

UPOV

TG/7/10(proj.4)

ORIGINAL: English

DATE: 2007-04-30

INTERNATIONAL UNION FOR THE PROTECTION OF NEW VARIETIES OF PLANTS

GENEVA

DRAFT

PEA

UPOV code: PISUM_SAT

Pisum sativum L.

GUIDELINES

FOR THE CONDUCT OF TESTS

FOR DISTINCTNESS, UNIFORMITY AND STABILITY

*prepared by an expert from the United Kingdom**to be considered by the**Technical Working Party for Agricultural Crops at its thirty-sixth session,
to be held in Budapest, Hungary, from May 28 to June 1, 2007,**and by the**Technical Working Party for Vegetables at its forty-first session,
to be held in Nairobi, Kenya, from June 11 to 15, 2007.*

Alternative Names:*

*UK Proposes the addition of Field Pea as a common English name for *Pisum arvense* L.*

Botanical name	English	French	German	Spanish
<i>Pisum sativum</i> L.	Pea	Pois	Erbse	Guisante, Arvejo
<i>Pisum arvense</i> L.	Field Pea			

The purpose of these guidelines ("Test Guidelines") is to elaborate the principles contained in the General Introduction (document TG/1/3), and its associated TGP documents, into detailed practical guidance for the harmonized examination of distinctness, uniformity and stability (DUS) and, in particular, to identify appropriate characteristics for the examination of DUS and production of harmonized variety descriptions.

ASSOCIATED DOCUMENTS

These Test Guidelines should be read in conjunction with the General Introduction and its associated TGP documents.

* These names were correct at the time of the introduction of these Test Guidelines but may be revised or updated. [Readers are advised to consult the UPOV Code, which can be found on the UPOV Website (www.upov.int), for the latest information.]

<u>TABLE OF CONTENTS</u>	<u>PAGE</u>
1. SUBJECT OF THESE TEST GUIDELINES.....	3
2. MATERIAL REQUIRED	3
3. METHOD OF EXAMINATION.....	3
3.1 Number of Growing Cycles	3
3.2 Testing Place	3
3.3 Conditions for Conducting the Examination.....	4
3.4 Test Design	4
3.5 Number of Plants / Parts of Plants to be Examined.....	4
3.6 Additional Tests	4
4. ASSESSMENT OF DISTINCTNESS, UNIFORMITY AND STABILITY.....	4
4.1 Distinctness	4
4.1.1 <i>General Recommendations</i>	4
4.1.2 <i>Consistent Differences</i>	4
4.1.3 <i>Clear Differences</i>	5
4.2 Uniformity.....	5
4.3 Stability	5
5. GROUPING OF VARIETIES AND ORGANIZATION OF THE GROWING TRIAL	5
6. INTRODUCTION TO THE TABLE OF CHARACTERISTICS	6
6.1 Categories of Characteristics.....	6
6.1.1 <i>Standard Test Guidelines Characteristics</i>	6
6.1.2 <i>Asterisked Characteristics</i>	6
6.2 States of Expression and Corresponding Notes.....	6
6.3 Types of Expression.....	7
6.4 Example Varieties	7
6.5 Legend.....	7
7. TABLE OF CHARACTERISTICS/TABLEAU DES CARACTÈRES/MERKMALSTABELLE/TABLA DE CARACTERES.....	8
8. EXPLANATIONS ON THE TABLE OF CHARACTERISTICS	30
8.1 Explanations covering several characteristics	30
8.2 Explanations for individual characteristics	30
9. LITERATURE	55
10. TECHNICAL QUESTIONNAIRE.....	56

NOTES:

- Underlined, highlighted text → Addition to previous draft
- ~~Strikethrough, highlighted text~~ → Deletion from previous draft
- *Italics, highlighted text* → Comments

1. Subject of these Test Guidelines

These Test Guidelines apply to all varieties of *Pisum sativum* L.

2. Material Required

2.1 The competent authorities decide on the quantity and quality of the plant material required for testing the variety and when and where it is to be delivered. Applicants submitting material from a State other than that in which the testing takes place must ensure that all customs formalities and phytosanitary requirements are complied with.

2.2 The material is to be supplied in the form of seed.

2.3 The minimum quantity of plant material, to be supplied by the applicant, should be:

1,000 g or at least 12,000 seeds

2.4 The seed should meet the minimum requirements for germination, species and analytical purity, health and moisture content, specified by the competent authority. In cases where the seed is to be stored, the germination capacity should be as high as possible and should, be stated by the applicant.

2.5 The plant material supplied should be visibly healthy, not lacking in vigor, nor affected by any important pest or disease.

2.6 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.

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".

3.3 *Conditions for Conducting the Examination*

3.3.1 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.

3.3.2 The optimum stage of development for the assessment of each characteristic is indicated by a number in the second column of the Table of Characteristics. The stages of development denoted by each number are described at the end of Chapter 8.

3.3.3 The recommended method of observing the characteristic is indicated by the following key in the second column of the Table 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

3.4 *Test Design*

3.4.1 Each test should be designed to result in a total of at least 100 plants, which should be divided between two or more 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 *Number of Plants / Parts of Plants to be Examined*

Unless otherwise indicated, all observations should be made on 20 plants or parts taken from each of 20 plants.

3.6 *Additional Tests*

Additional tests, for examining relevant characteristics, may be established.

4. Assessment of Distinctness, Uniformity and Stability

4.1 *Distinctness*

4.1.1 General Recommendations

It is of particular importance for users of these Test Guidelines to consult the General Introduction prior to making decisions regarding distinctness. However, the following points are provided for elaboration or emphasis in these Test Guidelines.

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 Test Guidelines are familiar with the recommendations contained in the General Introduction prior to making decisions regarding distinctness.

4.2 *Uniformity*

4.2.1 It is of particular importance for users of these Test Guidelines to consult the General Introduction prior to making decisions regarding uniformity. However, the following points are provided for elaboration or emphasis in these Test Guidelines:

4.2.2 For the assessment of uniformity, a population standard of 1% and an acceptance probability of at least 95% should be applied. In the case of a sample size of 100 plants, 3 off-types are allowed.

4.3 *Stability*

4.3.1 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.

4.3.2 Where appropriate, or in cases of doubt, stability may be tested, either by growing a further generation, or by testing a new seed stock to ensure that it exhibits the same characteristics as those shown by the previous material supplied.

5. Grouping of Varieties and Organization 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 organize the growing trial so that similar varieties are grouped together.

