 cm

4:5 |P-Q| > 3:5 |A-B|

“Two Notes” rule means at least <u>One note difference</u>

Purpose of DUS test

- **Characteristics as the Basis for Examination of DUS** TG/1/3: 2.4

char No.	8	11	15	16	17	24	27	41
characterisitics	Tassel: time of anthesis	Tassel: anthocyanin coloration of anthers	Ear: time of silk emergence	Ear: anthocyanin coloration of silks	Stem: anthocyanin coloration of brace roots	Plant: length	Peduncle: length	Ear: anthocyanin coloration of glumes of cob
Candidate variety	3	5	3	5	3	7	1	9
variety 1	3	5	3	5	3	5	1	9
variety 2	3	3	3	5	3	7	1	9
variety 3	3	5	5	5	3	7	1	9
variety 4	3	5	3	5	7	7	5	9
variety 5	3	5	3	5	3	3	1	9

Distinctness

Clear difference

PQ characteristics:

TG/1/3: 5.3.3.2.3

- **A different state in the Test Guidelines may not be sufficient to establish distinctness** (see also section 5.5.2.3). However, in certain circumstances, varieties described by the same state of expression may be clearly distinguishable.

  ✓ It is difficult to define a general rule on the difference in Notes to establish Distinctness.

  ✓ **should be assessed on a Case by case basis**

Examining Distinctness

Distinctness

Clear difference

	Characteristics	Assessment
QL	- discontinuous states - absent / present	one or more characteristics have expressions that fall into two different states
QN	- continuous states - length, width	A difference of two notes represents a clear difference
PQ	- more than one dimension - shape, color	A different state in the TGs may not be sufficient

Uniformity examination

Uniformity

Requirement:

Article 8; 91 Act of the UPOV

- A variety must be sufficiently uniform in its relevant characteristics, subject to the variation that may be expected from the particular features of its propagation

Where all the plants of a variety are very similar, and in particular for vegetative propagate and self-pollinated varieties, Uniformity is assessed by the number of off-types

How many off-types should we accept?

Uniformity

■ Acceptable number of off-types

features of propagation	Genetic variation	Acceptable Number of off-types
•Vegetative propagated	Low	Low
•Self-pollinated		
•Hybrid (single-cross)		
•Cross-pollinated		
•Hybrid (Multiple-cross)	High	High

Where all the plants of a variety are very similar, and in particular for vegetative propagate and self-pollinated varieties, Uniformity is assessed by the number of off-types

Uniformity

How many off-types should we accept?

According to the size of the sample examined, statistical tables give the maximum number of off-types tolerated in that given samples

e.g.: *population standard = 1% and*
acceptance probability = 95%

Sample size	***Number of off-types allowed***
1-5	***0***
6-35	***1***
36-82	***2***
83-137	***3***
138-198	***4***
199-262	***5***

Uniformity

How many off-types should we accept?

- **Population standard**

  (Acceptable Number of off-types)

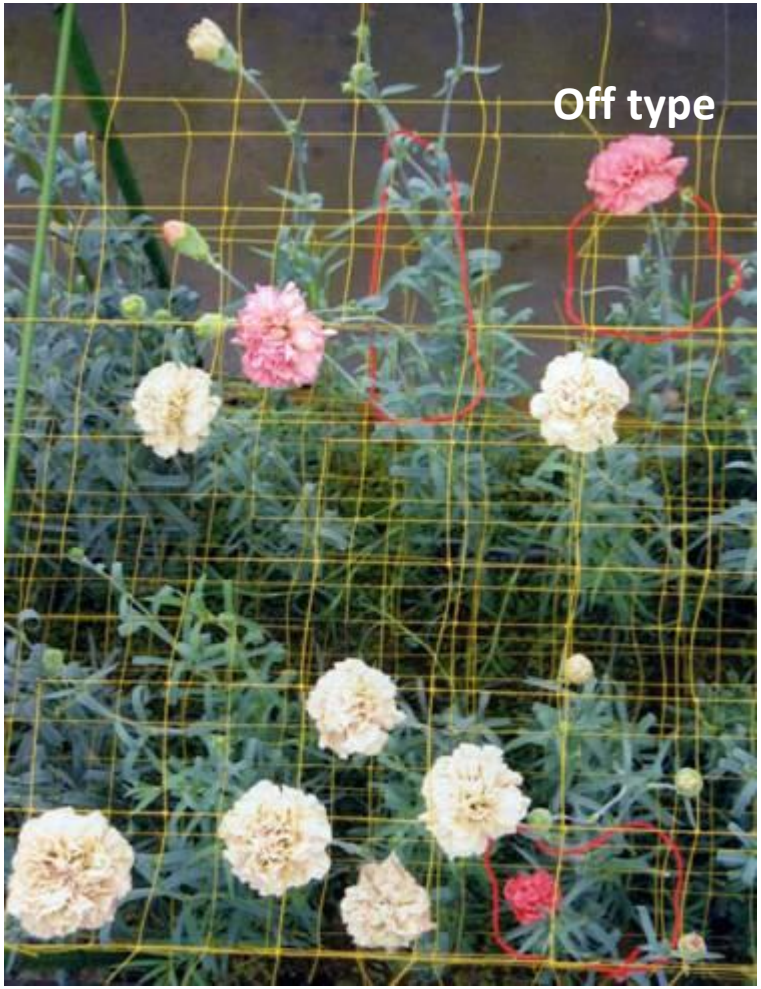
  - ✓ Percentage of off types to be accepted if all individuals of the variety could be examined

