

**Technical Working Party on Testing Methods and Techniques**

**TWM/1/11**

**First Session**

**Virtual meeting, September 19 to 23, 2022**

**Original:** English

**Date:** August 31, 2022

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**PRESENTATION OF PATHOSTAT APPLICATION**

*Document prepared by an expert from France*

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

The annex to this document contains a copy of a presentation on “Presentation of PATHOSTAT application”, prepared by an expert from France, to be made at the first session of the TWM.

[Annex follows]

# Presentation of PATHOSTAT application

Technical Working Party on Testing Methods  
and Techniques (TWM/1)

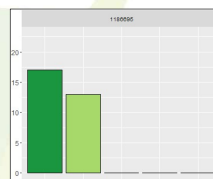


## Presentation of application

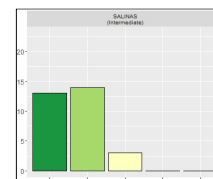
- Decision support system
- R Shiny app → Interactive web application  
⇒ <https://pathostat.geves.fr>
- Pathostat-Veg Project
- Objectives :
  - Support expert analysis with use of resistance test to diseases



1186962	1	3	7	0	0	0
	2	5	5	0	0	0
	3	3	6	0	0	0
PATRIOT (Susceptible)	1	0	0	3	4	3
	2	0	0	1	2	7
	3	0	0	2	1	7
NATEXIS (intermédiaire)	1	0	4	2	3	0
	2	0	4	3	3	0
	3	0	5	4	1	0
SALINAS (intermédiaire)	1	4	6	0	0	0
	2	4	4	2	0	0
	3	5	4	1	0	0
COSTA RICA (résistant)	1	7	3	0	0	0
	2	6	4	0	0	0
	3	10	0	0	0	0



More or less  
susceptible ?



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## Presentation of application

### ● Objectives :

- Select statistical tests applicable to the quantitative results of bio-tests
- For DUS:
  - Identify if varieties are distinct based on non qualitative data
  - Provide proof that it is uniform/homogeneous

### ● Purpose :

- Improvement and harmonisation of decision rules on the interpretation of biotest results
- Improvement of variety judgement
- Better correlation between applicants' claims and official tests



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## Presentation of application



- Free hosting and open access on GEVES website

⇒ <https://pathostat.geves.fr>



- Application is secure

⇒ Data are not saved within application



- User manual

⇒ Exists in English and French



- Application has 2 functions :

⇒ The respect of the regulatory framework and official protocol

⇒ Adaptability for methodology or research



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# Statistical Methods

29 août 2022, ANGERS

WWW.GEVES.FR



## Statistical Methods

### ● Test on the minimum number

Variety	Number $\geq$ threshold	Class 0	Class 1	Class 2	Class 3	Class 4
VARIETY A	✓	4	11	8	6	1
VARIETY B	✗	22	4	0	1	0
CASAQUE ROUGE (Susceptible)	✓	0	0	0	3	27
ANAHU X CASAQUE ROUGE (Resistant)	✓	23	7	0	0	0
CAMPEON (Intermediate)	✓	7	3	6	15	0
TYONIC (Intermediate)	✓	4	10	9	7	0

- Minimum threshold number depends on pathosystem (here 30 plants)
- Reference threshold number is automatically selected
- Option to change the value of the minimum threshold

## Statistical Methods

### ● Comparison of distribution between repetitions

#### – Stacked histogram

- To compare graphically distribution of symptoms between repetitions for each variety
- Highlights differences between repetitions

Distribution of symptoms for repetition 1 of variety 2019.13 appears different from others



## Statistical Methods

### ● Comparison of distribution between repetitions

#### – Homogeneity test of repetition

- To study the distribution of symptoms between repetitions
- All varieties are pooled together
- Highlights any problems in experimental protocol

#### ➡ Chi-squared test ( $\chi^2$ test)

- Condition for the validity:
  - Expected value  $\geq 5$  in at least 80 % of cases
- Hypothesis of test :
  - $H_0$  : homogeneity of the distribution of symptoms between repetitions
  - $H_1$  : heterogeneity of the distribution of symptoms between repetitions