5.3 The following have been agreed as useful grouping characteristics:

- (a) Plant: anthocyanin coloration (characteristic 1)
- (b) Leaf: leaflets (characteristic 10)
- (c) Stipule: 'rabbit-eared' stipules (characteristic 18) *UK Proposes deletion*
- (d) Stipule: flecking (characteristic 25)
- (e) Pod: parchment (characteristic 44)
- (f) Varieties without entire parchment only: Pod: thickened wall (characteristic 45)
- (g) Varieties without thickened pod wall only: Pod: shape of distal part (characteristic 46)
- (h) Pod: color (characteristic 51)
- (i) Immature seed: intensity of green color (characteristic 57)
- (j) Seed: type of starch grain (characteristic 59)
- (k) Seed: color of cotyledon (characteristic 63)
- (l) Varieties with anthocyanin only: Seed: marbling of testa (characteristic 64)
- (m) Varieties with anthocyanin only: Seed: violet or pink spots on testa (characteristic 65)
- (n) Seed: hilum color (characteristic 66)

5.4 Guidance for the use of grouping characteristics, in the process of examining distinctness, is provided through the General Introduction.

6. Introduction to the Table of Characteristics

6.1 *Categories of Characteristics*

6.1.1 Standard Test Guidelines Characteristics

Standard Test Guidelines characteristics are those which are approved by UPOV for examination of DUS and from which members of the Union can select those suitable for their particular circumstances.

6.1.2 Asterisked Characteristics

Asterisked characteristics (denoted by *) are those included in the Test Guidelines which are important for the international harmonization of variety descriptions and should always be examined for DUS and included in the variety description by all members of the Union, except when the state of expression of a preceding characteristic or regional environmental conditions render this inappropriate.

6.2 *States of Expression and Corresponding Notes*

States of expression are given for each characteristic to define the characteristic and to harmonize descriptions. Each state of expression is allocated a corresponding numerical note for ease of recording of data and for the production and exchange of the description.

6.3 *Types of Expression*

An explanation of the types of expression of characteristics (qualitative, quantitative and pseudo-qualitative) is provided in the General Introduction.

6.4 *Example Varieties*

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

6.5 *Legend*

- (*) Asterisked characteristic – see Chapter 6.1.2
- (QL) Qualitative characteristic – see Chapter 6.3
- (QN) Quantitative characteristic – see Chapter 6.3
- (PQ) Pseudo-qualitative characteristic – see Chapter 6.3

MG, MS, VG, VS: See Chapter 3.3.3

(a)-(c) See Explanations on the Table of Characteristics in Chapter 8.1

(+) See Explanations on the Table of Characteristics in Chapter 8.2

7. Table of Characteristics/Tableau des caractères/Merkmalstabelle/Tabla de caracteres

	English	français	deutsch	español	Example Varieties/ Exemples/ Beispielssorten/ Variedades ejemplo	Note/ Nota
1. (*) (+)	30 – Plant: anthocyanin coloration 240 VG	Plante: pigmentation anthocyanique	Pflanze: Anthocyanfärbung		<i>highlighted example varieties in italics are no longer in commerce: replacements to be advised at meeting</i>	
QL	absent	absente	fehlend		Avola, Solara	1
	present	présente	vorhanden		Pidgin, Rosakrone	9

TWA: Char. 2 () to be deleted. Char to be reconsidered after an explanation is provided on how to grow the plants and how to make the observation; TWV: Char2 to be deleted*

2. (+)	218 – Plant: height 230 MG/VG	Plante: hauteur	Pflanze: Höhe			
QN	very short	très petite	sehr niedrig		Columbia	1
	short	petite	niedrig		Solara, Mini	3
	medium	moyenne	mittel		<i>Lord Chancellor, Toskana</i>	5
	tall	grande	hoch		Blauwschokker, Rhea	7
	very tall	très grande	sehr hoch		Livioletta	9

TWA & TWV agree to delete asterisk Char 3

3. (+)	30-199 VG	Stem: fasciation	Tige: fasciation	Stengel: Verbänderung		
QL	absent	absente	fehlend		Avola, Solara	1
	present	présente	vorhanden		Bikini, Rosakrone	9

	English	français	deutsch	español	Example Varieties/ Exemples/ Beispielssorten/ Variedades ejemplo	Note/ Nota
<i>TWV: Asterisk to be added with indication MG/MS; TWA Asterisk to be added with indication MS only</i>						
4.	242 – Stem: length	Tige: longueur	Stengel: Länge			
(*)	250					
(+)	MS					
QN	very short	très petite	sehr kurz		<i>Elma</i>	1
	short	petite	kurz		<i>Birte</i> Mini	3
	medium	moyenne	mittel		<i>Lord Chancellor, Minor</i>	5
	long	grande	lang		Blauwschokker, Livia	7
	very long	très grande	sehr lang		<i>Enka</i>	9
<i>TWA: Char 5 ‘ up to and including first fertile node’ to be moved to Chapter 8; UK proposes Stem: number of first fertile node</i>						
5.	210 – Stem: number of	Tige: nombre de	Stengel: Anzahl			
(*)	240	nœuds jusqu’au	Knoten bis			
(+)	MS	premier fertile	einschliesslich des			
	<u>first fertile node up</u>	inclus	ersten Blütenstandes			
	<u>to and including</u>					
	<u>first fertile node</u>					
QN	very few	très petit	sehr gering		Kelvil	1
	few	petit	gering		<i>Miragreen, Waverking</i>	3
	medium	moyen	mittel		Markana, Susan	5
	many	grand	gross		Cooper	7
	very many	très grand	sehr gross		Regina	9
6.	30 – Stem: anthocyanin	Tige: pigmentation	Stengel:			
	240	anthocyanique au	Anthocyanfärbung			
	VG	point d’insertion du	der Achsel			
	coloration of axil	stipule				
QL	absent	absente	fehlend		Avola, Maro	1
	present	présente	vorhanden		Assas, Caroubel	9
7.	30- <u>Only varieties with</u>	Tige: type de la	Stengel: Typ der			
	240	pigmentation	Anthocyanfärbung			
	VG	anthocyanique au	der Achsel			
	<u>coloration of axil:</u>	point d’insertion du				
	Stem: type of	stipule				
	anthocyanin					
	coloration of axil					
QL	single ring	anneau simple	einfacher Ring		Assas, Tirabeque	1
	double ring	anneau double	doppelter Ring		Caroubel, <i>Enka</i>	2

