




Groupe d'Étude et de contrôle  
des Variétés Et des Semences



# TWC/31/Prep

Seoul – June 2013

C.CHEVALIER – Twc/31/Prep Seoul June 2013





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A SOFTWARE FOR ESTIMATING PHENOTYPICAL DISTANCES BETWEEN  
VARIETIES AND FOR MANAGING REFERENCE COLLECTION

## GAIA THEORETICAL PRESENTATION

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## Object

The aim of this software for each candidate variety is to:

- detect very distinct varieties = GAIA-distinct varieties, at the end of the first year of study (on the basis of description made in the field and stored in a database)
- detect varieties which need to be further compared to close varieties

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## Principle

- The estimation of the phenotypical distance between 2 varieties is based on the addition of the differences observed for the different characteristics
- Each difference observed is weighted by the crop expert according to the value of the difference and to the reliability of each characteristic

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**Example**

	Type of grain (QL)	Attitude of lateral branches (QL)	Anthocyanin coloration of glumes (QL)	Length of husks (QL)	Number of rows of grain (QL)	Diameter of the ear (QT)	Time of anthesis (QT)	...
Variety A	4	7	2	5	3	3	6	...
Variety B	4	5	1	7	3	5	7	...
Difference	0	2	1	2	0	2	1	...
Weighting	0	2	0	0	0	2	0	... $\Sigma W = 4$

(QL) = qualitative characteristics  
(QT) = quantitative characteristics

Estimation of the phenotypical distance between A and B

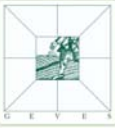
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## Rules for decision

- If the phenotypical distance between A and B > threshold (fixed by the crop expert)
  - A and B are declared GAIA-distinct and are not directly compared in the second year
- If the phenotypical distance between A and B < threshold
  - A and B are declared GAIA Non-distinct will be directly compared side by side in the field in the second year

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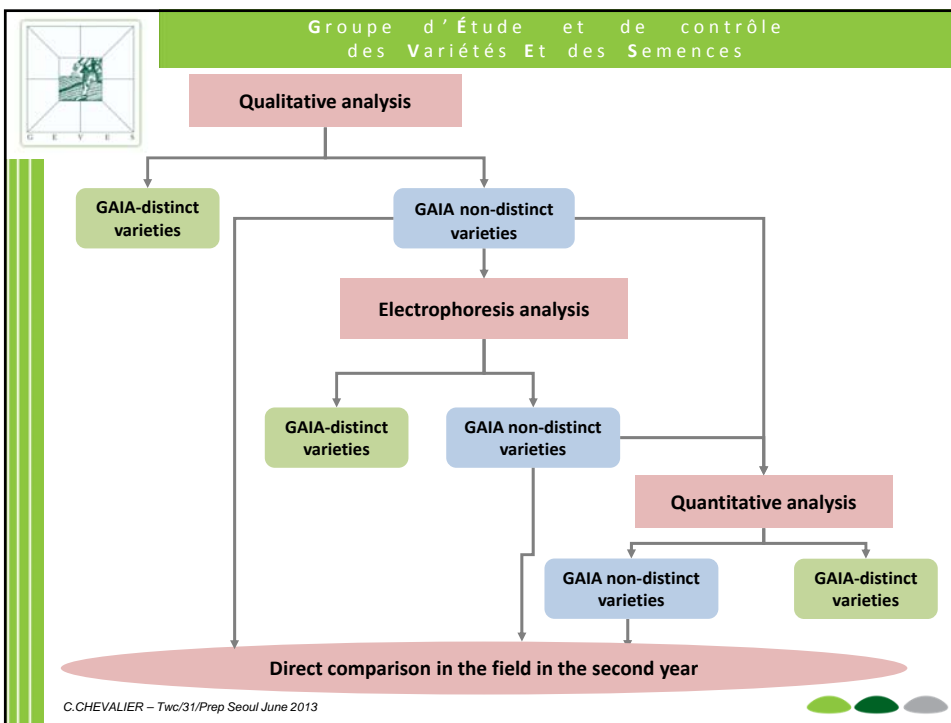



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## Different types of characteristics

- **Qualitative characteristics**  
 observed in a 1 to 9 scale or transformed into 1 to 9 scale
- **Quantitative characteristics**  
 measured
- **Electrophoretic characteristics**  
 observed as presence or absence of each allele

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## Qualitative analysis for 1 cycle


Comparison of varieties A and B:


	Leaf: Green colour
Variety A	<b>6</b>
Variety B	<b>4</b>
Difference	<b>2</b>
Weighting	

