



## **PROTOCOL FOR TESTS ON DISTINCTNESS, UNIFORMITY AND STABILITY**

***Chenopodium quinoa* Willd.**

**QUINOA**

UPOV Code: CHENO\_QUI

**Adopted on 25/03/2021**

**Entry into force on 01/03/2021**

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## 1. SUBJECT OF THE PROTOCOL AND REPORTING

### 1.1 Scope of the technical protocol

This Technical Protocol applies to all varieties of *Chenopodium quinoa* Willd.

The protocol describes the technical procedures to be followed in order to meet the requirements of Council Regulation 2100/94 on Community Plant Variety Rights. The technical procedures have been agreed by the Administrative Council and are based on documents agreed by the International Union for the Protection of New Varieties of Plants (UPOV), such as the General Introduction to DUS (UPOV Document TG/1/3 [http://www.upov.int/export/sites/upov/resource/en/tg\\_1\\_3.pdf](http://www.upov.int/export/sites/upov/resource/en/tg_1_3.pdf)), its associated TGP documents (<http://www.upov.int/tgp/en/>) and the relevant UPOV Test Guideline TG/328/1 dated 30/10/2018 (<https://www.upov.int/edocs/tgdocs/en/tg328.pdf>) for the conduct of tests for Distinctness, Uniformity and Stability.

### 1.2 Entry into Force

The present protocol enters into force on **01.03.2021**. Any ongoing DUS examination of candidate varieties started before the aforesaid date will not be affected by the approval of the Technical Protocol. Technical examinations of candidate varieties are carried out according to the TP in force when the DUS test starts. The starting date of a DUS examination is considered to be the due date for submitting of plant material for the first test period.

In cases where the Office requests to take-over a DUS report for which the technical examination has either been finalized or which is in the process to be carried out at the moment of this request, such report can only be accepted if the technical examination has been carried out according to the CPVO TP which was in force at the moment when the technical examination started.

### 1.3 Reporting between Examination Office and CPVO and Liaison with Applicant

#### 1.3.1 Reporting between Examination Office and CPVO

The Examination Office shall deliver to the CPVO a preliminary report ("the preliminary report") no later than two weeks after the date of the request for technical examination by the CPVO.

The Examination Office shall also deliver to the CPVO a report relating to each growing period ("the interim report") and, when the Examination Office considers the results of the technical examination to be adequate to evaluate the variety or the CPVO so requests, a report relating to the examination ("the final report").

The final report shall state the opinion of the Examination Office on the distinctness, uniformity and stability of the variety. Where it considers those criteria to be satisfied, or where the CPVO so requests, a description of the variety shall be added to the report.

If a report is negative the Examination Office shall set out the detailed reasons for its findings.

The interim and the final reports shall be delivered to the CPVO as soon as possible and no later than on the deadlines as laid down in the designation agreement.

#### 1.3.2 Informing on problems in the DUS test

If problems arise during the course of the test the CPVO should be informed immediately so that the information can be passed on to the applicant. Subject to prior permanent agreement, the applicant may be directly informed at the same time as the CPVO particularly if a visit to the trial is advisable.

#### 1.3.3 Sample keeping in case of problems

If the technical examination has resulted in a negative report, the CPVO shall inform the Examination Office as soon as possible in case that a representative sample of any relevant testing material shall be kept.

## 2. MATERIAL REQUIRED

### 2.1 Plant material requirements

Information with respect to the agreed closing dates and submission requirements of plant material for the technical examination of varieties can be found on <http://cpvo.europa.eu/applications-and-examinations/technical-examinations/submission-of-plant-material-s2-publication> in the special issue S2 of the Official Gazette of the Office. General requirements on submission of samples are also to be found following the same link.

