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MINIMUM DISTANCE OF VARIETIES

Document prepared by an expert from China

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The annex to this document contains a presentation "Minimum distance of varieties", made by an expert from China, at the fourth session of the TWM.

[Annex follows]

MINIMUM DISTANCE OF VARIETIES

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1. DEFINITION AND CHALLENGE

(vi) "variety" means a plant grouping within a single botanical taxon of the lowest known rank, which grouping, irrespective of whether the conditions for the grant of a breeder's right are fully met, can be

- defined by the expression of the characteristics resulting from a given genotype or combination of genotypes,
- distinguished from any other plant grouping by the expression of at least one of the said characteristics and
- considered as a unit with regard to its suitability for being propagated unchanged;

variety

trinity definiti on

DUS

Characteristic

4.2.1 The basic requirements that a characteristic should fulfill before it is used for DUS testing or producing a variety description are that its expression:

(a) results from a given genotype or combination of genotypes
(this requirement is specified in Article 1(vi) of the 1991 Act of the UPOV Convention but is a basic requirement in all cases);

(b) is sufficiently consistent and repeatable in a particular environment;

(c) exhibits sufficient variation between varieties to be able to establish distinctness;

(d) is capable of precise definition and recognition
(this requirement is specified in Article 6 of the 1961/1972 and 1978 Acts of the UPOV Convention, but is a basic requirement in all cases);

(e) allows uniformity requirements to be fulfilled;

(f) allows stability requirements to be fulfilled, meaning that it produces consistent and repeatable results after repeated propagation or, where appropriate, at the end of each cycle of propagation.

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1. DEFINITION AND CHALLENGE

The variety shall be deemed to be distinct if it is clearly distinguishable from any other variety whose existence is a matter of common knowledge at the time of the filing of the application. In particular, the filing of an application for the granting of a breeder's right or

Distinctness

Minimum distance

6.4.1.1 Determination of Off-Types by Visual Assessment

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. This definition makes it clear that, in the assessment of uniformity, the standard for distinctness between off-types and a candidate variety is the same as for distinctness between a candidate variety and other varieties (see Chapter 5, section 5.5.2).

Uniformity

Stability

7.3.1.1 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, experience has demonstrated that, for many types of variety, when a variety has been shown to be uniform, it can also be considered to be stable. Furthermore, if the variety is not stable, material produced will not conform to the characteristics of the variety, and where the breeder is unable to provide material conforming to the characteristics of the variety, the breeder's right may be cancelled.

7.3.1.2 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. Further guidance on the examination of stability is considered in document TGP/11, "Examining Stability."

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1. DEFINITION AND CHALLENGE

TG/1, TGP/1-15, TGs, QL/QN/PQ, VG/VS/MG/MS, t test, COYD, Off-types, COYU, Relative Variance...

Is it clear and workable for minimum distance of varieties in practice?

1. DEFINITION AND CHALLENGE

Challenge 1： numerous varieties

Statistics of total agricultural vareties number in China by the end of 2025

- Approved varieties of 5 crops： **70,219** (maize 31,761, rice 22,988, wheat 7382, soybean 5,116, cotton 2,772)
- Registered varieties of 29 crops: **36,847** (pepper 6,430, tomato 3,864, watermelon 3,840, Chinese cabbage 3,347, melon 2,674, oil seed 2,439, sunflower 2,324, cucumber 2,207, top 8 crops occupy 73.6% of all)
- Applications of PBR of 74 crops： **101,372** (maize 32,866, rice 21,949, wheat 6,097, top 3 crops occupy 60% of all)
- The proliferation of varieties has led to a decreasing distance between them, with an increasing number of varieties exhibiting only slight differences in 1-2 charactersitics.

1. DEFINITION AND CHALLENGE

Challenge 2：DUS VS VCU

After the 2015 revision of the Seed Law made DUS a basic requirement for variety approval and registration, debates about DUS have been ongoing. Many characteristics without commercial value are used for distinctness and uniformity determination, which is considered to be detrimental to variety innovation.

The approval authorities in China don’t agree on some official DUS testing reports. As a result, they set a stricter molecular distance standards for rice and corn with being more than 3 and 2 loci difference. They expanded the DUS testing scope from official testing to include green channel testing, consortium testing, and independent testing.

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1. DEFINITION AND CHALLENGE

Challenge 3：penotype VS genotype

Court case 1: 2014-2015，maize hybrid variety，SSR no difference. Defendent won the case because cob glumes color is obviously different.

Court case 2: 2017-2021，pepper hybrid variety，SSR no difference. Defendent won the case because there are some slight differences in plant height and fruiting habit.

Court case 3: 2021-2025，maize inbreed line，SSR 1 difference among 40 loci. Defendent lost the case because he couldn’t explain origin of material.

