

Role of DUS test and Functional characteristics



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1. Purpose of DUS test

- what is DUS**

2. Role of DUS test

- definition of a variety**
- How to observe characteristics**
- Examination of DUS**

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



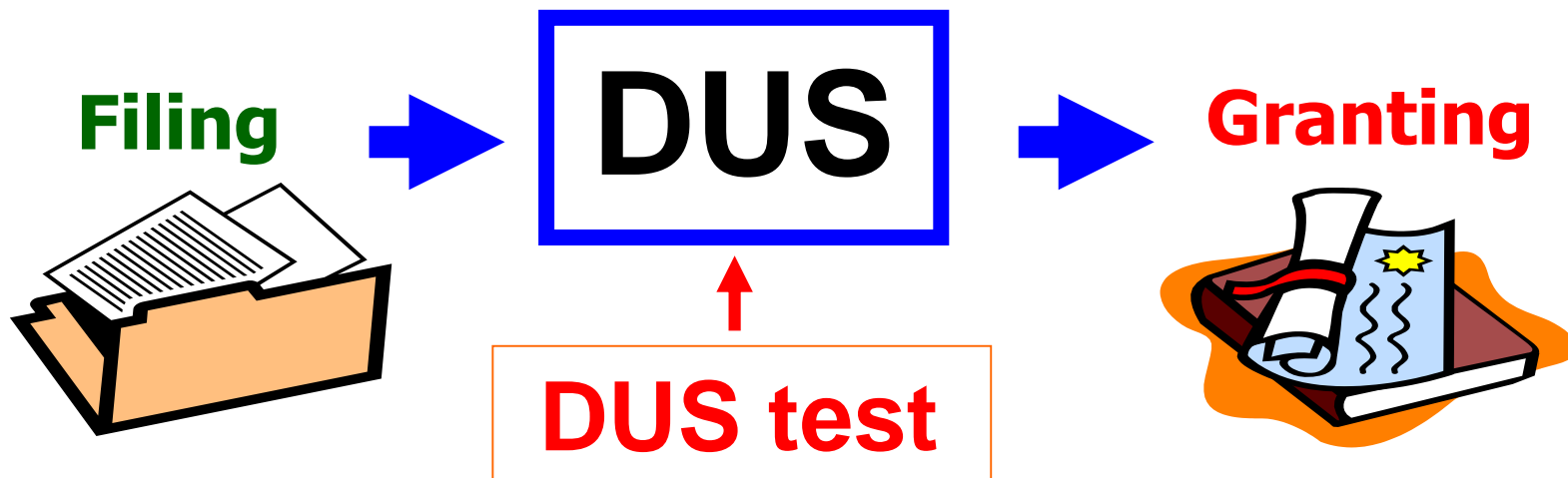
Next
generation

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 assess whether the variety complies 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

■ Variety description

total 41 chars.



Char No.	Characteristics	States of Expression
1	First leaf: anthocyanin coloration of sheath	5
2	First leaf: shape of apex	3
3	Foliage: intensity of green color	2
4	Leaf: undulation of margin of blade	2
5	Leaf: angle between blade and stem	3
6	Leaf: curvature of blade	3
7	Stem: degree of zig-zag	2
8	Tassel: time of anthesis	4
..

The variety description → defined by the expression of characteristics

Definition of a variety

TGs for Maize

1.	VG	First leaf: anthocyanin coloration of sheath	Example varieties	Note
QN		absent or very weak	0674	1
		weak	Empire (SC), F816	3
		medium	F259, Merkur (SC)	5
		strong	EP1	7
		very strong		9



1



3



5



7



9

Definition of a variety

TGs for Maize

2.	VG	First leaf: shape of tip	Example varieties	Note
PQ		pointed		1
		pointed to rounded	0674	2
		rounded	Empire (SC), F816	3
		rounded to spatulate	F259, Merkur (SC)	4
		spatulate	EP1	5



1



2



3



4



5



Definition of a variety

TGs for Corn

3.	VG	Foliage: intensity of green color	Example varieties	Note
QN		light	W182E	1
		medium	Empire (SC), W117	2
		dark	GSS 3287 (SC), W401	3

Definition of a variety

TGs for Corn

4.	VG	Leaf: undulation of margin of blade	Example varieties	Note
QN		absent or very weak	F2	1
		intermediate	F252, Puma (SC)	2
		strong	Empire (SC), F259	3



1



2



3

Definition of a variety

■ Variety description

total 65 chars.



Char No.	Characteristics	States of Expression
1	Coleoptile: anthocyanin coloration	3
2	Basal leaf: sheath color	3
3	Leaf: intensity 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	4
8	Leaf: pubescence of blade	4
9

The variety description → defined by the expression of characteristics

Definition of a variety

■ Variety description

total 61 chars.
(Resist. 16)



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

■ Variety description

total 33 chars.



Char No.	Characteristics	States of Expression
1	Plant: type	1
2	Only varieties with plant type: non-climbing: Plant: growth habit	2
3	Only varieties with plant type: non-climbing: Plant: natural height including inflorescence	5
4	Stem: fasciation	1
5	Stem: color	1
6	Stem: lenticels (in autum)	1
7	Stem: color of lenticels	
8	Leaf blade: length	5
9

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
 - ✓ vegetatively propagated varietiesand
 - ✓ 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.

Fruit: green shoulder (before maturity)



Absent 1



Present 9

Stem: anthocyanin coloration of nodes



Absent 1



Present 9

Type of Expression: QL

2.	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



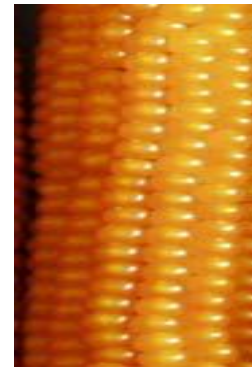
3



4



5



6

Type of Expression: QL

TG/76 Sweet Pepper, Hot Pepper, Paprika, Chili

23.	VG	Fruit: anthocyanin coloration	Example varieties	Note
QL	(a)	absent present	Lamuyo Alabástrom, Purple beauty, Violette	1 9