## **2.2 Informing the applicant of plant material requirements**

The CPVO informs the applicant that

- he is responsible for ensuring compliance with any customs and plant health requirements.
- the plant material supplied should be visibly healthy, not lacking in vigor, nor affected by any important pest or disease.
- the plant material should not have undergone any treatment which would affect the expression of the characteristics of the variety, unless the competent authorities allow or request such treatment. If it has been treated, full details of the treatment must be given.

## **2.3 Informing about problems on the submission of material**

The Examination Office shall report to the CPVO immediately in cases where the test material of the candidate variety has not arrived in time or in cases where the material submitted does not fulfil the conditions laid down in the request for material issued by the CPVO.

In cases where the examination office encounters difficulties to obtain plant material of reference varieties the CPVO should be informed.

## **3. METHOD OF EXAMINATION**

### **3.1 Number of growing cycles**

The minimum duration of tests should normally be two independent growing cycles.

### **3.2 Testing Place**

Tests are normally conducted at one place. In the case of tests conducted at more than one place, guidance is provided in TGP/9 "Examining Distinctness" [http://www.upov.int/edocs/tgpdocs/en/tgp\\_9.pdf](http://www.upov.int/edocs/tgpdocs/en/tgp_9.pdf).

### **3.3 Conditions for Conducting the Examination**

The tests should be carried out under conditions ensuring satisfactory growth for the expression of the relevant characteristics of the variety and for the conduct of the examination.

The optimum stage of development for the assessment of each characteristic is indicated by a number in the third column of the Table of Characteristics. The stages of development denoted by each number are described in Chapter 8.3.

### **3.4 Test design**

- 3.4.1 Each test should be designed to result in a total of at least 160 plants, which should be divided between at least 2 replicates.
- 3.4.2 The design of the tests should be such that plants or parts of plants may be removed for measurement or counting without prejudice to the observations which must be made up to the end of the growing cycle.

### **3.5 Special tests for additional characteristics**

In accordance with Article 23 of Implementing Rules N° 874/2009 an applicant may claim either in the Technical Questionnaire or during the test that a candidate has a characteristic which would be helpful in establishing distinctness. If such a claim is made and is supported by reliable technical data, a special test may be undertaken providing that a technically acceptable test procedure can be devised.

Special tests will be undertaken, with the agreement of the President of CPVO, where distinctness is unlikely to be shown using the characters listed in the protocol.

### **3.6 Constitution and maintenance of a variety collection**

The process for the constitution and the maintenance of a variety collection can be summarized as follows:

Step 1: Making an inventory of the varieties of common knowledge

Step 2: Establishing a collection ("variety collection") of varieties of common knowledge which are relevant for the examination of distinctness of candidate varieties

Step 3: Selecting the varieties from the variety collection which need to be included in the growing trial or other tests for the examination of distinctness of a particular candidate variety.

#### **3.6.1 Forms of variety collection**

The variety collection shall comprise variety descriptions and living plant material, thus a living reference collection. The variety description shall be produced by the EO unless special cooperation exists between EOs and the CPVO. The descriptive and pictorial information produced by the EO shall be held and maintained in a form of a database.

#### **3.6.2 Living Plant Material**

The EO shall collect and maintain living plant material of varieties of the species concerned in the variety collection.

#### **3.6.3 Range of the variety collection**

The living variety collection shall cover at least those varieties that are suitable to climatic conditions of a respective EO.

#### **3.6.4 Making an inventory of varieties of common knowledge for inclusion in the variety collection**

The inventory shall include varieties protected under National PBR (UPOV contracting parties) and Community PBR, varieties registered in the Common Catalogue, the OECD list, the Conservation variety list and varieties in trade or in commercial registers for those species not covered by a National or the Common Catalogue.

#### **3.6.5 Maintenance and renewal/update of a living variety collection**

The EO shall maintain seeds in conditions which will ensure germination and viability, periodical checks, and renewal as required. For the renewal of existing living material the identity of replacement living plant material shall be verified by conducting side-by-side plot comparisons between the material in the collection and the new material.