	English	français	deutsch	español	Example Varieties/ Exemples/ Beispielssorten/ Variedades ejemplo	Note/ Nota
8. 40- (* 240 (+ VG)	<u>Foliage: color</u>	Feuillage: couleur	Laub: Farbe			
PQ	yellow green	vert jaune	gelbgrün		Pilot	1
	green	vert	grün		Avola, Progreta	2
	blue green	vert bleu	blaugrün		Polar	3

9. 40- 240 VG	<u>Varieties with green foliage only:</u> Foliage: intensity of color					
QN	light	claire	hell		Twinkle, <i>Algera</i>	3
	medium	moyenne	mittel		Lisa, Rondo	5
	dark	foncée	dunkel		Waverex	7

TWA propose to introduce a new char Leaflet: type covering the first three types shown below as provided by experts from China. UK comment Char 10 could read Leaf: type with the following states: leaflets and tendrils (note 1), leaflets and no tendrils (note 2), many small leaflets and no tendrils (Parsley type) (note 3), tendrils and no leaflets (note 4) (see below). Request that China provide names of example varieties.

10. 20- (* 240 VG)	Leaf: leaflets	Feuille: folioles	Blatt: Blattfiedern			
QL	absent	absentes	fehlend		Hawk, Solara	1
	present	présentes	vorhanden		Avola, Rhea	9



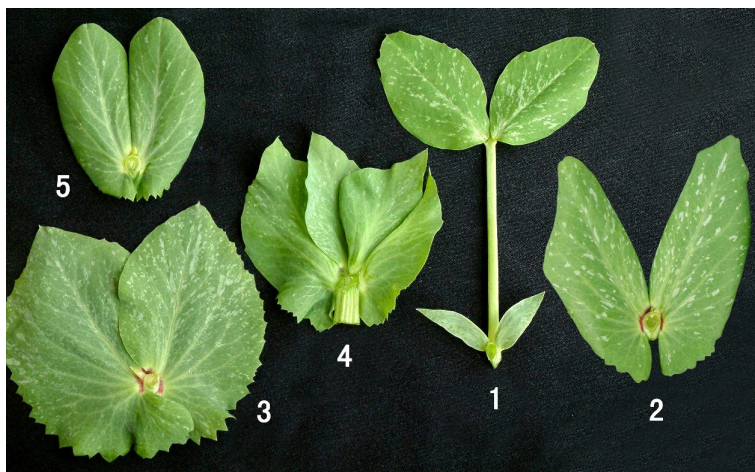
	English	français	deutsch	español	Example Varieties/ Exemples/ Beispielssorten/ Variedades ejemplo	Note/ Nota
<i>TWA and TWV agreed to delete Char. 11</i>						
11.	20- 240 VG	Leaf: waxiness of upper surface of leaflet	Feuille: pruine sur la surface de la foliole supérieure	Blatt: Wachsschicht der Oberfläche der obersten Blattfieder		
QL	absent	absente	fehlend		Citrina	1
	present	présente	vorhanden		Avola, Mare	9
<i>TWA and TWV agree to delete the word 'average' in Char 12. TWA: explanation to be provided and check growth stage</i>						
12.	30- 240 MS or VG	Leaf: average maximum number of leaflets	Feuille: moyen des nombres maximaux de folioles	Blatt: durchschnittliche maximale Anzahl von Blattfiedern		
QN	few	petit	gering		Jof	3
	medium	moyen	mittel		Dark Skin Perfection, Finale	5
	many	grand	gross		Ultimo	7
<i>TWA: add (+) with explanation in Chapter 8. UK proposes to add (surface area) after Leaflet: size</i>						
13.	216- 226 MS/ VG	Leaflet: size (surface area)	Foliole: taille	Blattfieder: Grösse		
QN	(a) very small	très petite	sehr klein		Payette	1
	small	petite	klein		Mini	3
	medium	moyenne	mittel		Finale	5
	large	grande	gross		Alderman	7
	very large	très grande	sehr gross		Mammoth Melting Sugar	9
14.	216- 226 MS/ VG	Leaflet: length	Foliole: longueur	Blattfieder: Länge		
QN	(a) short	courte	kurz		Polar, Eagle	3
	medium	moyenne	mittel		Bohatyr, Dakota	5
	long	longue	lang		Delikata, Mammoth Melting Sugar	7

	English	français	deutsch	español	Example Varieties/ Exemples/ Beispielssorten/ Variedades ejemplo	Note/ Nota
15.	216- 226 MS/ VG	Leaflet: width	Foliolo: largeur	Blattfieder: Breite		
QN	(a)	narrow	étroite	schmal	Alouette, Grapis	3
		medium	moyenne	mittel	Dakota, Irina	5
		broad	large	breit	Adept, Tirabeque	7
<i>TWV: add (+) with explanation in Chapter 8 that distance refers to the absolute distance</i>						
16.	216- 226 MS/ VG	Leaflet: distance from widest point to base	Foliolo: distance du point le plus large à la base	Blattfieder: Abstand zwischen der grössten Breite und der Basis		
QN	(a)	short	petite	klein	Griffin, Progreta	3
		medium	moyenne	mittel	Columbia, Maro	5
		long	grande	gross	Nobel, Salome	7
17.	30 – 240 (+) VG	Leaflet: dentation				
QN	(a)	absent or very weak	très faible	sehr gering	Progreta	1
		weak	faible	gering	Snowflake	3
		medium	moyenne	mittel	<i>Miracle</i>	5
		strong	forte	stark	Amos	7
		very strong	très forte	sehr stark	Sugar Star	9

English	français	deutsch	español	Example Varieties/ Exemples/ Beispielssorten/ Variedades ejemplo	Note/ Nota
---------	----------	---------	---------	---	---------------

TWV: Char 18 to be deleted; TWA: to revise the characteristic to consider the the types below

UK Comment: Note 1 is a different genotype('st') to the others; this characteristic has been withdrawn from the guidelines no varieties were known to be in commerce. China to provide name of an example variety if there is material in commerce. Note 4 is from a fasciated plant and is not a different leaf type. Apart from rabbit-eared types, the other notes reflect stipule size and shape which are already recorded by other characteristics.