The courts in China used to support DUS testing report prior to DNA report, but now, in order to strictly protect breeders' rights, they also directly make decision by trade secrets and molecular results.

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2. GENETICS AND BREEDING PERSPECTIVE

Breeding method	Genetic contribution of parent variety
selection	≈100%
backcross	＞95%
hybrid	50%～100%
GMO	＞95%
Gene editing	＞98%
Mutation / Mutagenesis	≈100%
MAS / GS	≈100%(single parent)
DH	≈100%

MAS: Marker-Assisted Selection
GS: Genomic Selection
DH: Doubled Haploid

propagation method	natural mutation
self-pollinated	**<1-4%**
barley	0.04-0.015%
soybean	0.5-1.0%
rice, wheat	4%
vegetative propagation	**1-3%**
often cross-pollinated	**5-50%**
sesame	3-20%
millet	5-50%
oil seed rape	10-30%
cross-pollinated (maize, ryegrass)	**>50%**

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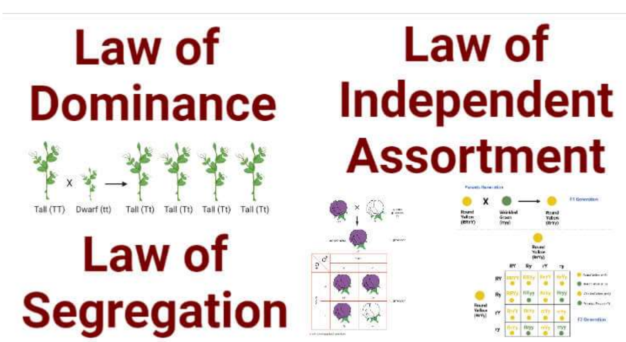
2. GENETICS AND BREEDING PERSPECTIVE



n=Allele pairs

Types of gemate =2^n (A, a)

Types of genotypes after self-pollination=3^n (AA, Aa, aa)

Types of phenotypes after self-pollination=2^n (AA & Aa, aa)

Types of Gemate fusion=4^n (AA, Aa, Aa, aa)

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2. GENETICS AND BREEDING PERSPECTIVE

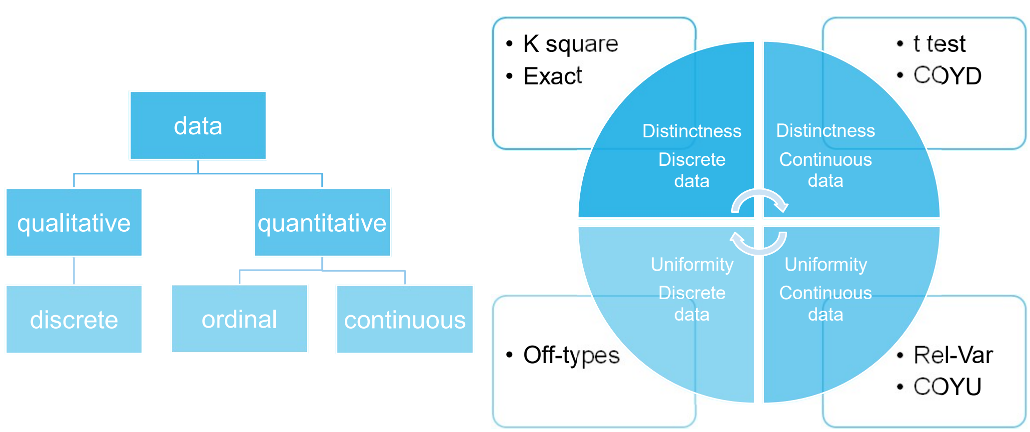
Disease resistant non-adapted cultivar — Susceptible adapted cultivar

PP × *pp*
↓
1st Backcross *PP* × *Pp:pp* — F_1,50% genes from *pp* cultivar
↓
2nd Backcross *PP* × *Pp:pp* — BC_1F_1,75% genes from *pp* cultivar
↓
3rd Backcross *PP* × *Pp:pp* — BC_2F_1,87.5% genes from *pp* cultivar
↓
4th Backcross *PP* × *Pp:pp* — BC3F1,93.5% genes from *pp* cultivar
↓
5th Backcross *PP* × *Pp:pp* — BC_4F_1,96.875% genes from *pp* cultivar
↓
Pp:pp — BC_5F_1,98.4375% genes from *pp* cultivar
↓
1PP:2Pp:1pp — Self-pollinate Pp plants from BC5 to recover PP plant