#### • Chi-squared test

Pearson's Chi-squared test

data: pooled data  
X-squared = 3.0944, df = 6, p-value = 0.7969



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## Statistical Methods

### Comparison of distribution between repetitions

#### Homogeneity test of repetition per variety

##### Fisher's exact test

- To compare distribution between repetitions of each variety
- Preferred to  $\chi^2$  test because:
  - The small number of each repetition
  - The predictable imbalance of the expected value
- Hypothesis of test:
  - $H_0$  : homogeneity of the distribution of symptoms between repetitions
  - $H_1$  : heterogeneity of the distribution of symptoms between repetitions

Variety	P-value	Result
2019.01	1.000	Homogeneity of repetitions
2019.02	0.062	Homogeneity of repetitions
2019.03	0.508	Homogeneity of repetitions
2019.04	1.000	Homogeneity of repetitions
2019.05	1.000	Homogeneity of repetitions
2019.06	0.095	Homogeneity of repetitions
2019.07	0.180	Homogeneity of repetitions
2019.08	0.335	Homogeneity of repetitions
2019.09	0.513	Homogeneity of repetitions
2019.1	0.262	Homogeneity of repetitions
2019.11	0.141	Homogeneity of repetitions
2019.12	0.749	Homogeneity of repetitions
2019.13	0.020	Heterogeneity of repetitions
CASAQUE ROUGE (Susceptible)	1.000	Homogeneity of repetitions
ANAHU X CASAQUE ROUGE (Resistant)	1.000	Homogeneity of repetitions
CAMPEON (Intermediate)	0.118	Homogeneity of repetitions
TYONIC (Intermediate)	0.899	Homogeneity of repetitions



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## Statistical Methods

### Study of the susceptibility/resistance of varieties

#### Histogram – Pie chart

- Allows to view distribution of symptoms for each variety

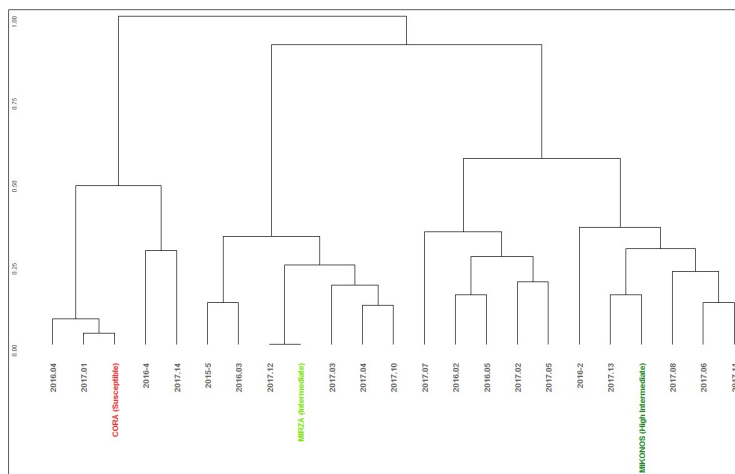


## Statistical Methods

### ● Study of the susceptibility/resistance of varieties

#### – Hierarchical Cluster Analysis

- Principle of the method :
  - ↗ intraclass homogeneity
  - ↗ interclass heterogeneity
- Criterion of similarity : relative frequency of affiliation to each class of symptom
- Based on Euclidean distance
 
$$d(x, y) = \sqrt{\sum_{i=1}^n (x_i - y_i)^2}$$
- Dendrogram (classification tree)
- 5 agglomerative methods
- Cophenetic correlation coefficient



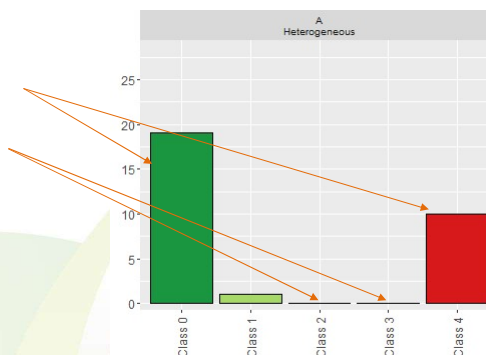
## Statistical Methods

### ● Study of the susceptibility/resistance of varieties

#### – Decisions

##### ➡ Heterogeneity rule

- Variety is proposed heterogeneous if there are:
  - Plants in both extreme classes within the limit of the tolerated number of off-types
  - No plant in at least one of the intermediate classes
- The tolerated number of off-types of extreme classes depends on:
  - Species
  - Number of plant in extreme classes of control