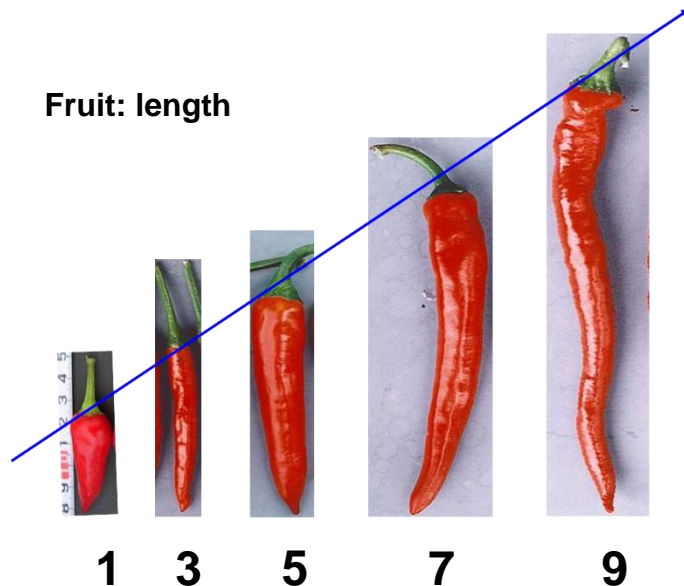
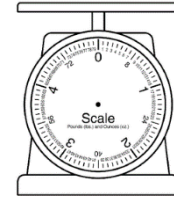
Type of expression (blue arrow pointing to QL)

States of expression (red arrow pointing to absent/present)

Notes (green arrow pointing to 1/9)

Type of Expression: QN

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



states of expression

- very short
- very short to short
- short
- short to medium
- medium
- medium to long
- long
- long to very long
- very long

Notes

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9

Type of Expression: QN

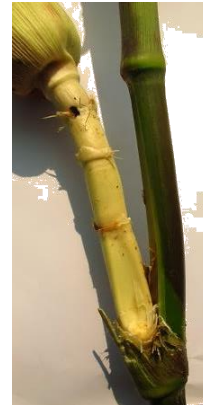
Ear: length of peduncle



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

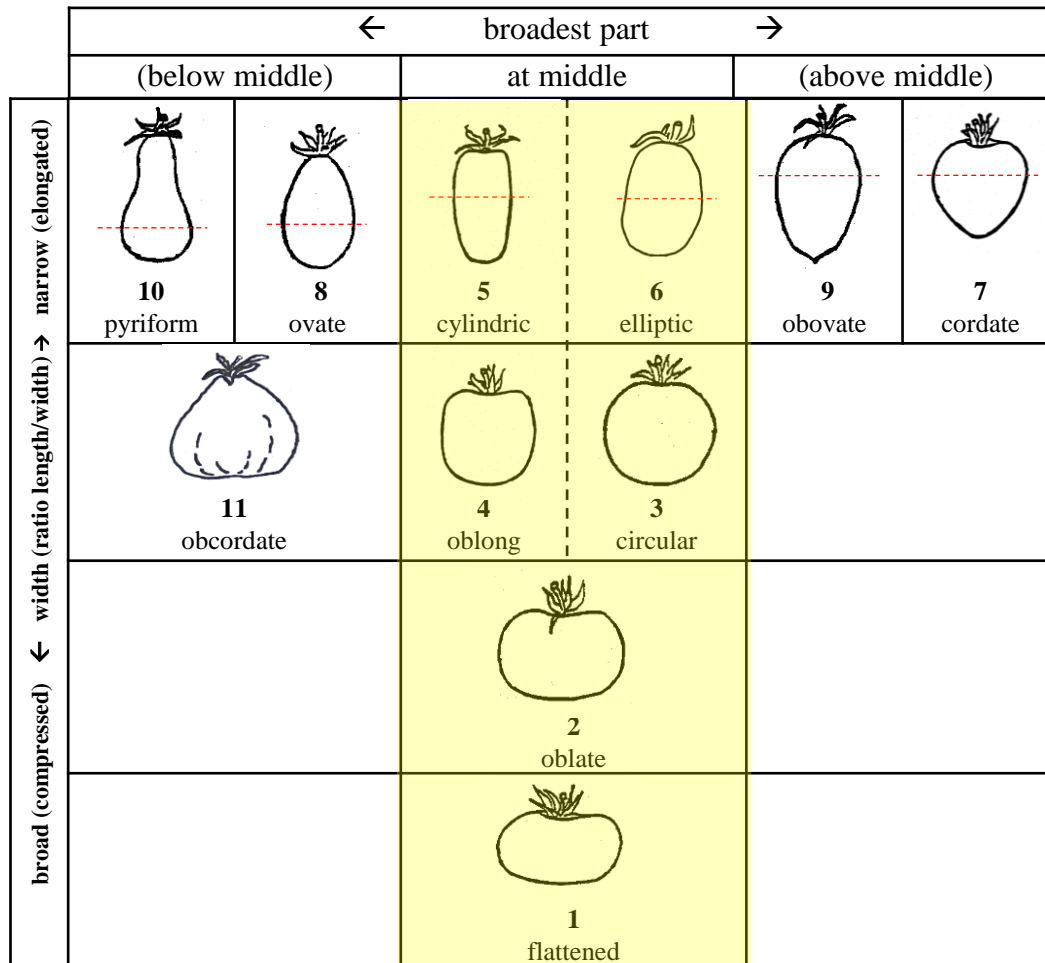
note	states
1	Absent or very weak
2	weak
3	strong