The weightings matrix for this characteristic :

	1	2	3	4	5	6	7	8	9
1	0	1	3	4	6	6	6	6	6
2		0	1	3	4	6	6	6	6
3			0	1	3	4	6	6	6
4				0	1	3	4	6	6
5					0	1	3	4	6
6						0	1	3	4
7							0	1	3
8								0	1
9									0

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4				0	1	3	4	6	6
5					0	1	3	4	6
6						0	1	3	4
7							0	1	3
8								0	1
9									0

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4				0	1	3	4	6	6
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7							0	1	3
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## Qualitative analysis for 1 cycle

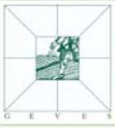
● Comparison of varieties A and B:

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Variety A	6
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Weighting	3

The weightings matrix for this characteristic :

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3			0	1	3	4	6	6	6
4				0	1	3	4	6	6
5					0	1	3	4	6
6						0	1	3	4
7							0	1	3
8								0	1
9									0

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## Qualitative analysis for 1 cycle

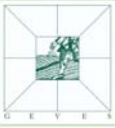
**Comparison of varieties A and B:**

	Leaf: Green colour	Leaf: Dentation
Variety A	6	7
Variety B	4	5
Difference	2	2
Weighting	3	

The weightings matrix for this characteristic :

	1	2	3	4	5	6	7	8	9
1	0	0	2	3	6	6	6	6	6
2		0	0	2	3	6	6	6	6
3			0	0	2	3	6	6	6
4				0	0	2	3	6	6
5					0	0	2	3	6
6						0	0	2	3
7							0	0	2
8								0	0
9									0

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3			0	0	2	3	6	6	6
4				0	0	2	3	6	6
5					0	0	2	3	6
6						0	0	2	3
7							0	0	2
8								0	0
9									0

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	1	2	3	4	5	6	7	8	9
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2		0	0	2	3	6	6	6	6
3			0	0	2	3	6	6	6
4				0	0	2	3	6	6
5					0	0	2	3	6
6						0	0	2	3
7							0	0	2
8								0	0
9									0

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	1	2	3	4	5	6	7	8	9
1	0	0	2	3	6	6	6	6	6
2		0	0	2	3	6	6	6	6
3			0	0	2	3	6	6	6
4				0	0	2	3	6	6
5					0	0	2	3	6
6						0	0	2	3
7							0	0	2
8								0	0
9									0

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## Qualitative analysis for 1 cycle

● Comparison of varieties A and B:

	Leaf: Green colour	Leaf: Dentation
Variety A	6	7
Variety B	4	5
Difference	2	2
Weighting	3	2

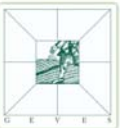
$\Sigma = 5$

↙

The phenotypic distance between A and B

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## Qualitative analysis for 2 cycles


● Example of the characteristic : Green colour of the leaf

	Cycle 1
Variety A	6
Variety B	5
Difference	1
Weighting	

The weightings matrix for this characteristic for 1 cycle:

	1	2	3	4	5	6	7	8	9
1	0	1	3	4	6	6	6	6	6
2		0	1	3	4	6	6	6	6
3			0	1	3	4	6	6	6
4				0	1	3	4	6	6
5					0	1	3	4	6
6						0	1	3	4
7							0	1	3
8								0	1
9									0

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## Qualitative analysis for 2 cycles


Example of the characteristic : Green colour of the leaf

	Cycle 1
Variety A	<b>6</b>
Variety B	<b>5</b>
Difference	<b>1</b>
Weighting	<b>1</b>

The weightings matrix for this characteristic for 1 cycle:

	1	2	3	4	5	6	7	8	9
1	0	1	3	4	6	6	6	6	6
2		0	1	3	4	6	6	6	6
3			0	1	3	4	6	6	6
4				0	1	3	4	6	6
5					0	1	3	4	6
6						0	1	3	4
7							0	1	3
8								0	1
9									0

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## Qualitative analysis for 2 cycles

Green colour of the leaf

	Cycle 1	Cycle 2
Variety A	<b>6</b>	<b>5</b>
Variety B	<b>5</b>	<b>4</b>
Difference	<b>1</b>	<b>1</b>
Weighting	<b>1</b>	

The weightings matrix for this characteristic for 1 cycle: =>

	1	2	3	4	5	6	7	8	9
1	0	3	4	6	6	6	6	6	6
2		0	3	4	6	6	6	6	6
3			0	3	4	6	6	6	6
4				0	3	4	6	6	6
5					0	3	4	6	6
6						0	3	4	6
7							0	3	4
8								0	3
9									0