18. (*) (+)	30 – 240 VG	Stipule: 'rabbit-eared' habit	Stipule: stipules en forme d'oreilles de lapin	Nebenblatt: hasenohrartige Nebenblätter		
QN	(b)	absent or weakly expressed	absentes ou très faibles	fehlend oder sehr schwach	Avola, Maro	1
		moderately expressed	moyennement expressés	mittelmäßig ausgeprägt	<i>France to provide example variety</i>	2
		strongly expressed	fortement expressés	stark ausgeprägt	Ibiza	3
19. (+)	216- 226 MS/ VG	Stipule: length	Stipule: longueur	Nebenblatt: Länge		
QN	(b)	short	courte	kurz	Eagle, Steffi	3
		medium	moyenne	mittel	Twinkle, Timo	5
		long	longue	lang	Alderman, Rhea	7

	English	français	deutsch	español	Example Varieties/ Exemples/ Beispielssorten/ Variedades ejemplo	Note/ Nota
20.	216- 226	Stipule: width	Stipule: largeur	Nebenblatt: Breite		
(+)	MS/ VG					
QN	(b)	narrow	étroite	schmal	Eagle, Steffi	3
		medium	moyenne	mittel	Twinkle, Timo	5
		broad	large	breit	<u>Nettuno</u>	7

TWV and TWA agree to add 'surface area' in brackets for Char 21

21.	216- 226	Stipule: size (surface area)	Stipule: taille	Nebenblatt: Grösse		
	MS/ VG					
QN	(b)	small	petite	klein	Alfetta, Dakota	3
		medium	moyenne	mittel	Jackpot, Misty	5
		large	grande	gross	Beetle, <u>Manille</u>	7

22.	216- 226	Stipule: length from axil to tip	Stipule: longueur du point d'insertion au stipule à l'extrémité	Nebenblatt: Länge zwischen der Achsel und der Spitze		
(+)	MS					
QN	(b)	short	courte	kurz	Alfetta, Fortress	3
		medium	moyenne	mittel	Orka, Cabree	5
		long	longue	lang	Beetle, <u>Manille</u>	7

TWA and TWV agreed to delete Char23

23.	216- 226	Stipule: length from axil to base	Stipule: longueur du point d'insertion au stipule à l'extrémité	Nebenblatt: Länge zwischen der Achsel und der Basis		
(+)	MS					
QN	(b)	short	courte	kurz	<u>Toscana, Dakota</u>	<u>3</u>
		medium	moyenne	mittel	<u>Eiffel, Misty</u>	<u>5</u>
		long	longue	lang	<u>Quantum, Manille</u>	<u>7</u>

	English	français	deutsch	español	Example Varieties/ Exemples/ Beispielssorten/ Variedades ejemplo	Note/ Nota
<i>TWA and TWV agreed that Char 24 should read Stipule: lobe below axil with an indication of VG/MS and the addition of the state absent or very short for note 1</i>						
24.	216- Stipule: length of					
	226 lobe below axil					
(+)	VG/ MS					
QN	(b) absent of very short					1
	short				Ramrod, Dakota	3
	medium				Kahuna, Twinkle	5
	long				Eden, Quantum	7
<i>The TWA and TWV agreed to delete the words in brackets 'on the whole plant' for Char 25</i>						
25.	20- Stipule: flecking	Stipule: macules	Nebenblatt:			
(*)	240 the whole plant		Marmorierung			
(+)	VG					
QL	absent	absentes	fehlend		Lisa, Tafila	1
	present	présentes	vorhanden		Avola, Maro	9
26.	20- Stipule: maximum	Stipule: densité	Nebenblatt:			
	240 density of flecking	maximale des	maximale Dichte der			
(+)	VG (on the whole plant)	macules	Marmorierung			
QN	very sparse	très lâche	sehr locker		Progreta	1
	sparse	lâche	locker		Waxwing, Backgammon	3
	medium	moyenne	mittel		Ambassador, Accent	5
	dense	dense	dicht		<i>Sephia</i> , Avola	7
	very dense	très dense	sehr dicht		Oregon Sugar Pod	9
27.	216- Petiole: length (from					
	226 axil to the first					
(+)	MS/ VG leaflet or tendril)					
QN	short	court	kurz		Hellas, Keo	3
	medium	moyen	mittel		Avola, Solara	5
	long	long	lang		Saskia, Tafila	7

	English	français	deutsch	español	Example Varieties/ Exemples/ Beispielssorten/ Variedades ejemplo	Note/ Nota
28.	216- 226	<u>Varieties without leaflets only:</u> Petiole:				
(+)	MS/ VG	total length (from axil to last tendril)				
QN	short	court	kurz		Choucas, Fredrio	3
	medium	moyen	mittel		Alambo, Alezan	5
	long	long	lang		Calao, Arosa	7
29.	214	Time of flowering	Époque de floraison	Zeitpunkt der Blüte		
(*)	MS/					
(+)	VG					
QN	very early	très précoce	sehr früh		Tempo	1
	early	précoce	früh		Smart, <i>Sparkle</i>	3
	medium	moyenne	mittel		Carlton, Waverex	5
	late	tardive	spät		Cooper, Purser	7
	very late	très tardive	sehr spät		Livioletta	9
30.	216- 226	<u>Non-fasciated varieties only:</u> Plant:	<u>Variétés non-fasciées seulement:</u> Plante:	<u>Nur nicht-verbänderte Sorten:</u> Pflanze:		
(*)	MS/ VG	maximum number of flowers per node	nombre maximal de fleurs par nœud	maximale Anzahl Blüten pro Knoten		
QL	one	une	eine		Progress No. 9, Tyla	1
	two	deux	zwei		Banff, Cooper	2
	three	trois	drei		<i>Nettuno</i> , Ultimo	3
	four or more	quatre ou plus	ie roder mehr		<i>F to provide example</i>	4
31.	216- 218	<u>Varieties with anthocyanin coloration only:</u> Flower:	<u>Variétés avec anthocyane seulement:</u> Fleur:	<u>Nur Sorten mit Anthocyan :</u> Blüte :		
(*)	VG	color of wing	pigmentation anthocyanique de l'aile	Anthocyanfärbung des Flügels		
PQ	(b)	white with pink blush	<i>rose pâle</i>	<i>blassrosa</i>	<i>Golf</i>	1
		pink	rose	rosa	Rosakrone	2
		reddish purple	pourpre rougeâtre	rötlich purpur	Assas	3