Type of Expression: PQ

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

Fruit: shape in longitudinal section



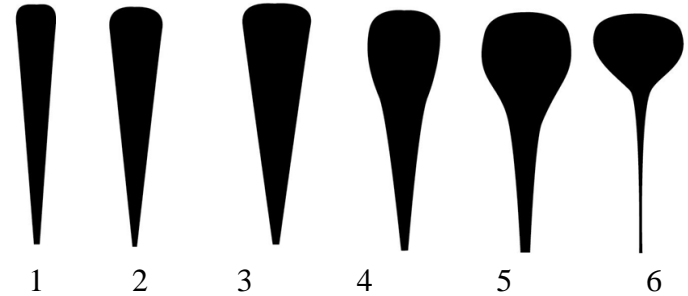
Type of Expression: PQ

TG/44 Tomato

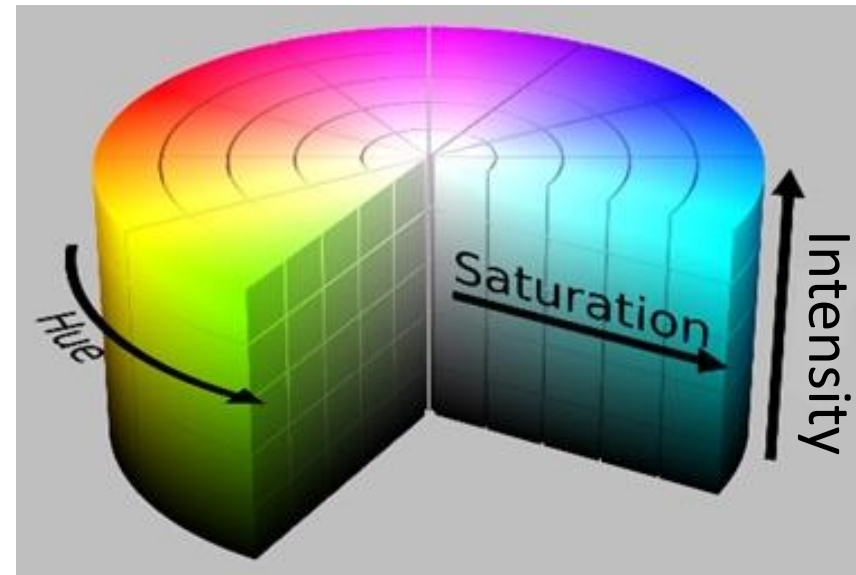
28. (* (+)	VG MS	Fruit: shape in longitudinal section	Example Varieties	Note
		oblate	Liebesapfel	1
PQ	(b)	circular	Cherry Sweet	2
		cordate	Daniel	3
		square	Delphin, Yolo Wonder	4
		rectangular	Clovis, Nocera rosso	5
		trapezoidal	Delta, Marconi	6

Type of Expression: PQ

1	VG	Root: shape	TG/218/2
(*)			Parsnip
(+)			
PQ		narrow obtriangular	Fist 1
		medium obtriangular	Countess 2
		broad obtriangular	Tenor 3
		medium obovate	Merlin 4
		broad obovate	White King 5
		napiform	Kral, Rotund 6

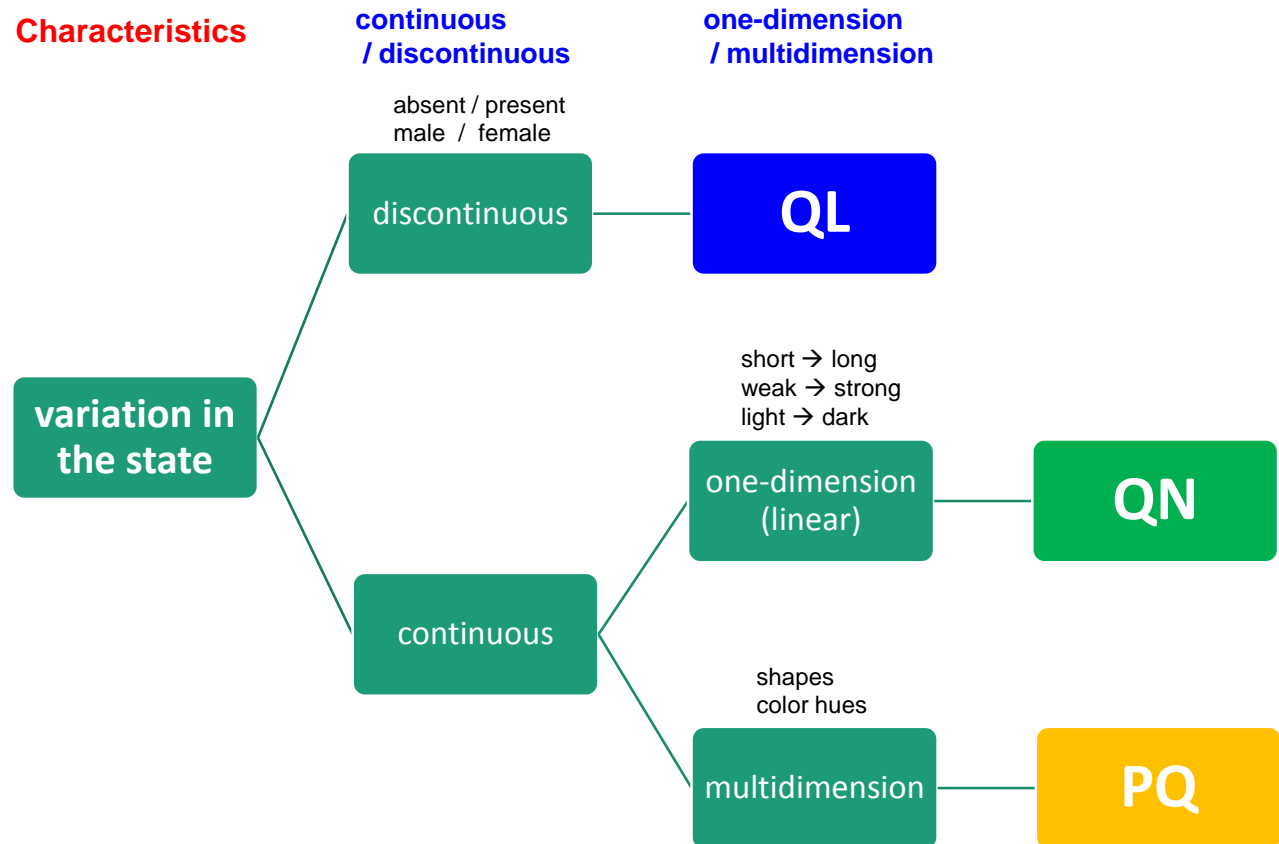


39.	VG	<u>Excluding varieties with ear type of grain: sweet: Ear: color of dorsal side of grain</u>	TG/2/7
			Maize
PQ		white	F481 1
		yellowish white	A188 2
		yellow	3
		yellow orange	F66 4
		orange	EP1 5
		red orange	6
		red	7
		purple	8
		brownish	9
		blue black	10



