E

TWC/34/17
ORIGINAL: English
DATE: May 6, 2016

# INTERNATIONAL UNION FOR THE PROTECTION OF NEW VARIETIES OF PLANTS

Geneva

## TECHNICAL WORKING PARTY ON AUTOMATION AND COMPUTER PROGRAMS

## Thirty-Fourth Session
## Shanghai, China, June 7 to 10, 2016

GENOTYPE BY ENVIROMENT INTERACTION (GEI) - DUS TEST AND DATA TRANSFORMATION INTO NOTES

*Document prepared by experts from Italy and Finland*

*Disclaimer: this document does not represent UPOV policies or guidance*

The Annex to this document contains a copy of a presentation on “Genotype by Environment Interaction (GEI) - DUS test and data transformation into notes” that will be made at the thirty-fourth session of the Technical Working Party on Automation and Computer Programs (TWC).

[Annex follows]

ANNEX

GENOTYPE BY ENVIROMENT INTERACTION (GEI) - DUS TEST AND DATA TRANSFORMATION INTO NOTES

UPOV TWC *Shanghai ▪ China* 7-10 June 2016

# *Genotype by Environment Interaction (GEI) - DUS test and data transformation into notes*

Maurizio Giolo
CREA SCS (ITALY)

Sami Markkanen
EVIRA (FINLAND)

1

## The «ambiguity» of the Characteristic

The term «characteristic» is often used in various contexts, but the intended meaning may be different: "genetic" .... "observed" ... "measured", etc.

For example:
The measure of «plant length» may be considered a «genetic characteristic» but it is actually a «**phenotipic expression of a specific year**».

Genotype x environment interaction takes place when different genotypes respond in a different way to different environments.

The use of the wrong type of expression of a characteristic may influence statistics. It is not a responsibility of statisticians - they work with data - the cause is upstream.

2

## Qualitative and Quantitative characteristics

### Qualitative characteristics QL

- Phenotypes easy to measure
- Mendelian inheritance (monogene)
- Limited environmental effect

Example: French bean [char. 3 - Plant: growth type]

### Quantitative characteristics QN

- Continuous range of variation
- Complex inheritance (polygene)
- Significative environmental effect

Examples: height, width and length in plants or plan organs

3

## Relationship Genotype - Phenotype


### Phenotype

Phenotype variation is due to plant genetics and environment (e.g. year and location).

A single genotype can produce multiple phenotypes in response to the environment.

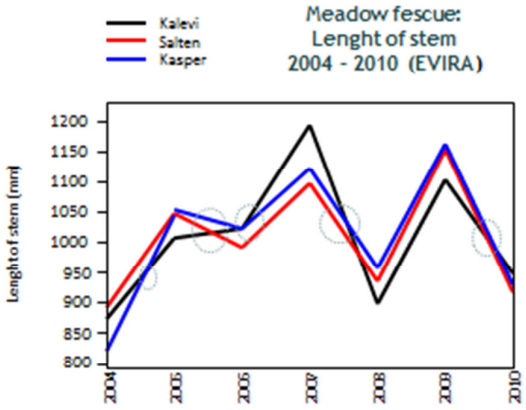
Observations and trials data are based on phenotypes and may change over years because of GEI (genotype-environment interaction).

4

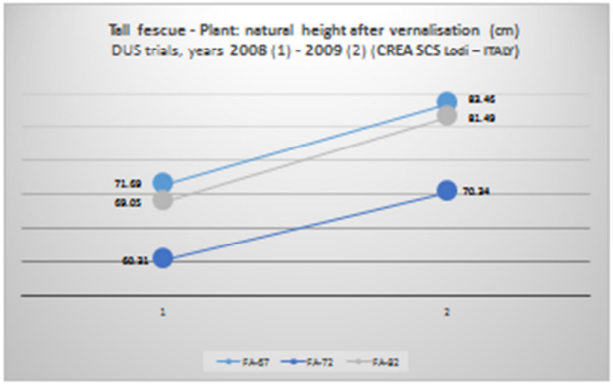
## Graphic view of main GEI cases


Environments: E1, E2 (e.g. years)

## Finland DUS herbage trials: examples of GEI over 7 years

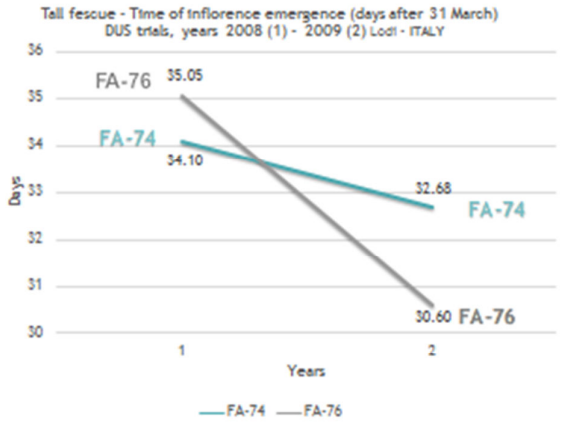


## Italian DUS herbage trials: environmental effect but no interaction




7

## Italian DUS herbage trials: example of GEI




8

## Effects of GEI on trials

Many studies have shown that plant species may produce a ***broad range of phenotypes*** in response to the variation in the environment.

If a characteristic (e.g. QN) is influenced by the environment its measures over years may change because of GEI.

To limit the environmental influence and, consequently, the number of the possible phenotypes, the use of ***one permanent location for DUS trials as «reference location»*** is recommended.

9

## 'Example varieties' and 'Delineating reference varieties'
USE and LIMITATIONS

Example varieties and Delineating reference varieties are state references that are used as comparisons of varietal descriptions. Their use can be appropriate but it should be treated carefully because changes of rank over years are possible when characteristics are influenced by the environment.