## **4. ASSESSMENT OF DISTINCTNESS, UNIFORMITY AND STABILITY**

The prescribed procedure is to assess distinctness, uniformity and stability in a growing trial.

### **4.1 Distinctness**

#### **4.1.1 General recommendations**

It is of particular importance for users of this Technical Protocol to consult the UPOV-General Introduction to DUS (link in chapter 1 of this document) and TGP 9 'Examining Distinctness' ([http://www.upov.int/edocs/tgpdocs/en/tgp\\_9.pdf](http://www.upov.int/edocs/tgpdocs/en/tgp_9.pdf)) prior to making decisions regarding distinctness. However, the following points are provided for elaboration or emphasis in this Technical Protocol.

#### **4.1.2 Consistent differences**

The differences observed between varieties may be so clear that more than one growing cycle is not necessary. In addition, in some circumstances, the influence of the environment is not such that more than a single growing cycle is required to provide assurance that the differences observed between varieties are sufficiently consistent. One means of ensuring that a difference in a characteristic, observed in a growing trial, is sufficiently consistent is to examine the characteristic in at least two independent growing cycles.

#### **4.1.3 Clear differences**

Determining whether a difference between two varieties is clear depends on many factors, and should consider, in particular, the type of expression of the characteristic being examined, i.e. whether it is expressed in a qualitative, quantitative, or pseudo-qualitative manner. Therefore, it is important that users of these Technical Protocols are familiar with the recommendations contained in the UPOV-General Introduction to DUS prior to making decisions regarding distinctness.

## **Decision standards**

4.1.3.1 If distinctness is assessed using the 2 x 1% criterion, the varieties need to be significantly different in the same direction at the 1% level in at least two out of three years in one or more measured characteristics. The tests in each year are based on Student's two-tailed t-test of the differences between variety means with standard errors estimated using the residual mean square from the analysis of the variety x replicate plot means.

4.1.3.2 If distinctness is assessed by the combined over years distinctness analysis (COYD) the difference between two varieties is clear if the respective characteristics are different at the 1% significance level or less ( $p < 0.01$ ) in a test over either two or three years.

If the significance level or statistical methods proposed are not appropriate the method used should be clearly described.

### 4.1.4 Number of plants/parts of plants to be examined

Unless otherwise indicated, for the purposes of distinctness, all observations on single plants should be made on 40 plants or parts taken from each of 40 plants and any other observations made on all plants in the test, disregarding any off-type plants.

*Where appropriate, the following sentence may be added:*

In the case of observations of parts taken from single plants, the number of parts to be taken from each of the plants should be 1.

### 4.1.5 Method of observation

The recommended method of observing the characteristic for the purposes of distinctness is indicated by the following key in the third column of the Table of Characteristics (see document TGP/9 "Examining Distinctness", Section 4 "Observation of characteristics"):

MG: single measurement of a group of plants or parts of plants  
MS: measurement of a number of individual plants or parts of plants  
VG: visual assessment by a single observation of a group of plants or parts of plants  
VS: visual assessment by observation of individual plants or parts of plants

Type of observation: visual (V) or measurement (M)

"Visual" observation (V) is an observation made on the basis of the expert's judgment. For the purposes of this document, "visual" observation refers to the sensory observations of the experts and, therefore, also includes smell, taste and touch. Visual observation includes observations where the expert uses reference points (e.g. diagrams, example varieties, side-by-side comparison) or non-linear charts (e.g. color charts). Measurement (M) is an objective observation against a calibrated, linear scale e.g. using a ruler, weighing scales, colorimeter, dates, counts, etc.

Type of record: for a group of plants (G) or for single, individual plants (S)

For the purposes of distinctness, observations may be recorded as a single record for a group of plants or parts of plants (G), or may be recorded as records for a number of single, individual plants or parts of plants (S). In most cases, "G" provides a single record per variety and it is not possible or necessary to apply statistical methods in a plant-by-plant analysis for the assessment of distinctness.