The weightings matrix for this characteristic for 2 cycles:

	1	2	3	4	5	6	7	8	9
1	0	3	4	6	6	6	6	6	6
2		0	3	4	6	6	6	6	6
3			0	3	4	6	6	6	6
4				0	3	4	6	6	6
5					0	3	4	6	6
6						0	3	4	6
7							0	3	4
8								0	3
9									0

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## Qualitative analysis for 2 cycles

Green colour of the leaf

	Cycle 1	Cycle 2
Variety A	6	5
Variety B	5	4
Difference	1	1
Weighting	<del>4</del>	

The weightings matrix for this characteristic for 1 cycle: =>

1	6	6	6	6	6	6	6	6
2	0	1	3	4	6	6	6	6
3	0	0	1	3	6	6	6	6
4	0	0	0	1	3	4	6	6
5	0	0	0	0	1	3	4	6
6	0	0	0	0	0	1	3	4
7	0	0	0	0	0	0	1	3
8	0	0	0	0	0	0	0	1
9	0	0	0	0	0	0	0	0

The weightings matrix for this characteristic for 2 cycles:

1	0	3	4	6	6	6	6	6	6
2	0	3	4	6	6	6	6	6	6
3	0	3	4	6	6	6	6	6	6
4	0	3	4	6	6	6	6	6	6
5	0	3	4	6	6	6	6	6	6
6	0	3	4	6	6	6	6	6	6
7	0	3	4	6	6	6	6	6	6
8	0	3	4	6	6	6	6	6	6
9	0	3	4	6	6	6	6	6	6

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## Qualitative analysis for 2 cycles

Green colour of the leaf

	Cycle 1	Cycle 2
Variety A	6	5
Variety B	5	4
Difference	1	1
Weighting	<del>4</del>	
Weighting	3	3


The weightings matrix for this characteristic for 1 cycle: =>

1	6	6	6	6	6	6	6	6
2	0	1	3	4	6	6	6	6
3	0	0	1	3	6	6	6	6
4	0	0	0	1	3	4	6	6
5	0	0	0	0	1	3	4	6
6	0	0	0	0	0	1	3	4
7	0	0	0	0	0	0	1	3
8	0	0	0	0	0	0	0	1
9	0	0	0	0	0	0	0	0

The weightings matrix for this characteristic for 2 cycles:

1	0	3	4	6	6	6	6	6	6
2	0	3	4	6	6	6	6	6	6
3	0	3	4	6	6	6	6	6	6
4	0	3	4	6	6	6	6	6	6
5	0	3	4	6	6	6	6	6	6
6	0	3	4	6	6	6	6	6	6
7	0	3	4	6	6	6	6	6	6
8	0	3	4	6	6	6	6	6	6
9	0	3	4	6	6	6	6	6	6

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## Qualitative analysis for 2 cycles

● Green colour of the leaf


	Cycle 1	Cycle 2
Variety A	6	5
Variety B	5	<del>4</del> 3

The weightings matrix for this characteristic for 2 cycles:

	1	2	3	4	5	6	7	8	9
1	0	3	4	6	6	6	6	6	6
2		0	3	4	6	6	6	6	6
3			0	3	4	6	6	6	6
4				0	3	4	6	6	6
5					0	3	4	6	6
6						0	3	4	6
7							0	3	4
8								0	3
9									0

Difference	1	1
Weighting	<del>4</del>	
Weighting	3	3

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## Qualitative analysis for 2 cycles

● Green colour of the leaf

	Cycle 1	Cycle 2
Variety A	6	5
Variety B	5	<del>4</del> 3

The weightings matrix for this characteristic for 2 cycles:

	1	2	3	4	5	6	7	8	9
1	0	3	4	6	6	6	6	6	6
2		0	3	4	6	6	6	6	6
3			0	3	4	6	6	6	6
4				0	3	4	6	6	6
5					0	3	4	6	6
6						0	3	4	6
7							0	3	4
8								0	3
9									0

Difference	1	<del>1</del> 2
Weighting	<del>4</del>	
Weighting	3	3

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## Qualitative analysis for 2 cycles

● Green colour of the leaf

	Cycle 1	Cycle 2
Variety A	6	5
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The weightings matrix for this characteristic for 2 cycles:

	1	2	3	4	5	6	7	8	9
1	0	3	4	6	6	6	6	6	6
2		0	3	4	6	6	6	6	6
3			0	3	4	6	6	6	6
4				0	3	4	6	6	6
5					0	3	4	6	6
6						0	3	4	6
7							0	3	4
8								0	3
9									0