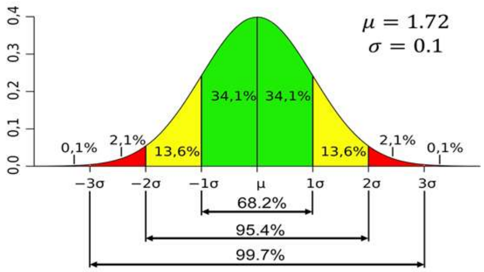
% Homozygosity				
0		Pp		
50	1/4 PP	1/2Pp	1/4pp	1st generation of self-pollination
75	3/8 PP	1/4Pp	3/8pp	2nd generation of self-pollination
87.5	7/16 PP	1/8Pp	7/16pp	3rd generation of self-pollination
93.5	15/32 PP	1/16Pp	15/32pp	4th generation of self-pollination
96.875	31/64 PP	1/32Pp	31/64pp	5th generation of self-pollination
98.4375	63/128 PP	1/64Pp	63/128pp	6th generation of self-pollination
99.21875	127/256 PP	1/128Pp	127/256pp	7th generation of self-pollination

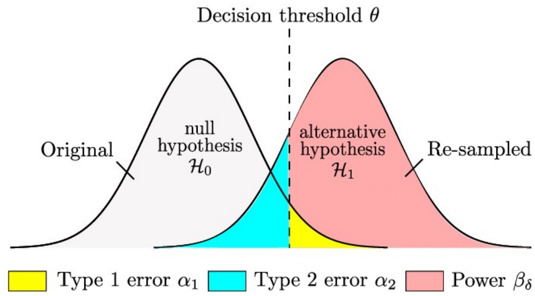
Should minimum distance be set between BC_4F_1 and BC_5F_1 generation?

3. STATISTICAL ANALYSIS PERSPECTIVE



3. STATISTICAL ANALYSIS PERSPECTIVE





$$n = \frac{(u_{1-\alpha/2} + u_{1-\beta})^2 \sigma^2}{(\mu_0 - \mu_1)^2}$$

estimating the population mean

$$n = \frac{(\sigma_1^2 + \sigma_2^2)(u_{1-\alpha/2} + u_{1-\beta})^2}{\Delta^2}$$

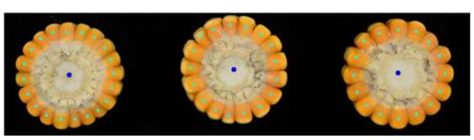
estimating the difference in means between two samples

$$n = \frac{p_0 q_0 \left(u_{1-\alpha/2} + u_{1-\beta}\sqrt{\frac{p_1 q_1}{p_0 q_0}}\right)^2}{(p_1 - p_0)^2}$$

estimating the difference between sample rate and population rate

3. STATISTICAL ANALYSIS PERSPECTIVE

Ear: number of rows of grain



8-24, only even numbers, 2 rows normally means “clearly distinguishable”

128 varieties, trial 2019-2020, 20 samples
mean: 12.6~21.5
standard deviation: 0.79~2.24
coefficient correlation between years: 0.88

LSD

trial	2019	2020
mean	16.31	16.28
st	1.43	1.44
min	13	12.6
max	21.5	21.1
$LSD_{0.05}$	0.888	0.891

COYD

mean	16.30
st	0.29
min	13.05
max	20.85
$LSD_{0.05}$	1.074

3. STATISTICAL ANALYSIS PERSPECTIVE

analyze as decrete data

sample size = 20

uniformity by off-types

population standard=3%

only 2 off-types allowed

distinctness by chi square

18:2 vs 2:18 D

18:2 vs 13:7 ND

distinctness by Exact

18:2 vs 2:18 D

14:6 vs 6:14 ND

NO.	R	C
1	16	18
2	16	18
3	16	18
4	16	18
5	16	18
6	16	18
7	16	18
8	16	18
9	16	18
10	16	18
11	16	18
12	16	18
13	16	18
14	16	18
15	16	18
16	16	18
17	16	18
18	16	18
19	18	16
20	18	16

analyze as continuous data

sample size = 20

uniformity by relative variance

18:2 vs 7:13 NU α=0.05

18:2 vs 6:14 U α=0.05

distinctness by 2*1%

18:2 vs 10:10 D

18:2 vs 11:9 ND

NO.	R	C
1	16	18
2	16	18
3	16	18
4	16	18
5	16	18
6	16	18
7	16	18
8	16	18
9	16	18
10	16	18
11	16	16
12	16	16
13	16	16
14	16	16
15	16	16
16	16	16
17	16	16
18	16	16
19	18	16
20	18	16
样本量	20	20
均值	16.2	17
标准差	0.616	1.026

The results of statistical analysis are smaller than 2.

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4. DISCUSSION

- Do we need genetic or breeding distance instead of 0 after statistical analysis to assess distinctness?
- Should the breeding distance be a fixed minimum distance value being set for each characteristic, or should it be 3% or population standard of expression range of variety collection or similar varieties?
- Should the characteristics for uniformity assessment be limited to commercial characteristics, such as characteristics related to yield, quality and resistance?

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**THANK YOU
FOR YOUR ATTENTION!**

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[End of Annex and of document]