	English	français	deutsch	español	Example Varieties/ Exemples/ Beispielssorten/ Variedades ejemplo	Note/ Nota
32.	216- 218	Varieties without anthocyanin only:	Variétés sans antho- cyane seulement:	Nur Sorten ohne Anthocyan: Blüte:		
(+)	VG	Flower: color of standard	Fleur: couleur de l'étendard	Farbe der Fahne		
PQ	(b)	white	blanc	weiss	Gloton, Record	1
		whitish cream	blanc à crème	weiss bis cremefarben	Maro, Cooper	2
		cream	crème	cremefarben	Orcado, Cratos	3
33.	216- 218	Flower: width of standard	Fleur : largeur maximale de l'étendard	Blüte: maximale Breite der Fahne		
(+)	MS/ VG					
QN	(b)	narrow	étroite	schmal	Progreta, Eagle	3
		medium	moyenne	mittel	Cooper, Bikini	5
		broad	large	breit	Pilot, Birdie	7
34.	216- 218	Flower: shape of base of standard	Fleur : forme de la base de l'étendard	Blüte: Form des Fahnengrunds		
(*) (+)	VG					
QN	(b)	strongly raised	fortement cunéiforme	stark keilförmig		4
		moderately raised	cunéiforme	keilförmig	Progreta	3
		level	droite	gerade	Markado, Solara	5
		moderately arched	arquée	zweilappig	Avola, Cooper	7
		strongly arched	fortement arquée	stark zweilappig	Bohatyr, Kennedy	9
35.	216- 218	Flower: undulation of standard	Fleur : intensité de l'ondulation de l'étendard	Blüte: Intensität der Wellung der Fahne		
(+)	VG					
QN	(b)	absent or very weak	nulle ou très faible	fehlend oder sehr gering	Ultimo, Woody	1
		weak	faible	gering	Cooper, Dakota	3
		medium	moyenne	mittel	Alex , Kodiak	5
		strong	forte	stark	Reveille, Koka	7
		very strong	très forte	sehr stark	Téléphone nain, Télévision	9

	English	français	deutsch	español	Example Varieties/ Exemples/ Beispielssorten/ Variedades ejemplo	Note/ Nota
36.	216- 218 VG	Flower: width of upper sepal	Fleur: largeur du sépale	Blüte: Breite des Kelchblatts		
QN	(b)	narrow	étroite	schmal	Abador	3
		medium	moyenne	mittel	Conservor	5
		broad	large	breit	Kodiak	7
<i>TWA: (+) to be added to Char 37 with an illustration based on TGP/14.2.1 (&.2) Draft 5, II, Section 2.4.3 (Page 19)</i>						
37.	212- 240 (+) VG	Flower: shape of apex of upper sepal	Fleur : forme du sommet du sépale supérieur (au deuxième florifère)	Blüte: Form der Spitze des oberen Kelchblatts (am zweiten blüentra- genden Knoten)		
PQ	(b)	acuminate	acuminé	mit langer ausgezogener Spitze	Dawn	1
		pointed	pointu	zugespitzt	Kelvedon Wonder	2
		rounded	arrondi	abgerundet	Kodiak	3
38.	235- 245 (+) MS/ VG	Peduncle: length from stem to first pod				
QN	(c)	short	court	kurz	Goblin, Orcado	3
		medium	moyen	mittel	Bohatyr, Maro	5
		long	long	lang	Kabuki, Reveille	7
39.	235 – 245 (+) MS/ VS	Peduncle: length of between 1st and second pods				
QN	(c)	short	court	kurz	Atila, Alize	3
		medium	moyen	mittel	<u>Access</u> , Kirio	5
		long	long	lang	<u>Alex</u> , Aladin	7

	English	français	deutsch	español	Example Varieties/ Exemples/ Beispielssorten/ Variedades ejemplo	Note/ Nota
<i>Should growth stage be 218 – 230? The spur may degenerate after flowering</i>						
40. 235 – Peduncle: length of spur						
245						
(+) MS/VS						
QN (b)	short	court	kurz		Cabro, Kirio	3
	medium	moyen	mittel		Rialto, Metaxa	5
	long	long	lang		Alezan, Calao	7
<i>TWA & TWV agreed for Char 41: indicate as MS with states absent or few (1) medium (2) many (3) and (+) to be added with an explanation of how the characteristic is calculated on the basis of averages across plants. UK: (+) not necessary - as 20 plants recorded at second fertile node. Average calculated in usual way for MS characteristics.</i>						
41. 235 – Peduncle: number of bracts						
245						
(+) MS						
QN (c)	<i>absent or very few</i>				<i>Kirio, Fauvette</i>	<i>1</i>
	<i>few</i>				<i>France to provide example variety</i>	<i>3</i>
	<i>medium</i>				<i>Delta, Duez</i>	<i>5 2</i>
	<i>many</i>				<i>Eiffel, Goelan</i>	<i>7 3</i>
	<i>very many</i>				<i>France to provide example variety</i>	<i>9</i>
42. 240 Pod: length		Gousse: longueur	Hülse: Länge			
(*) MS/VS						
QN (c)	very short	très courte	sehr kurz		Vermio, Cepia	1
	short	courte	kurz		Progreta, Solara	3
	medium	moyenne	mittel		Cooper, Jof	5
	long	longue	lang		Hurst Green Shaft, Protor	7
	very long	très longue	sehr lang		<i>Roi de Carouby</i>	9

	English	français	deutsch	español	Example Varieties/ Exemples/ Beispielssorten/ Variedades ejemplo	Note/ Nota
43. 240 (*) MS/ (+) VG	Pod: width	Gousse : largeur maxi male	Hülse: maximale Breite			
QN	(c) very narrow	très étroite	sehr schmal		Disco	1
	narrow	étroite	schmal		Picar, Ultimo	3
	medium	moyenne	mittel		Progreta, Solara	5
	broad	large	breit		Finale, Kahuna	7
	very broad	très large	sehr breit		Kennedy	9
44. 310 (*) VG (+)	Pod: parchment	Gousse: parchemin	Hülse: Pergamentschicht			
QL	(c) not entire	absent	fehlend		Sugar Ann	1
	entire	entièrement présent	vollständig vorhanden		Avola, Solara	2
<i>TWA & TWV agree: Char 45 to read: Only varieties without entire parchment</i>						
45. 240 (*) VG (+)	<u>Only varieties without entire parchment:</u> Pod: thickened wall	<u>Variétés sans parchemin ou avec parchemin partiel seulement:</u> Gousse : paroi épaisse	<u>Nur Sorten mit fehlender oder teilweise vorhandener Pergamentschicht: Hülse: verdickte Wand</u>			
QL	(c) absent	absente	fehlend		Nofila, Reuzensuiker	1
	present	présente	vorhanden		Cygnnet, Sugar Ann	9
46. 240 (*) VG (+)	<u>Varieties without thickened pod wall only:</u> Pod: shape of distal part	<u>Variétés à gousse sans paroi épaisse seulement :</u> Gousse : forme de la partie distale	<u>Nur Sorten ohne verdickte Hülsewand:</u> Hülse: Form des Hülseendes			
QL	(c) pointed	pointue	zugespitzt		Jof, Oskar	1
	blunt	tronquée	stumpf		Avola, Solara	2