In cases where more than one method of observing the characteristic is indicated in the Table of Characteristics (e.g. VG/MG), guidance on selecting an appropriate method is provided in document TGP/9, Section 4.2.

## **4.2 Uniformity**

4.2.1 It is of particular importance for users of this Technical Protocol to consult the UPOV-General Introduction to DUS (link in chapter 1 of this document) and TGP 10 'Examining Uniformity' ([http://www.upov.int/edocs/tgpdocs/en/tgp\\_10.pdf](http://www.upov.int/edocs/tgpdocs/en/tgp_10.pdf)) prior to making decisions regarding uniformity. However, the following points are provided for elaboration or emphasis in this Technical Protocol:

4.2.2 This Technical Protocol has been developed for the examination of self-pollinated varieties. For varieties with other types of propagation the recommendations in the UPOV-General Introduction to DUS and document TGP/13 "Guidance for new types and species", Section 4.5 "Testing Uniformity" should be followed.

For the assessment of uniformity of self-pollinated varieties, a population standard of 5% and an acceptance probability of at least 95% should be applied. In the case of a sample size of 160 plants, 13 off-types are allowed.

### 4.3 Stability

- 4.3.1 It is of particular importance for users of this Technical Protocol to consult the UPOV-General Introduction to DUS (link in chapter 1 of this document) and TGP 11 'Examining Stability' ([http://www.upov.int/edocs/tgpdocs/en/tgp\\_11.pdf](http://www.upov.int/edocs/tgpdocs/en/tgp_11.pdf))

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.

- 4.3.2 Where appropriate, or in cases of doubt, stability may be further examined by testing a new seed or plant stock to ensure that it exhibits the same characteristics as those shown by the initial material supplied.

## 5. GROUPING OF VARIETIES AND ORGANISATION OF THE GROWING TRIAL

- 5.1 The selection of varieties of common knowledge to be grown in the trial with the candidate varieties and the way in which these varieties are divided into groups to facilitate the assessment of distinctness are aided by the use of grouping characteristics.
- 5.2 Grouping characteristics are those in which the documented states of expression, even where produced at different locations, can be used, either individually or in combination with other such characteristics: (a) to select varieties of common knowledge that can be excluded from the growing trial used for examination of distinctness; and (b) to organise the growing trial so that similar varieties are grouped together.
- 5.3 The following have been agreed as useful grouping characteristics:
- a) Grain: saponin content (characteristic 1)
  - b) Time of flowering (characteristic 7)
  - c) Inflorescence: colour (characteristic 12)
  - d) Seed: colour (characteristic 18)
- 5.4 If other characteristics than those from the Technical Protocol are used for the selection of varieties to be included into the growing trial, the EO shall inform the CPVO and seek the prior consent of the CPVO before using these characteristics.
- 5.5 Guidance for the use of grouping characteristics, in the process of examining distinctness, is provided through the UPOV-General Introduction to DUS and document TGP/9 "Examining Distinctness".

## 6. INTRODUCTION TO THE TABLE OF CHARACTERISTICS

### 6.1 Characteristics to be used

The characteristics to be used in DUS tests and preparation of descriptions shall be those referred to in the table of characteristics. All the characteristics shall be used, providing that observation of a characteristic is not rendered impossible by the expression of any other characteristic, or the expression of a characteristic is prevented by the environmental conditions under which the test is conducted or by specific legislation on plant health. In the latter case, the CPVO should be informed.

The Administrative Council empowers the President, in accordance with Article 23 of Commission Regulation N°874/2009, to insert additional characteristics and their expressions in respect of a variety.