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

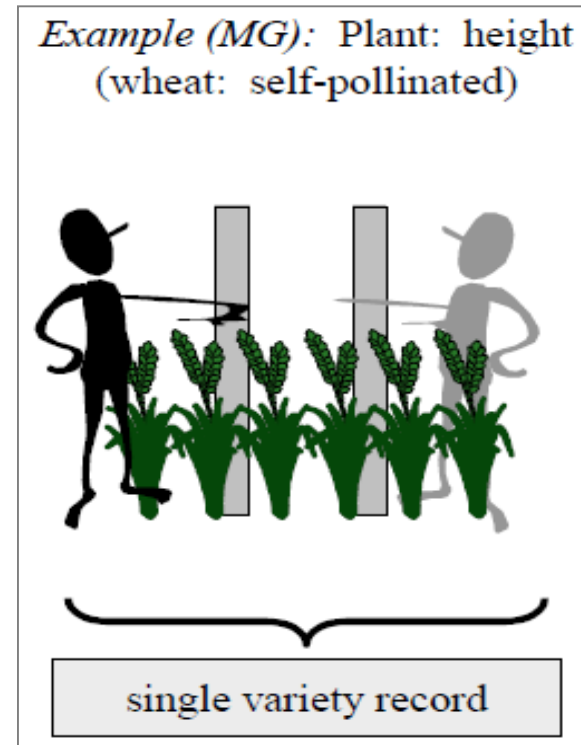
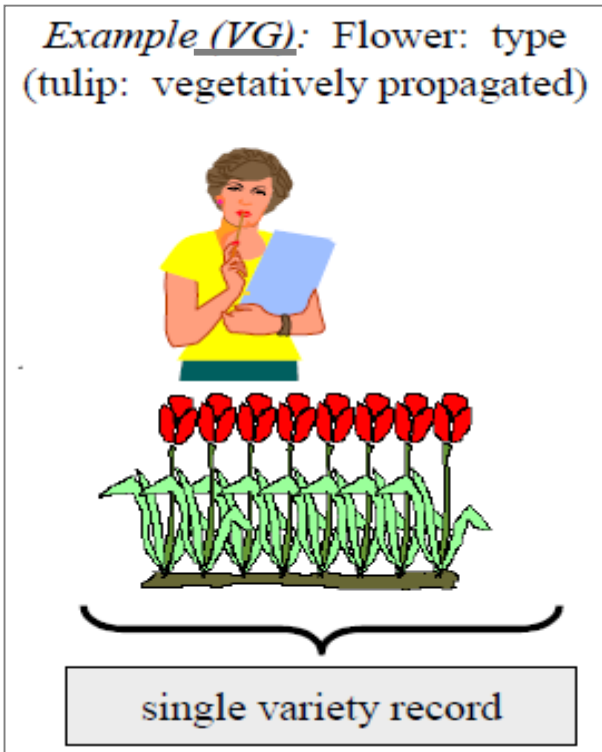
S (Single) : records for a number of single plants or parts of plants

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.



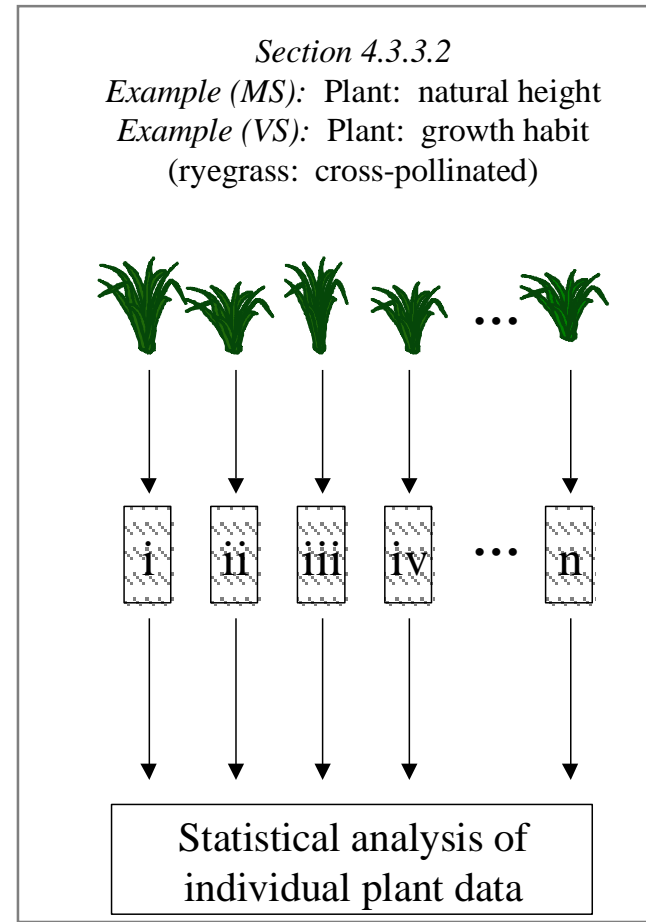
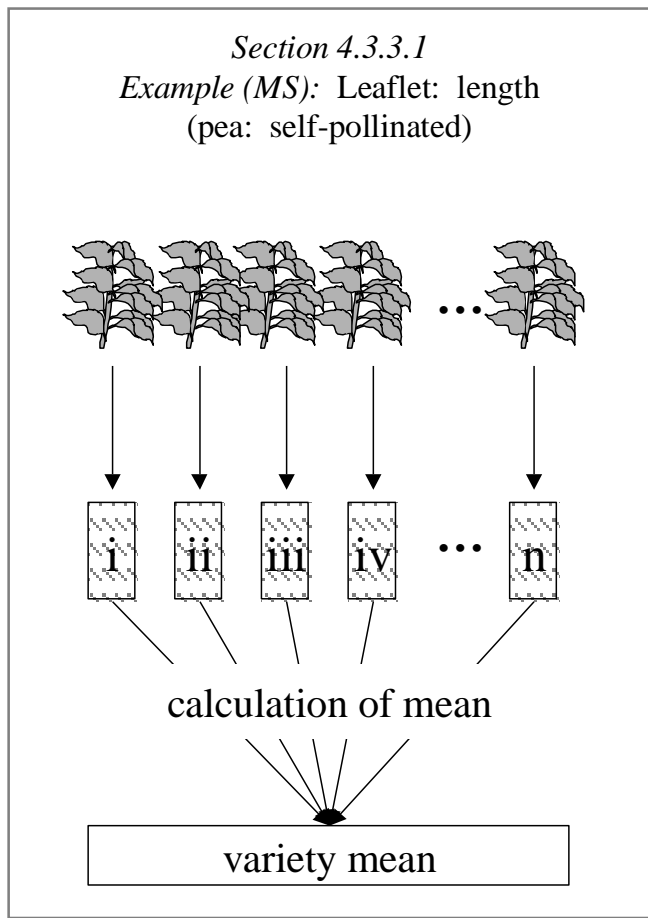
Type of Assessment

16.	VG	Ear: anthocyanin coloration of silks		
(*)				
QN		absent or very weak	Bonus (SC), F7, F195,	1
		weak	El Toro (SC), F257	3
		medium	F244, Gyöngymazsola (SC)	5
		strong	W401	7
		very strong		9
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,	5
			Montfavet H 63.5	
		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.