	English	français	deutsch	español	Example Varieties/ Exemples/ Beispielssorten/ Variedades ejemplo	Note/ Nota
<i>TWA & TWV agree to delete Char 47</i>						
47	235— 240	Pod: type of concave curvature				
(+)	VG					
QL	(e)	curvature along the length of the pod			Edula	1
		curvature towards the pod apex only			Jof	2
48.	240	Pod: degree of curvature	Gousse : intensité de la courbure	Hülse: Stärke der Krümmung		
(*)	VG					
(+)						
QN	(c)	absent or very weak	absente ou très faible	fehlend oder sehr gering	Finale, Maro	1
		weak	faible	gering	Eagle, Span	3
		medium	moyenne	mittel	Hurst Green Shaft, Carlton	5
		strong	forte	stark	Jof, Delikata	7
		very strong	très forte	sehr stark	Edula, Oskar	9
<i>TWA and TWV agree to delete Char 49.</i>						
49.	240	Pod: position of the ovary compared to the midpoint of the pod				
(+)	MS					
	(e)	above			Edula, Carlton	1
		level			Banff	2
		below			Avola, Hawk	3
<i>TWA & TWV agree to replace Char 50 by a characteristic for a type of curvature similar to that used in bean</i>						
50.	240	Pod: position of the apex compared to the midpoint of the seed-bearing suture				
(+)	MS					
	(e)	above			Edula, Jof	1
		level			Milor, Pluton	2
		below				3

	English	français	deutsch	español	Example Varieties/ Exemples/ Beispielssorten/ Variedades ejemplo	Note/ Nota	
50.	240	Pod: type of curvature	<i>UK proposes to delete as insufficient example varieties</i>				
(+)							
		convex peduncle end and straight tip			Avola, Hawk	1	
	(c)	convex peduncle end and concave tip				2	
		straight peduncle end with concave tip			Jof	3	
		concave peduncle end and concave tip			Oskar	4	
51.	230 – Pod: color	Gousse: couleur	Hülse: Farbe				
(*)	240						
	VG						
PQ	(c)	yellow	jaune	gelb	<u>Orlex</u>	1	
		green	verte	grün	Avola, Solara	2	
		blue-green	vert bleu	blaugrün	<u>Miracle, Miragreen</u>	3	
		purple	pourpre	purpur	Blauwschokker	4	
52.	230 – Pod: intensity of green color	Gousse : intensité de la couleur verte	Hülse: Intensität der grünen Farbe				
	240						
	VG						
QN	(c)	light	claire	hell	Ultimo, Solara	3	
		medium	moyenne	mittel		5	
		dark	foncée	dunkel	Hawaii,	7	
					Dark Skin Perfection		
<i>UK proposal to replace underlined qualification with Only varieties without entire parchment which would be consistent with Char 45</i>							
53.	240- Varieties with no or partial Only varieties without entire parchment only:	Variétés sans parcheminou avec parchemin partiel seulement : Gousse :	Nur Sorten mit fehlender oder teilweise vorhandener Pergamentschicht:	=			
(*)	245	parcheminou avec parchemin partiel	seulement : Gousse :	Hülse: Fäden der Naht			
(+)	VG	Pod: suture strings	fil de la suture				
QL	(c)	absent or rudimentary	absents ou rudimentaires	fehlend oder rudimentär	Nofila, Sugar Lace	1	
		present	présents	vorhanden	Reuzensuiker, Crispi	9	

	English	français	deutsch	español	Example Varieties/ Exemples/ Beispielssorten/ Variedades ejemplo	Note/ Nota
<i>TWA & TWV agree to delete Char 54</i>						
54.	240- 255	<u>Varieties with anthocyanin only:</u> Pod: anthocyanin coloration of suture	<u>Variétés avec anthocyan</u> <u>seulement:</u> Gousse: pigmentation anthocyanique de la suture	<u>Nur Sorten mit Anthocyan:</u> Hülse: Anthocyanfärbung der Naht		
(+),	VG					
QL	(e)	absent	absente	fehlend	Pidgin, Desiree	4
		present	présente	vorhanden	Lisa, Super-Delicia	9
<i>TWA & TWV agree to delete Char 55</i>						
55.	240- 255	<u>Varieties with anthocyanin only:</u> Pod: spots of anthocyanin coloration on outer wall	<u>Variétés avec anthocyan</u> <u>seulement:</u> Gousse: pigmentation anthocyanique en taches sur la paroi externe	<u>Nur Sorten mit Anthocyan:</u> Hülse: Anthocyanflecke auf der Aussenwand		
(+)	VG					
QL	(e)	absent	absente	fehlend	Sirius, Lisa	4
		present	présente	vorhanden	Pidgin, Caroubel	9
<i>TWA & TWV agree Char 56 Stage of development to be 226.(+) to be added with an explanation that the characteristic concerns the number of ovules and not the number of seeds. UK: (+) not necessary as there is no seed development at the flat pod stage.</i>						
56.	230 240 226 MS	Pod: number of ovules	Gousse: nombre d'ovules	Hülse: Anzahl Samen- anlagen		
(*)						
QN	(c)	few	faible	gering	Pegas, De Grace	3
		medium	moyen	mittel	Hawk, Backgammon	5
		many	élevé	gross	Karisma	7
57.	230- 240	Immature seed: intensity of green color	Gousse: intensité de la couleur verte de la graine immature	Hülse: Intensität der grünen Farbe des unreifen Samens		
(*)	VG					
QN		light	claire	hell	Ultimo, Solara	3
		medium	moyenne	mittel		5
		dark	foncée	dunkel	Dark Skin Perfection, Hawaii	7

English	français	deutsch	español	Example Varieties/ Exemples/ Beispielssorten/ Variedades ejemplo	Note/ Nota
---------	----------	---------	---------	---	---------------

TWA: Char. 58 illustrations to be provided and number of states to be checked. Find 3-dimensional term for triangular. TWV (+) to be added

UK proposal to change Char 58 to read Seed: predominant shape, merge states 1 and 2 to read spherical/ ovoid, rename existing state 4 rhomboid / trapezoid and rename existing state 6 to read other. Renummer states according to the above revision.