### 6.2. States of expression and corresponding notes

In the case of qualitative and pseudo-qualitative characteristics, all relevant states of expression are presented in the characteristic. However, in the case of quantitative characteristics with 5 or more states, an abbreviated scale may be used to minimize the size of the Table of Characteristics. For example, in the case of a quantitative characteristic with 9 states, the presentation of states of expression in the Test Guidelines may be abbreviated as follows:

State	Note
small	3
medium	5
large	7

However, it should be noted that all of the following 9 states of expression exist to describe varieties and should be used as appropriate:

State	Note
very small	1
very small to small	2
small	3
small to medium	4
medium	5
medium to large	6
large	7
large to very large	8
very large	9

Further explanation of the presentation of states of expression and notes is provided in UPOV document TGP/7 "Development of Test Guidelines".

### 6.3 Example Varieties

Where appropriate, example varieties are provided to clarify the states of expression of each characteristic.

### 6.4 Legend

For column 'CPVO N°':

G	Grouping characteristic	-see Chapter 5
QL	Qualitative characteristic	
QN	Quantitative characteristic	
PQ	Pseudo-qualitative characteristic	
(+)	Explanations for individual characteristics	-see Chapter 8.2

For column 'UPOV N°':

The numbering of the characteristics is provided as a reference to the UPOV guideline.

(*)	UPOV Asterisked characteristic	-Characteristics that are important for the international harmonization of variety descriptions.
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For column 'Stage, method':

MG, MS, VG, VS		-see Chapter 4.1.5
(a)-(c)	Explanations covering several characteristics	-see Chapter 8.1
00-99	Explanations on growth stages	-see Chapter 8.3



## 7. TABLE OF CHARACTERISTICS

CPVO N°	UPOV N°	Stage, Method	Characteristics	Example varieties	Note		
<b>1.</b> <b>(+)</b>	<b>1.</b> <b>(*)</b>	<b>MG</b>	<b>Grain: saponin content</b>				
			<b>QN</b>	<b>00</b>	absent or low	Jessie, Vikinga	1
					medium	Carmen, Zeno	2
<b>G</b>			high	Puno, Titicaca	3		
<b>2.</b>	<b>2.</b> <b>(*)</b>	<b>VG</b>	<b>Foliage: colour</b>				
			<b>PQ</b>	<b>5</b>	light green	Jessie	1
				<b>(a)</b>	medium green	Titicaca	2
					dark green	Puno	3
					red		4
			purple	Red Carina	5		
<b>3.</b>	<b>3.</b>	<b>VG</b>	<b>Foliage: glaucosity</b>				
			<b>QN</b>	<b>5</b>	absent or weak	Vikinga	1
				<b>(a)</b>	medium	Jessie, Red Carina	3
			strong	Regalona	5		
<b>4.</b>	<b>4.</b>	<b>VG</b>	<b>Leaf: size</b>				
			<b>QN</b>	<b>5-6</b>	small	Vikinga	3
				<b>(a)</b>	medium	Riobamba, Titicaca	5
			large	Carmen	7		
<b>5.</b> <b>(+)</b>	<b>5.</b>	<b>VG</b>	<b>Leaf: dentation</b>				
			<b>QN</b>	<b>5-6</b>	absent or weak	Riobamba	1
				<b>(a)</b>	medium	Puno	3
			strong	Red Carina	5		
<b>6.</b> <b>(+)</b>	<b>6.</b>	<b>VG</b>	<b>Leaf: angle of base</b>				
			<b>PQ</b>	<b>5-6</b>	acute	Regalona	1
				<b>(a)</b>	obtuse	Puno, Riobamba	2
			truncate	Atlas	3		