Type of Assessment

28.	MS	Ear: length		
QN		very short		1
		short	F2	3
		medium	A654, Spirit (SC)	5
		long	Empire (SC), MO17	7
		very long		9

Type of Assessment

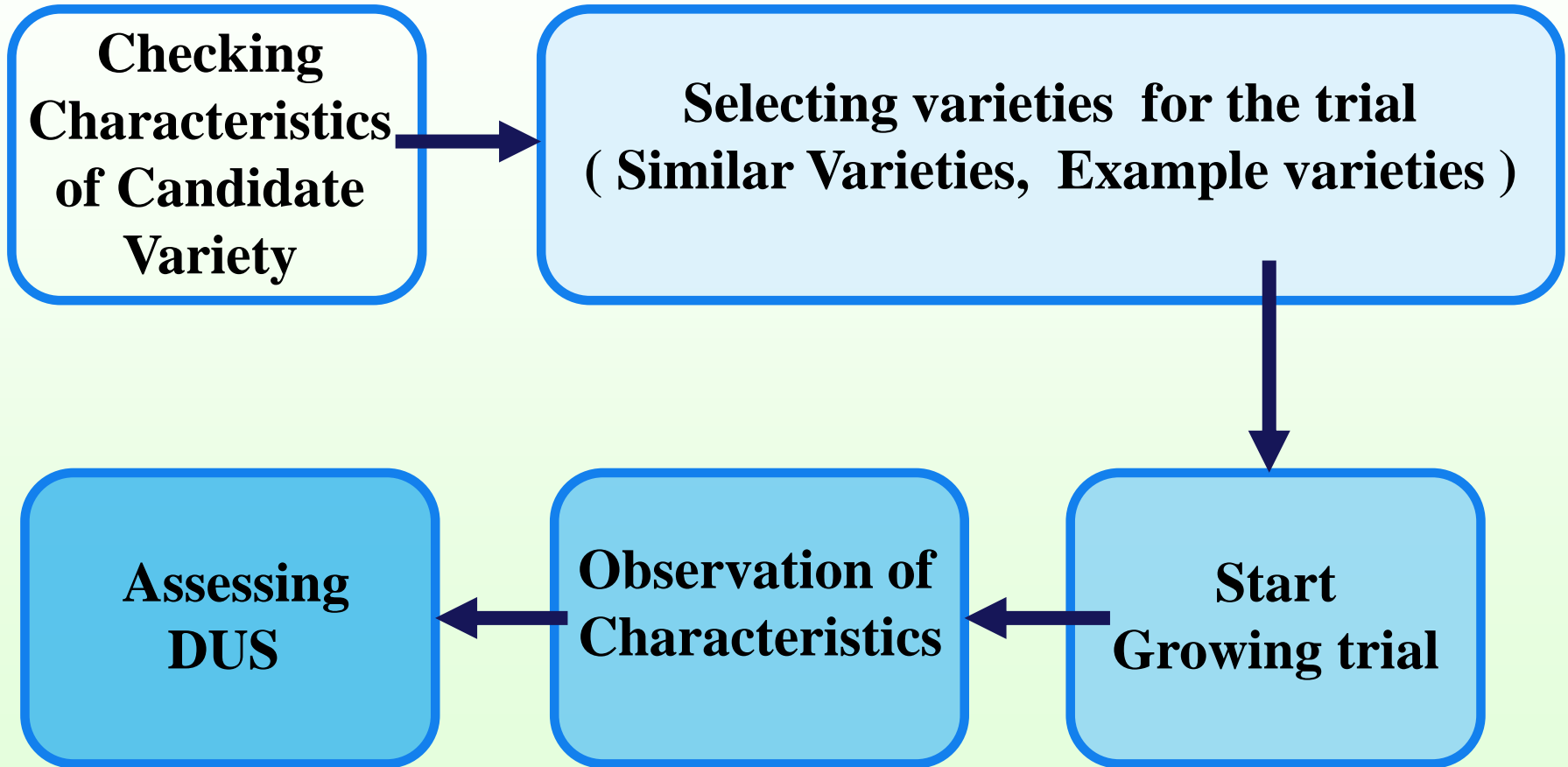
■ Type of assessment in Maize TGs

	QL	PQ	QN	Total
VS	0	0	0	0
VG	2	3	25	30
VG/MS	0	0	1	1
MS	0	0	8	8
MG	0	0	2	2
	2	3	36	41

DUS

Examination

Workflow of the DUS test



DUS test

DUS test



Candidate variety



Similar varieties



Example varieties

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

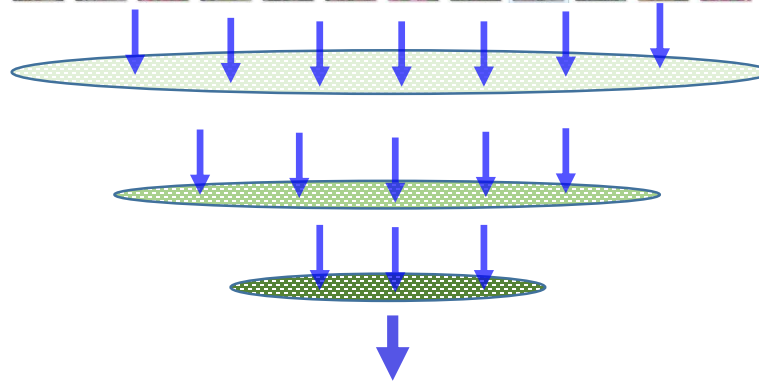
How to select different group of varieties?