58. 320 (+) VG	Seed: predominant shape	Graine: forme	Samen: Form		
PQ	spherical	sphérique	kugelförmig	Nofila, Goeland	1
	spherical /ovoid	ovoïde	eiförmig	Solara	2 1
	cylindrical	cyllindrique	zylindrisch	Span, Timo	3 2
	flattened sphere				3
	rhomboid/ trapezoid	rhomboïde	rhomboid	Maro, Progreta	4 4
	triangular	triangulaire	dreieckig	Protor	5 5
	irregular other	irrégulière	unregelmässig	Géant à fleur violette	6 5
59. 320 (*) VG (+)	Seed: type of starch grains	Graine: forme du grain d'amidon	Samen: Form des Stärkekorns		
QL	simple	lisse	einfach	Maro, Solara, Adagio	1
	compound	étoilé	zusammengesetzt	Avola, Polar	2

TWV: Char. 60 - explanation to provide illustrations of different types of wrinkling and dimpling.

TWA: to check if character is necessary

UK proposes to limit recording to seeds with cylindrical or flattened sphere shape and simple starch grains

60. 320 (*) VG (+)	Varieties with cylindrical or flattened sphere shaped seeds and simple starch grains only: Seed: wrinkling of cotyledon				
QL	absent	absentes	fehlend	Paris, Atila	1
	present	présentes	vorhanden	Garde	9

English	français	deutsch	español	Example Varieties/ Exemples/ Beispielssorten/ Variedades ejemplo	Note/ Nota
---------	----------	---------	---------	---	---------------

TWA & TWV agree to delete underlined section. To check example varieties Adagio and Zorba

UK proposal to limit assessment of wrinkling to varieties with compound starch grains only

61.	320	Varieties with <u>wrinkled seed</u> <u>compound starch grains only</u>; Seed: intensity of wrinkling of cotyledon	Graine : intensité des rides sur les cotylédons	Samen: Stärke der Schrumpfung des Keimblatts		
(*)	VG					
QN	weak				Darfon, Zefier	3
	medium	moyenne	mittel		Ziggy	5
	strong	forte	stark		Quad, Oskar	7
	very strong					9

UK proposes to delete this characteristic following changes to Chars 58, 60 and 61

62.	320	<u>Varieties with unwrinkled seed and simple starch grains only</u>; Seed: dimpled cotyledons	Variétés avec graines sans rides et avec grains d'amidon lisses seulement : Graine : fossettes sur les cotylédons	Nur Sorten mit Samen ohne Schrumpfung und mit einfachen Stärkekörnern : Samen : Grübchen des Keimblatts		
(*)	VG					
(+)						
QL	absent	absentes	fehlend		Columbia, Solara	4
	present	présentes	vorhanden		Maro, Progeta	9

TWA: Char 63 - check if more colour states needed. China to provide leading expert with photographs of seeds with and without testas for varieties with different colours of seeds and different colours of testas. UK request China to provide example varieties for new states

63.	320	Seed: color of cotyledon	Graine: couleur des cotylédons	Samen: Farbe des Keimblatts		
(*)	VG					
(+)						
QL	green	verts	grün		Avola, Solara	1
	yellow	jaunes	gelb		Hardy, Caractacus	2
	orange	orange	orange		Oliver	3

	English	français	deutsch	español	Example Varieties/ Exemples/ Beispielsorten/ Variedades ejemplo	Note/ Nota
64. 320 (*) VG	<u>Varieties with anthocyanin only:</u> Seed: marbling of testa	Variétés avec anthocyane seulement: Graine: marbrure des téguments	Nur Sorten mit Anthocyan: Samen: Marmorierung der Samenschale			
QL	absent	absente	fehlend		Rif, Rhea	1
	present	présente	vorhanden		Assas, <i>Birdie</i>	9
65. 320 (*) VG	<u>Varieties with anthocyanin only:</u> Seed: violet or pink spots on testa	Variétés avec anthocyane seulement: Graine: taches violettes ou roses sur les téguments	Nur Sorten mit Anthocyan: Samen: violette oder rosa Punktierung auf der Samenschale			
QL	absent	absentes	fehlend		Rif, <i>Birdie</i>	1
	faint	faibles	gering		Assas, Susan	2
	intense	intenses	intensiv		Arvika, Rhea	3
<i>TWA & TWV Char 66 - agree to rename states not colored (1) and colored (2)</i>						
66. 320 (*) VG (+)	Seed: hilum color	Graine: couleur du hile	Samen: schwarze Nabelfarbe			
QL	not black not colored	autre que noir	anders als schwarz		Avola, <i>Birdie</i>	1
	black colored	noir	schwarz		Nofila, Rif	2
<i>TWA: check if more colour states needed. China to provide leading expert with photographs of seeds with and without testas for varieties with different colours of seeds and different colours of testas.</i>						
67. 320 VG	<u>Varieties with anthocyanin only:</u> Seed: color of testa	Variétés avec anthocyane seulement: Graine: couleur du tégument	Nur Sorten mit Anthocyan: Samen: Farbe der Samenschale			
PQ	reddish brown	brun rougeâtre	rötlichbraun		Pidgin, Rosakrone	1
	brown	brun	braun		<i>Poneka</i>	2
	brownish green	vert brunâtre	bräunlichgrün		Lisa, Susan	3