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## Statistical Methods

### Study of the susceptibility/resistance of varieties

#### – Decisions

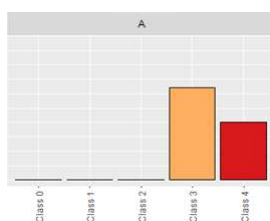
- Susceptibility / resistance level of varieties decided on comparison with control
- Model which compare each variety with each control

$$N_{test} = N_{variety} \times N_{control}$$

#### ➡ Cochran-Armitage test for trend

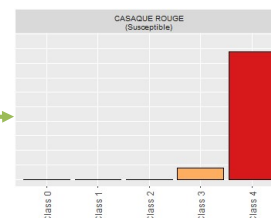
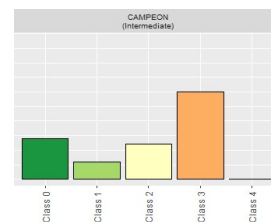
- Can be considered as an enhancement of the  $\chi^2$  test considering the general tendency

Susceptibility / resistance level of variety A ?



More susceptible than control CAMPEON ?

More resistant than control CASAQUE ROUGE ?



## Statistical Methods

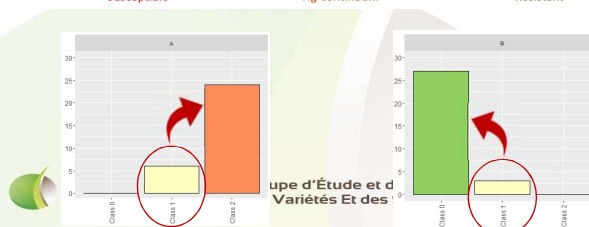
### Study of the susceptibility/resistance of varieties

#### – Decisions

#### ➡ Cochran-Armitage test for trend

- No condition for the validity
- CPVO decision rules will determine interpretation of the variety in comparison with controls
  - No control bound

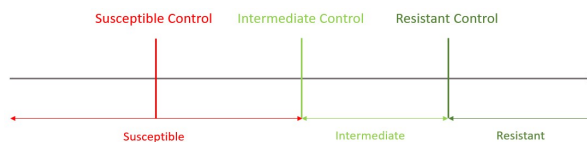
#### – Class 1 mobile



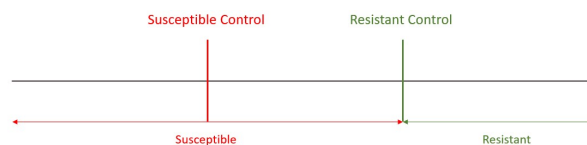


## Statistical Methods

- IR control lower bound



- Resistant control lower bound

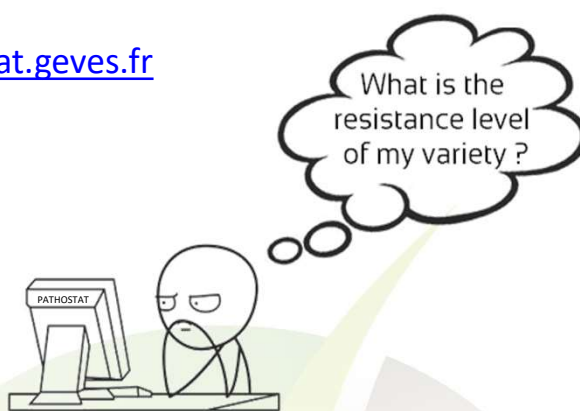


- Susceptible control higher bound



## Demonstration of application

➡ <https://pathostat.geves.fr>



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## Any Question ?

Thank your for listening !

ANY  
QUESTIONS  
...



So, it is over to you !

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