CPVO N°	UPOV N°	Stage, Method	Characteristics	Example varieties	Note
<b>7. (+)</b>	<b>7. (*)</b>	<b>MG</b>	<b>Time of flowering</b>		
<b>QN</b>		<b>8</b>	early	Jessie, Vikinga	3
			medium	Red Carina, Regalona	5
<b>G</b>			late	Atlas	7
<b>8.</b>	<b>8. (*)</b>	<b>VG</b>	<b>Stem: colour</b>		
<b>PQ</b>		<b>11</b>	white		1
		<b>(b)</b>	green	Riobamba, Titicaca	2
			yellow	Puno	3
			purple	Red Carina	4
<b>9.</b>	<b>9.</b>	<b>VG</b>	<b>Stem: stripes</b>		
<b>QL</b>		<b>11</b>	absent	Red Carina	1
		<b>(b)</b>	present	Puno	9
<b>10.</b>	<b>10.</b>	<b>VG</b>	<b>Stem: colour of stripes</b>		
<b>PQ</b>		<b>11</b>	green	Regalona	1
		<b>(b)</b>	yellow	Carmen, Titicaca	2
			pink	Puno	3
			red	Pasto	4
			purple		5
<b>11.</b>	<b>11.</b>	<b>VG</b>	<b>Stem: pigmentation at leaf axil</b>		
<b>PQ</b>		<b>11</b>	absent or very weak	Jessie	1
		<b>(b)</b>	weak		3
			medium	Pasto	5
			strong		7

CPVO N°	UPOV N°	Stage, Method	Characteristics	Example varieties	Note
<b>12.</b>	<b>12.</b>	<b>VG</b>	<b>Inflorescence: colour</b>		
	<b>(*)</b>				
<b>PQ</b>		<b>11</b>	white	Jessie, Regalona	1
			green		2
			yellow	Atlas	3
			orange	Titicaca	4
			pink	Carmen	5
<b>G</b>			purple	Red Carina	6
<b>13.</b>	<b>13.</b>	<b>MG</b>	<b>Time of maturity</b>		
<b>(+)</b>	<b>(*)</b>				
<b>QN</b>		<b>12</b>	early	Jessie	3
			medium	Regalona, Vikinga	5
			late	Atlas	7
<b>14.</b>	<b>14.</b>	<b>MG/VG</b>	<b>Plant: height</b>		
<b>(+)</b>	<b>(*)</b>				
<b>QN</b>		<b>12</b>	short	Pasto	3
			medium	Titicaca	5
			tall	Atlas	7
<b>15.</b>	<b>15.</b>	<b>VG</b>	<b>Panicle: colour</b>		
	<b>(*)</b>				
<b>PQ</b>		<b>12</b>	light yellow brown	Jessie	1
			brown	Atlas	2
			black	Red Carina	3
<b>16.</b>	<b>16.</b>	<b>VG</b>	<b>Panicle: density</b>		
<b>QN</b>		<b>12</b>	sparse	Titicaca	3
		<b>(c)</b>	medium	Riobamba	5
			dense	Dutchess	7

CPVO N°	UPOV N°	Stage, Method	Characteristics	Example varieties	Note	
<b>17. (+)</b> <b>QN</b>	<b>17.</b>	<b>MG/VG</b>	<b>Panicle: width</b>			
			12	narrow	Titicaca	3
			(c)	medium	Riobamba	5
				broad	Red Carina	7
<b>18. (+)</b> <b>PQ</b>  <b>G</b>	<b>18. (*)</b>	<b>VG</b>	<b>Seed: colour</b>			
			12	whitish	Puno	1
				yellow	Jessie	2
				red		3
				light brown	Carmen	4
				grey		5
				black	Red Carina	6
<b>19. (+)</b> <b>PQ</b>	<b>19. (*)</b>	<b>VG</b>	<b>Seed: colour without tegument</b>			
			12	white	Atlas	1
				yellow	Carmen	2
				red		3
				grey	Red Carina, Titicaca	4
<b>20. (+)</b> <b>QN</b>	<b>20.</b>	<b>MG</b>	<b>1000 seed weight</b>			
			12	very low		1
				low	Red Carina	3
				medium	Jessie	5
				high	Titicaca	7
				very high		9

## 8. EXPLANATIONS ON THE TABLE OF CHARACTERISTICS

### 8.1 Explanations covering several characteristics

Characteristics containing the following key in the third column of the Table of Characteristics should be examined as indicated below:

- a) To be observed on the middle part of the plant.
- b) To be observed on the lower third of the plant.
- c) To be observed on the upper third of the plant.