- **Acceptance probability**
  - ✓ Probability of correctly accepting that a variety is uniform

PS, AP in each UPOV TGs

1	95	8	1	Alstromeria, Hydrangea, Clematis, Rose of Sharon, Canna, Hebe
1	95	9	1	Phalaenopsis, Oncidium
1	95	10	1	Bougainvillea, Camellia, Pineapple, Dendrobium, TeaTree, Brachyscome, Poinsetia
1	95	12	1	Dahlia
1	95	15	1	ZonalPelargonium, Banana, Lobelia, Osteospermum, Sutera
1	95	20	1	Yam, Peppermint, Pumpkin, Tomato, Lily, Melon, Gladiolus, Chrysanthemum
1	95	24	1	sugarcane
1	95	25	1	tulip
1	95	40	2	bitter gourd, asparagus, Brussels sprout,cucumber, Petunia, Antirrhinum,Onion
1	95	50	2	Amaranth, Sweet potato, Sesame
1	95	60	2	cornsalad, chinese Cabbage, broccoli, Calabres sprouting, chimes Chive, Shiitake
1	95	90	3	Oyster Mushroom
1	95	100	3	Chick Pea, Lentil
2	95	20	2	Elatior Begonia, Kalanchoe,Chili,Watermelon,
2	95	200	7	Beetroot, Carrot,Leek, Radish, Black Radish
1	95	20	1	Tomato
5	95	40	4	Artichoke, Cardoon
Hybrids:2 inbred:2	Hybrids:95 inbred:95	Hybrids:100 inbred:200,30	Hybrids:5 inbred:7,2	Parsnip
Hybrids:2 inbred:3	Hybrids:95 inbred:95	Hybrids:100 inbred:100	Hybrids:5 inbred:6	Spinach,
inbred:1 (s)cross:3	inbred:95 (s)cross:95	inbred:60 (s)cross:60	inbred:2 (s) cross:4	Cauliflower

Uniformity



Uniformity

Off-type

- A plant is to be considered an off-type if it can be ***clearly distinguished from the variety*** in the expression of any characteristic of the whole or part of the plant that is used in the testing of distinctness, taking into consideration the particular features of its propagation.