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



VS

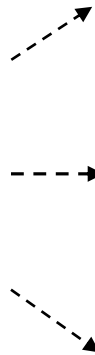


Compare *Candidate variety* **VS** *Similar varieties*

Selection of Similar Varieties



Candidate varieties



≠



≠



≠



Similar varieties

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

Grouping characteristics

■ Grouping characteristics: Corn

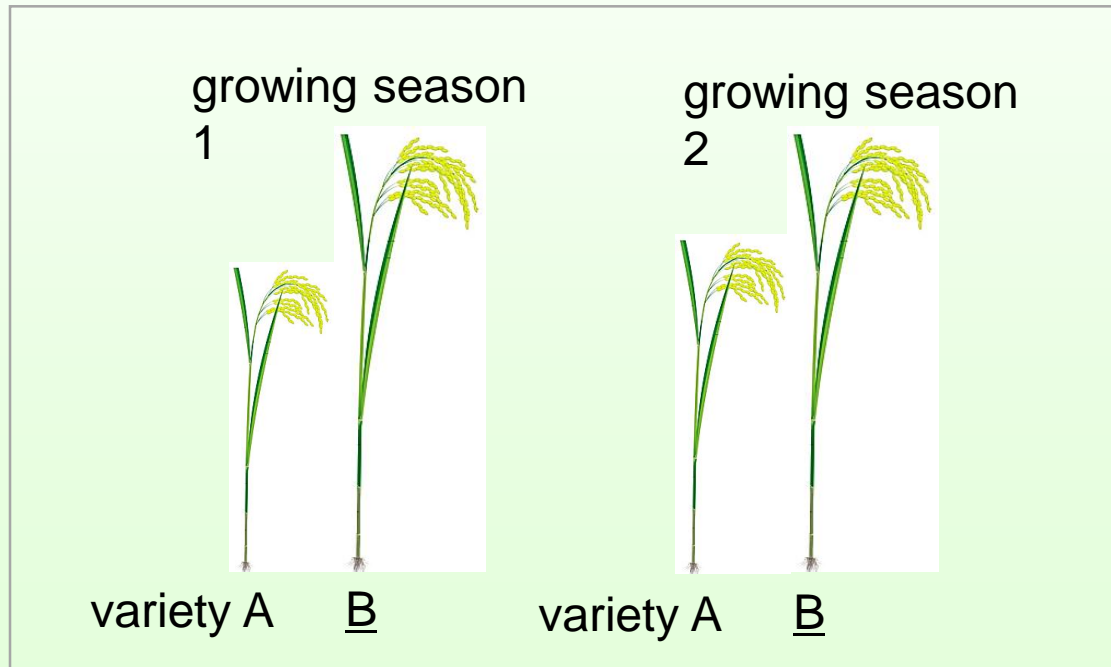
- (a) Tassel: time of anthesis (cha. 8: QN)
- (b) Tassel: anthocyanin coloration at base of glume (char. 9: QN)
- (c) Ear: anthocyanin coloration of silks (char. 16: QN)
- (d) Plant: length (char. 24: QN)
- (e) Ear: type of grain (char. 36: QL)
- (f) Excluding varieties with ear type of grain: sweet:
Ear: color of dorsal side of grain (char. 39: PQ)
- (g) Ear: anthocyanin coloration of glumes of cob (char. 41: QN)

Distinctness

Consistent difference

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

Clear difference

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

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**

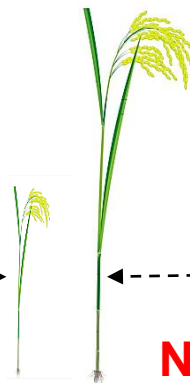
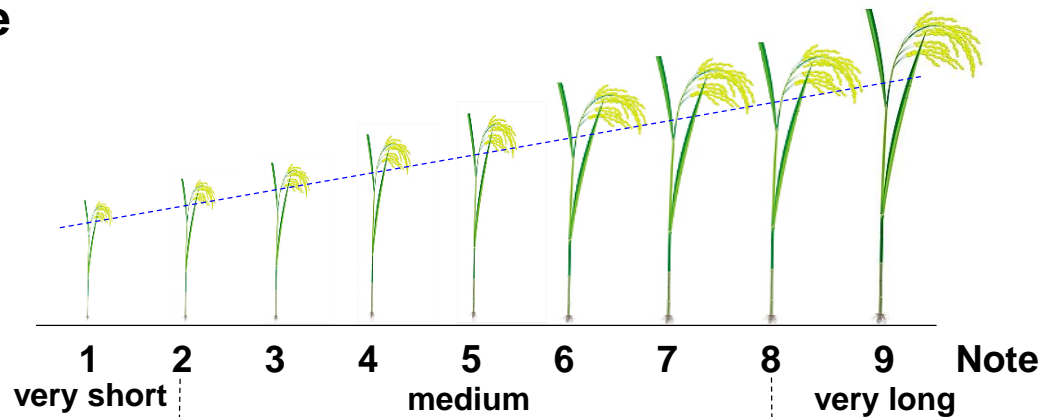
Distinctness

Clear difference

QN characteristics:

clear difference

(stem: Length)