### 8.2 Explanations for individual characteristics

#### Ad. 1: Grain: saponin content

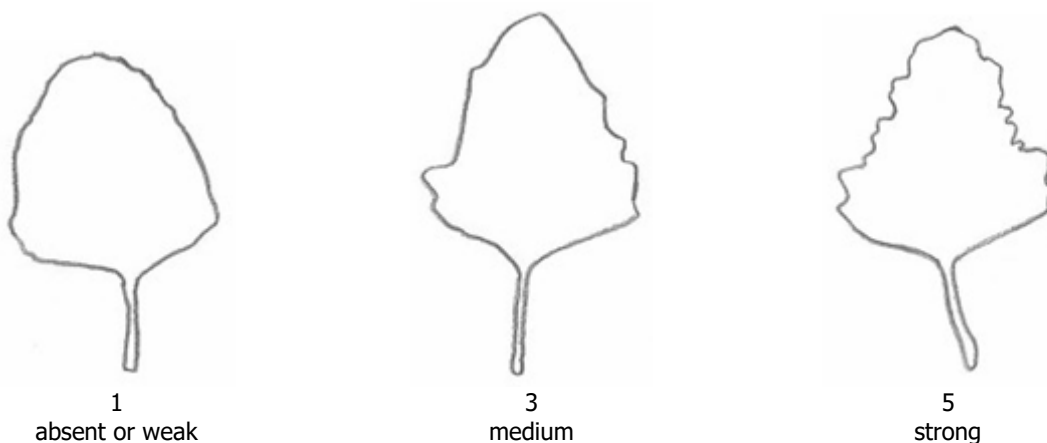
Grain saponin content is measured as a foam test. Testing should have a minimum of at least 3 replicates.

Standard afrosimetric method (Koziol, 1991)

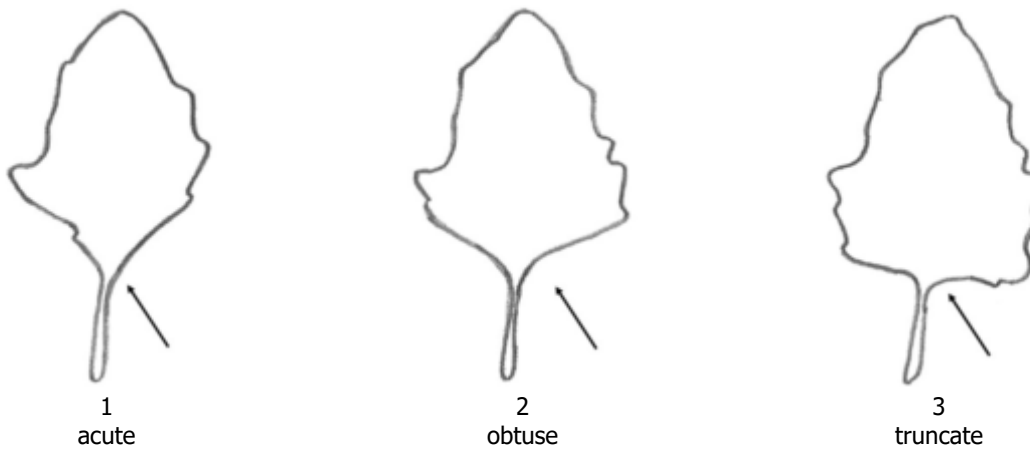
- 1 Weigh 0,5 g (+/- 0,2 g) quinoa seeds into a test tube (160x16 mm)
- 2 Addition 5 ml of distilled water, and cap the test tube.
- 3 Shake the test tube vigorously (4 shakes/s.) for 30 s in up and down movements.
- 4 Let the test tube rest for 30 minutes.
- 5 Repeat number 3-4.
- 6 After the second rest period, shake the test tube again for 30 s give a last shakedown as one would to a thermometer.
- 7 Rest for 5 minutes.
- 8 Measure the height of the foam.