Difference	1	<del>1</del> 2
Weighting	<del>4</del>	
Weighting	3	<del>3</del> 4

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## Qualitative analysis for 2 cycles

● The different options

	Cycle 1	Cycle 2
Variety A	6	5
Variety B	5	3
Difference	1	2
Weighting	3	4

Weighting = 4

● Weighting associated to the highest difference: **maximalist option**

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## Qualitative analysis for 2 cycles

● The different options

	Cycle 1	Cycle 2
Variety A	<b>6</b>	<b>5</b>
Variety B	<b>5</b>	<b>3</b>
Difference	<b>1</b>	<b>2</b>
Weighting	<b>3</b>	<b>4</b>

- Weighting associated to the highest difference: **maximalist option**
- Weighting associated to the lowest difference: **minimalist option**



Weighting = 3

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## Qualitative analysis for 2 cycles

● The different options


	Cycle 1	Cycle 2
Variety A	<b>6</b>	<b>5</b>
Variety B	<b>5</b>	<b>3</b>
Difference	<b>1</b>	<b>2</b>
Weighting	<b>3</b>	<b>4</b>

- Weighting associated to the highest difference: **maximalist option**
- Weighting associated to the lowest difference: **minimalist option**
- Mean of weightings: **mean option**



Weighting = 3.5

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## Qualitative analysis for 2 cycles


● Take into account the direction of the difference or not?

	Cycle 1	Cycle 2
Variety A	6	<del>5</del> 4
Variety B	5	<del>3</del> 5
Difference	1	<del>2</del> -1
Weighting	3	4

The weightings matrix for this characteristic for 2 cycles:

	1	2	3	4	5	6	7	8	9
1	0	3	4	6	6	6	6	6	6
2		0	3	4	6	6	6	6	6
3			0	3	4	6	6	6	6
4				0	3	4	6	6	6
5					0	3	4	6	6
6						0	3	4	6
7							0	3	4
8								0	3
9									0

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## Qualitative analysis for 2 cycles

● Take into account the direction of the difference or not?

	Cycle 1	Cycle 2
Variety A	6	<del>5</del> 4
Variety B	5	<del>3</del> 5
Difference	1	<del>2</del> -1
Weighting	3	4

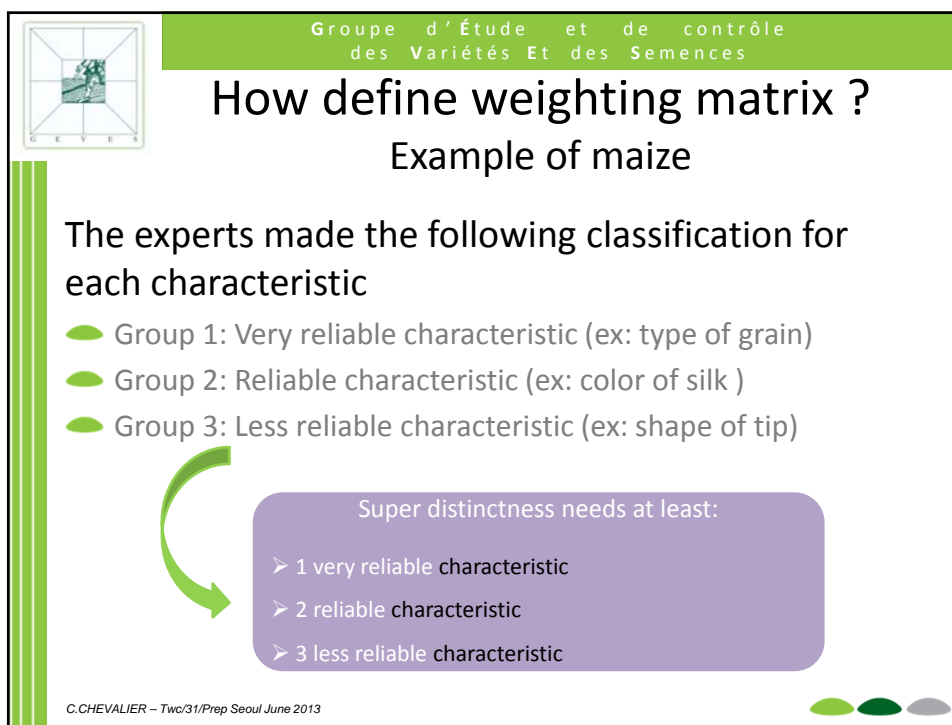
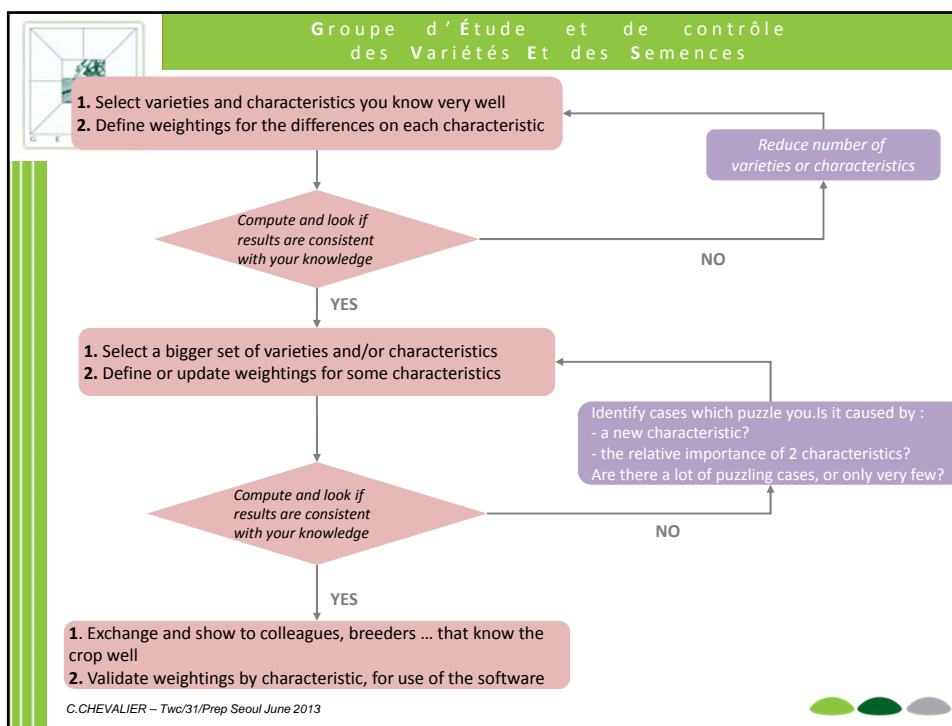
The weightings matrix for this characteristic for 2 cycles:

	1	2	3	4	5	6	7	8	9
1	0	3	4	6	6	6	6	6	6
2		0	3	4	6	6	6	6	6
3			0	3	4	6	6	6	6
4				0	3	4	6	6	6
5					0	3	4	6	6
6						0	3	4	6
7							0	3	4
8								0	3
9									0


● Take into account the direction of the difference:  
=> no weighting is associated

● Not take into account the direction of the difference:  
=> weighting = 3

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## The threshold value ?


The common multiple between 1,2 and 3 is 6

=> 6 will be the threshold for "super distinction"  
in maize

- > 1 very reliable characteristic will be enough to reach the threshold value
- > 2 reliable characteristics will be enough to reach the threshold value
- > 3 less reliable characteristics will be enough to reach the threshold value

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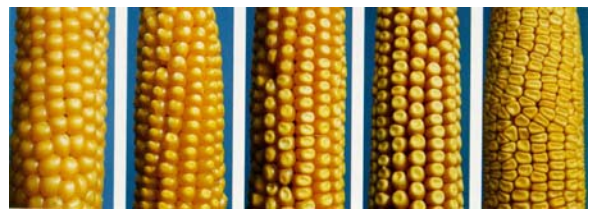
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## Example of Very reliable characteristic

### Ear: Type of grain

**Stade** :92 grain dur  
**Niveau** : tiers moyen de l'épi

**Time** :92 hard grain  
**Place** :middle third of ear



	1	2	3	4	5	6	7
1	0	0	6	6	6	6	6
2		0	0	6	6	6	6
3			0	0	6	6	6
4				0	0	6	6
5					0	0	6
6						0	0
7							0

**1 corné**  
*flint*


**2 corné à corné-denté**  
*flint-like*

**3 corné-denté**  
*intermediate*

**4 corné-denté à denté**  
*dent-like*

**5 denté**  
*dent*

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des Variétés Et des Semences

### Example of less reliable characteristic First leaf: shape of tip

**Stade :14**  
4 feuilles étalées

**Time :14**  
4 leaves unfolded



**1 pointu**  
*pointed*

**3 arrondi**  
*round*

**5 spatulé**  
*spatulate*

	1	2	3	4	5
1	0	0	2	2	2
2		0	0	2	2
3			0	0	2
4				0	0
5					0