Note 2:8; clear difference

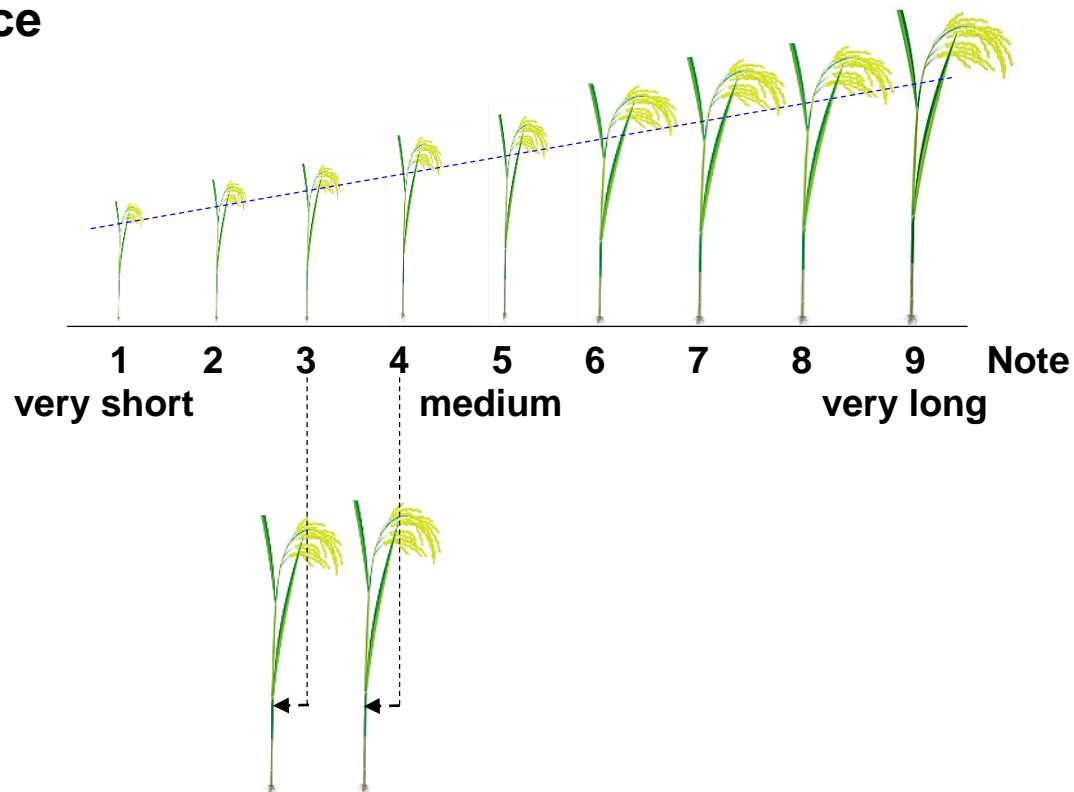
Distinctness

Clear difference

QN characteristics:

clear difference

(stem: Length)