Grain: saponin Foam height	absent or low < 1.0 cm	medium 1.0 cm – 5.0 cm	high > 5.0 cm
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#### Ad. 5: Leaf: dentation



Ad. 6: Leaf: angle of base



Ad. 7: Time of flowering

The time of flowering is reached when 50% of plants have open flowers on the upper third of the plant.

Ad. 13: Time of maturity

The time of maturity is reached when 50% of plants are dried on the upper third of the plant.

Ad. 14: Plant: height

Observations should be made including inflorescence.

Ad. 17: Panicle: width

Observations should be made one third from the top of plant.



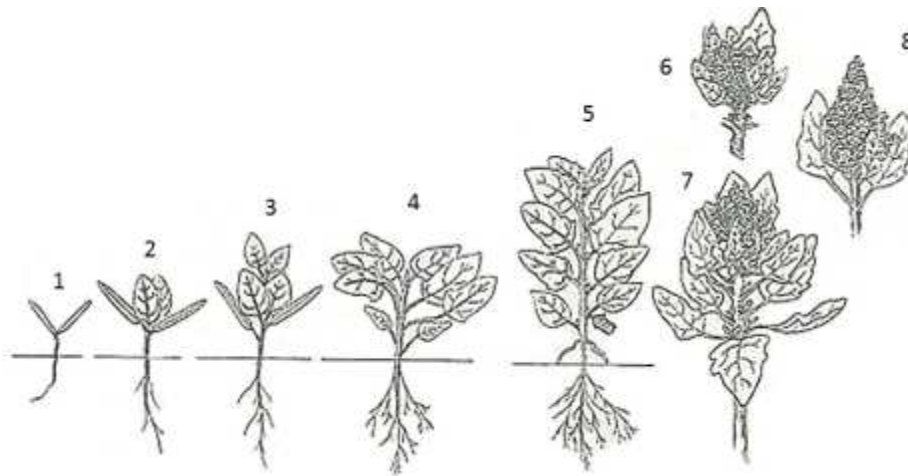
Ad. 19: Seed: colour without tegument

To be observed after seeds have been softly rubbed with sanding paper.

### 8.3 Explanations on growth stages

00-99 : explanation on the relevant growth stages scale

*Phenology of Quinoa (Chenopodium quinoa Willd.)*



(Mujica, A., Canahua, A., 1989)

1. Emergence (cotyledons)
2. Vegetative stage - two leaves
3. Vegetative stage - four leaves
4. Vegetative stage - six leaves
5. Ramification
6. Beginning of inflorescence emergence (panicle)
7. Inflorescence
8. Beginning of flowering
9. Flowering
10. Milky grain
11. Doughy grain
12. Physiological maturity



## 9. LITERATURE

Jacobsen, S.-E., Stølen, O., 1993: Quinoa - Morphology, phenology and prospects for its production as a new crop in Europe. *European Journal of Agronomy* 2, pp 19 to 29.

Koziol, M.J. 1991: Afrosimetric estimation of threshold saponin concentration for bitterness in quinoa (*Chenopodium quinoa* Willd). *Journal of the Science of Food and Agriculture*, 54, pp. 211 to 219.

Mujica, A., Canahua, A., 1989: Fenología del cultivo de la quinua. En Curso Taller de Fitopatología de Cultivos Andinos y Uso de la Información Agrometeorológica. PICA. INIIA. Puno, PE.

## 10. TECHNICAL QUESTIONNAIRE

The Technical Questionnaire is available on the [CPVO website](#) under the following reference:  
CPVO-TQ/328/1 - *Chenopodium quinoa* Willd. - quinoa