clearly distinguished from the variety **= same criteria as for Distinctness**

Stability examination

Stability

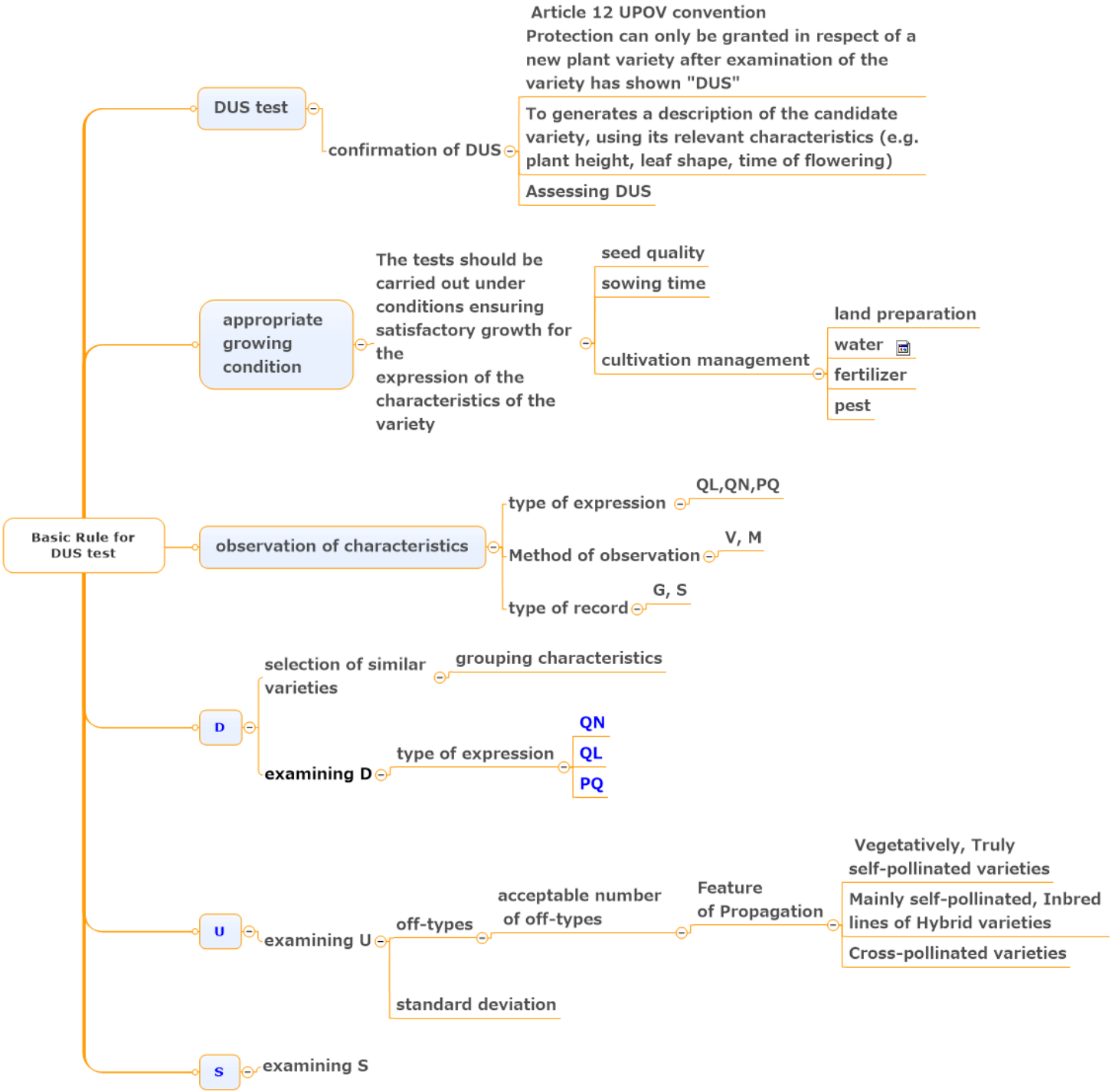
Requirement:

Article 9; 91 Act of the UPOV

- Relevant characteristics must remain unchanged after repeated propagation

  - In practice, it is not usual to perform tests of stability that produce results as certain as those of the testing of distinctness and uniformity.
  - However, for many types of variety, when a variety has been shown to be uniform, it can also be considered to be stable
  - Where appropriate, or in cases of doubt, stability may be tested, either by growing a further generation, or by testing a new seed or plant stock to ensure that it exhibits the same characteristics as those shown by the previous material supplied.

Making a Test Report


Basic Rule for DUS test
DUS test
confirmation of DUS
Article 12 UPOV convention
Protection can only be granted in respect of a new plant variety after examination of the variety has shown "DUS"
To generates a description of the candidate variety, using its relevant characteristics (e.g. plant height, leaf shape, time of flowering)
Assessing DUS
appropriate growing condition
The tests should be carried out under conditions ensuring satisfactory growth for the expression of the characteristics of the variety
seed quality
sowing time
cultivation management
land preparation
water
fertilizer
pest
observation of characteristics
type of expression
QL,QN,PQ
Method of observation
V, M
type of record
G, S
D
selection of similar varieties
grouping characteristics
examining D
type of expression
QN
QL
PQ
U
examining U
off-types
acceptable number of off-types
Feature of Propagation
Vegetatively, Truly self-pollinated varieties
Mainly self-pollinated, Inbred lines of Hybrid varieties
Cross-pollinated varieties
standard deviation
S
examining S

Thank you for your attention!