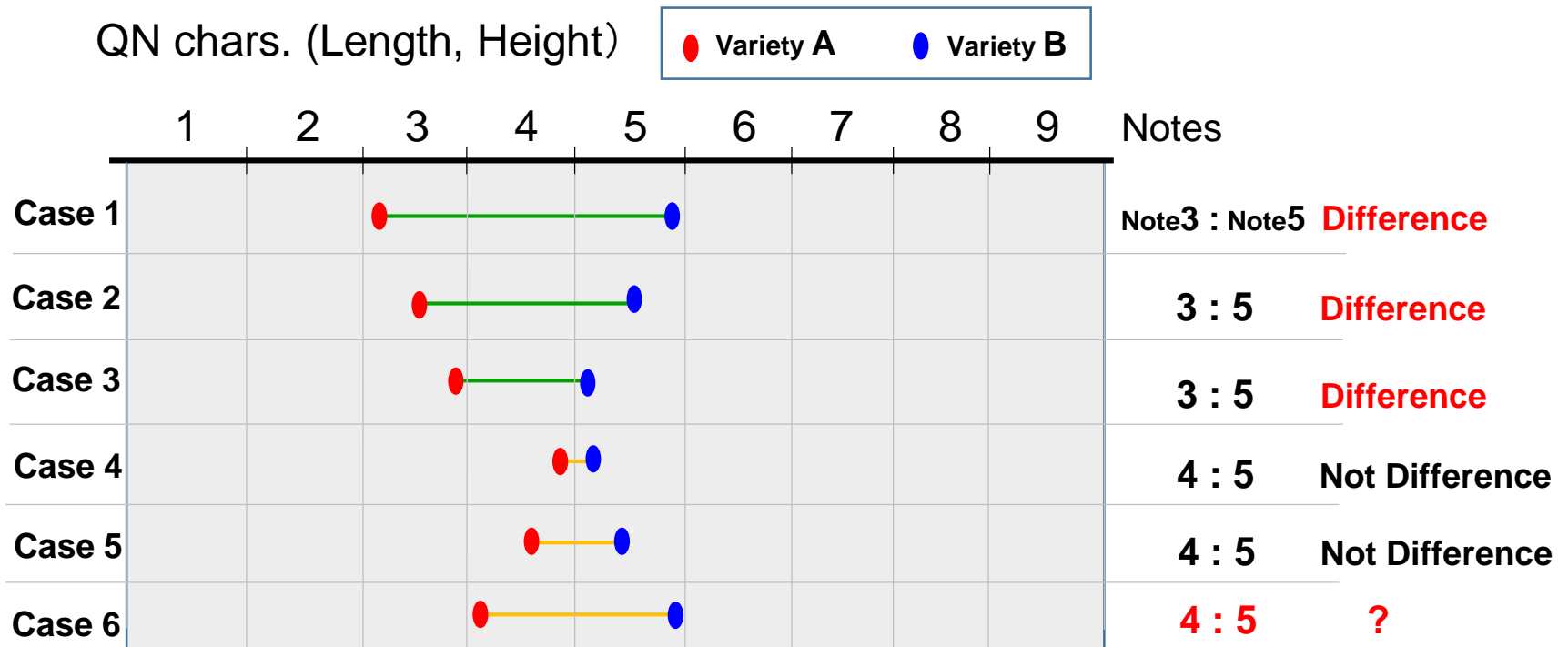


Distinctness

Clear difference

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

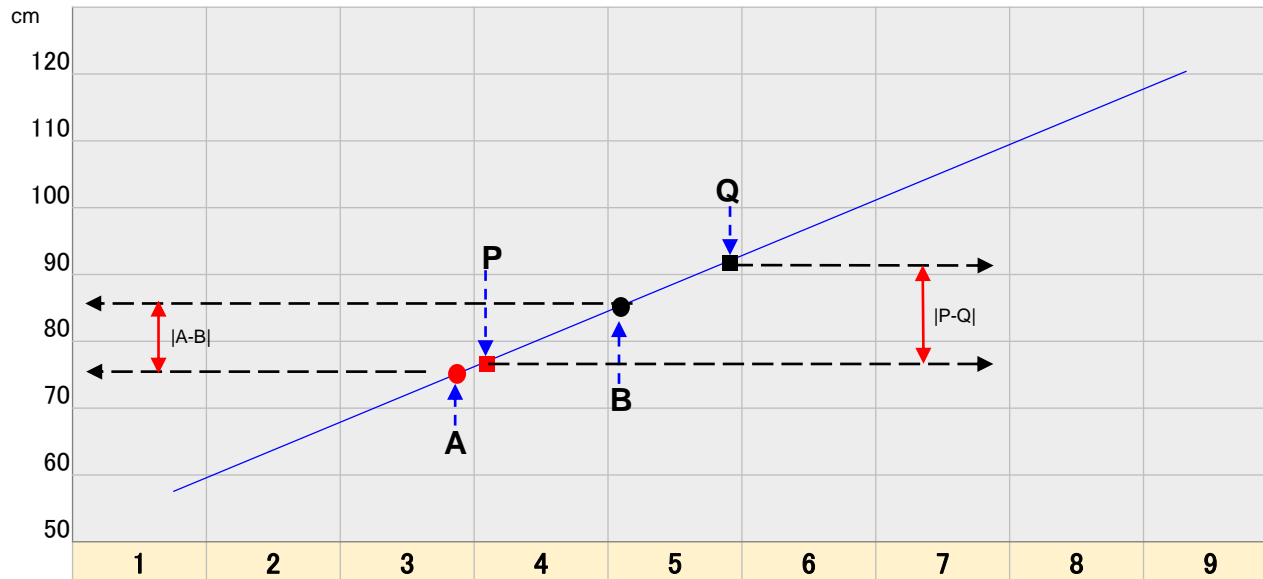
“Two Note” rule



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

Note

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 One note difference

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
characteristics	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	<ul style="list-style-type: none">- discontinuous states- absent / present	one or more characteristics have expressions that fall into two different states
QN	<ul style="list-style-type: none">- continuous states- length, width	A difference of two notes represents a clear difference
PQ	<ul style="list-style-type: none">- 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

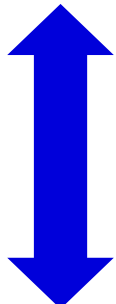

- A variety must be sufficiently uniform in its relevant characteristics, subject to the variation that may be expected from the **particular features of its propagation**

Where all the plants of a variety are very similar, and in particular for vegetatively 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
•Vegetatively propagated	Low	Low
•Self-pollinated		
•Hybrid (single-cross)		
•Cross-pollinated		
•Hybrid (Multiple-cross)		

Where all the plants of a variety are very similar, and in particular for vegetatively 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%

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

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

population standard	Acceptance probability	sample size	Number of off types	species
0.1	95	1500	4	Rice
0.1	95	2000	5	Durum wheat
1	95	5	0	Almond, Blueberry, Persimmon, Avocado, coffee, fig, Dragon fruit, Mango
1	95	6	1	Nerium, BirdCherry, Buddleja, Papaya
1	95	7	1	Eucalyptus, Rubber
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
3	95	40	3	Maize
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

S

Stability examination

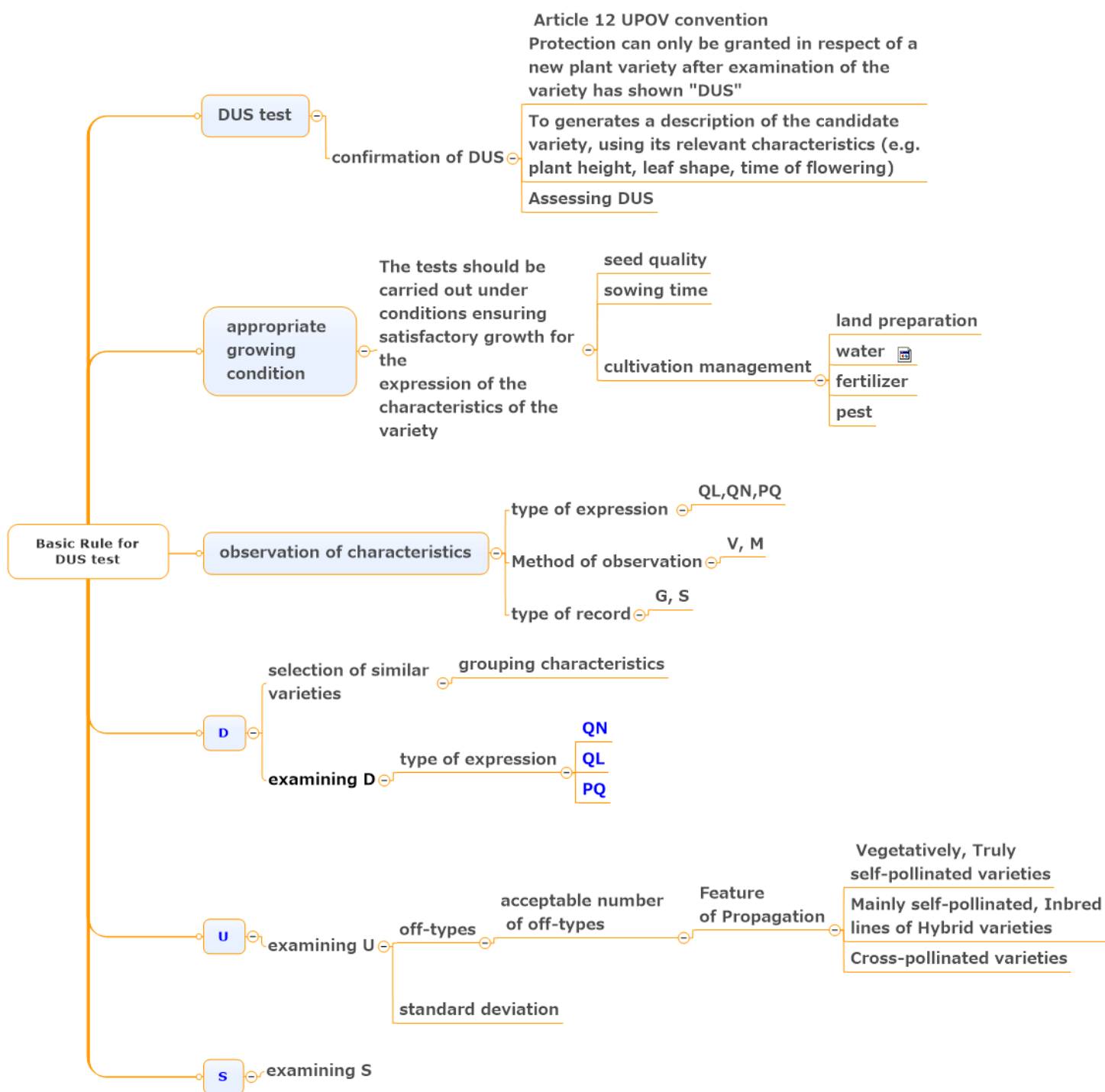
Stability

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



Thank you for your attention

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