The ability of a single genotype to produce multiple phenotypes in response to the environment is called «phenotypic **plasticity**» while the opposite is «**stability**».

A stable genotype tends to maintain constant QN characteristics across environments.

10

## Example varieties and Delineating reference varieties 'Use and Limitations'

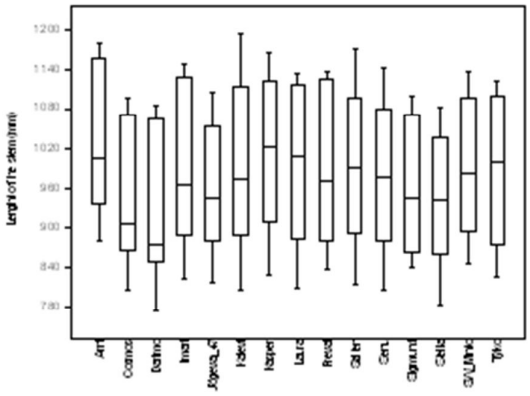
*Example varieties and Delineating reference varieties* should be as stable as possible.

An estimator of varietal stability over years for QN characteristics is the **coefficient of variation** (CV). It is defined as the ratio of the standard deviation to the mean and it can also be expressed as a percentage:

$$CV = (SD / Mean) * 100$$

11

## Finland herbage trials - Boxplot of lenght of stem of 14 Meadow fescue varieties, Years 2004-2012 (EVIRA)




12

## Comment of slide 12

*Boxplots describe graphically data dispersion through their quartiles. Every box spans from the first quartile (Q1) to the third quartile (Q3). Two whiskers are extended from the top and the bottom of the box to the highest and lowest non-outlier value, respectively. The horizontal line drawn at Q2 is the median.*

The **slide 12** "length of stem" of 14 Meadow fescue varieties shows the spread of data over 12 years and the skewness of some of them towards either extreme.

Usually the character "length of stem" is one of grass characteristics with largest variation. Visually, Finnish data do not seem to display great differences in variation among varieties. Probably the climatic conditions they were exposed to were quite stable.

13

## Coefficient of variation (CV %) of 14 Meadow fescue varieties Years 2004-2012 - EVIRA - Finland

«Example and Delineating reference varieties» with low CV % are recommended.

| Varieties | CV % |
|---|---|
| Sigmund | 9,44 |
| SW Minto | 10,17 |
| Jõgeva 47 | 10,18 |
| Ami | 10,28 |
| Tyko | 10,42 |
| Stella | 10,51 |
| Preval | 10,71 |
| Cosmos | 10,72 |
| Laura | 10,78 |
| Seriu | 10,92 |
| Ilmari | 11,28 |
| Derimo | 11,36 |
| Kasper | 11,60 |
| Salten | 12,03 |
| Kalevi | 12,35 |

14

## Use of regional sets of Example varieties

Databases can be increased by adding new data from candidate, reference and foreign varieties. Databases can include data of varieties grown and/or tested in a reference location where DUS test takes place.

The use of regional sets of Example varieties is preferable because it enables to compare characteristics of all varieties included in a database, as well as to test how stable a variety is in a specific region.

Where large regions are present in the same country because of very different agro-climatic conditions, more than one reference location is conceivable. In this case we could have more than one description for a single variety due to different phenotypes. Only one description should be the official one.

15

## Official description: criteria for choosing

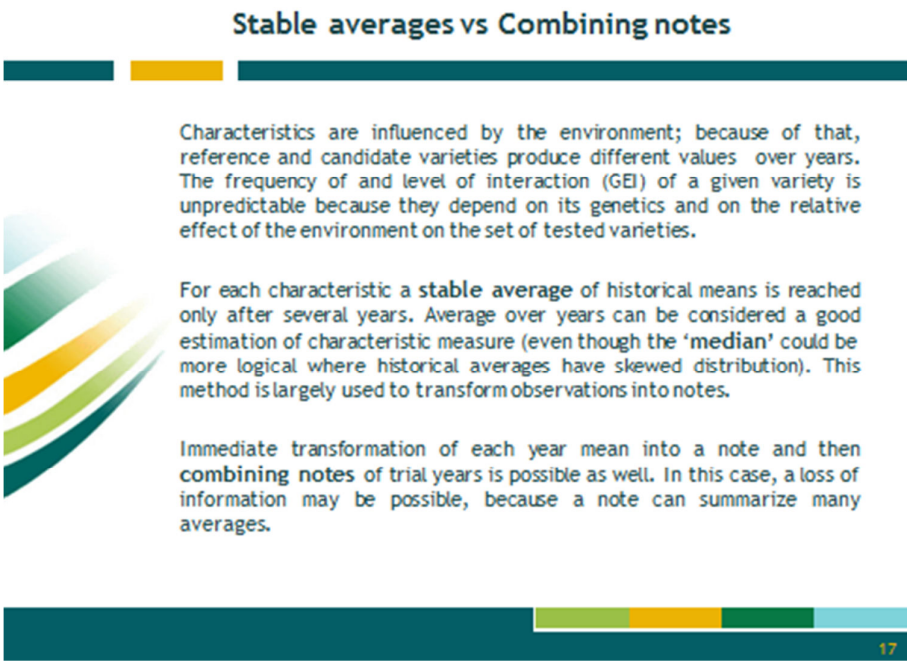
If more than one location is used for DUS trials and more than one description is produced, criteria to choose the official one are needed.

Possible criteria for choosing the 'official Location/description':

- Location in the area with the largest adaptation/cultivation of the species
  (choice based on the most ***common phenotype*** in that area)
- Location where CV range of varieties is the lowest
  (choice based on ***stability*** over years)

04/05/2016

16




[End of Annex and of document]