	English	français	deutsch	español	Example Varieties/ Exemples/ Beispielssorten/ Variedades ejemplo	Note/ Nota
68	320	Seed: weight	Graine: poids de semences	Samen: Samengewicht		
(*)	MG					
(+)						
QN	very low				Ultimo	1
	low				Hawk, Iceberg	3
	medium				Mammoth Melting Sugar, Toskana	5
	high				Kennedy, Maro	7
	very high				Bamby, Cratos	9
69.	VS	Resistance to <u>Fusarium oxysporum</u> f. sp. <u>pisi</u>	Résistance à <u>Fusarium oxysporum</u> f. sp. <u>pisi</u>	Resistenz gegen <u>Fusarium oxysporum</u> f. sp. <u>pisi</u>		
(+)						
QL	Race 1	Race 1	Pathotyp 1			
69.1	absent	absente	fehlend		JI 1365 ex 'Little Marvel'	1
	present	présente	vorhanden		JI 1362 ex 'Dark Skin Perfection'	9
69.2	Race 2	Race 2	Pathotyp 2			
	absent	absente	fehlend		JI 1363 (WSU 28)	1
	present	présente	vorhanden		JI 1364 (WSU 23)	9
69.3	Race 5	Race 5	Pathotyp 5			
	absent	absente	fehlend		JI 1365 ex 'Little Marvel'	1
	present	présente	vorhanden		JI 1364 (WSU 23)	9
69.4	Race 6	Race 6	Pathotyp 6			
	absent	absente	fehlend		JI 1365 ex 'Little Marvel'	
	present	présente	vorhanden		JI 1363 (WSU 28)	
70.	VG	Resistance to <u>Erysiphe pisi</u> Syd	Résistance à <u>Erysiphe pisi</u> Syd.	Resistenz gegen <u>Erysiphe pisi</u> Syd.		
(+)						
QL	absent	absente	fehlend		JI 502 ex 'Rondo'	1
	present	présente	vorhanden		JI 1559 (Mexique 4)	9

	English	français	deutsch	español	Example Varieties/ Exemples/ Beispielssorten/ Variedades ejemplo	Note/ Nota
71.	VS	Resistance to	Résistance à	Resistenz gegen		
(+)	<u>Ascochyta pisi</u>, Race C	<u>Ascochyta pisi</u>, race C	<u>Ascochyta pisi</u>, Pathotyp C			
QL	absent	absente	fehlend		JI 394 ex 'Kelvedon Wonder'	1
	present	présente	vorhanden		JI 502 ex 'Rondo'	9
72.	VS	Resistance to	Résistance à	Resistenz gegen		
(+)	<u>Pseudomonas</u> <u>syringae pv. pisi</u>	<u>Pseudomonas</u> <u>syringae pv. pisi</u>	<u>Pseudomonas</u> <u>syringae pv. pisi</u>			
72.1	Pathovar 2	Pathotype 2	Pathotyp 2			
QL	absent	absente	fehlend		JI 2430 ex 'Kelvedon Wonder'	1
	present	présente	vorhanden		JI 2431 ex 'Early Onward'	9
72.2	Pathovar 4	Pathotype 4	Pathotyp 4			
QL	absent	absente	fehlend		JI 2431 ex 'Early Onward'	1
	present	présente	vorhanden		JI 2439 ex 'Fortune'	9
73.	VS	Resistance to Seed-	Résistance au virus	Resistenz gegen		
(+)	borne Mosaic Virus	de la mosaïque	transmis par les	Saatgutübertragenes		
	(SbmV) Strain P1	semences (SbmV)	race P1	Blattrollmosaikvirus		
				(SbmV) Pathotyp P1		
QL	absent	absente	fehlend		JI 363 ex 'Lincoln'	1
	present	présente	vorhanden		JI 968 (WBH 1779)	9
74.	VS	Resistance to Bean	Résistance au virus	Resistenz gegen		
(+)	Yellow Mosaic Virus	de la mosaïque	jaune du Haricot	Gelbes		
	(BYMV)	(BYMV)		Bohnenmosaikvirus		
				(BYMV)		
QL	absent	absente	fehlend		JI 502 ex 'Rondo'	1
	present	présente	vorhanden		JI 394 ex 'Kelvedon Wonder'	9

	English	français	deutsch	español	Example Varieties/ Exemples/ Beispielssorten/ Variedades ejemplo	Note/ Nota
75. VS	Resistance to Pea Enation Mosaic Virus (PEMV)	Résistance au virus enation de la mosaïque du Pois (PEMV)	Resistenz gegen Scharfes Adermosaik (PEMV)			
(+)						
QL	absent	absente	fehlend		ex 'Dark Skin Perfection'	1
	present	présente	vorhanden		ex 'Perfected Freezer 60'	9

8. Explanations on the Table of Characteristics

8.1 *Explanations covering several characteristics*

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

- (a) Leaflet: Unless otherwise indicated, all observations should be made on the first leaflet at the second flowering node.
- (b) Stipule, flower and peduncle: Unless otherwise indicated, all observations should be made at the second flowering node
- (c) Pod: Unless otherwise indicated, all observations should be made at the second fertile node

8.2 *Explanations for individual characteristics*

Ad. 1: Plant: anthocyanin coloration

The anthocyanin coloration should be recorded as present if anthocyanin occurs in one or more of the following: seed, foliage, stem, axil, flower or pod.

Ad. 2: Plant: height

The observation should be made on plants supported by wire, when at least 30% of the plants have one flower open.

Ad. 3: Stem: fasciation

The expression of fasciation is more clearly expressed in longer daylengths. The expression of fasciation varies considerably with environmental conditions, being more clearly expressed in long daylengths. However, the presence or absence of fasciation in any environment is usually clear. Fasciated stems may be ribbed and flattened up to a width of 3 cm; several apical growing points often result in multiple flowers or pods at the top of the plant. Flower and pod counts should not be assessed on fasciated varieties.



Ad. 4: Stem: length

The observations should be made on harvested plants when seed is green and fully developed. The measurement should include the first two nodes with scale leaves.

Stem length may vary considerably with site and season due to different responses to daylength, temperature and soil moisture. However, within years, both characteristics are highly discriminating. Only the main stem should be recorded.

If there is sufficient soil moisture present, some varieties will continue to grow after flowering, while others will not. The differentiation of these varieties can be achieved by comparing plant height and stem length.

Ad 5. Stem: number of first fertile nodes up to and including the first fertile node

The first two nodes, which have 'scale' leaves, should be included in all node counts. Only the main stem should be recorded.

Ad. 8 Foliage color

In some genetic backgrounds yellow-green foliage color is difficult to separate from the pale green foliage color without the use of example varieties.

Ad. 12. Leaf: maximum number of leaflets

Assessment should be made over the whole plant.

Ad. 13. Leaflet: size (surface area)

Size may be assessed visually or by measuring surface area using digital techniques

Ad. 17: Leaflet: dentation

The maximum expression should be recorded; observations should only be made on the main stem (excluding aerial and basal branches), and above node six. In some varieties dentation appears absent in some years, but may develop up to three teeth (or coarser notches) on the leaflet margin.

To be provided

1	3	5	7	9
very weak	weak	medium	strong	very strong

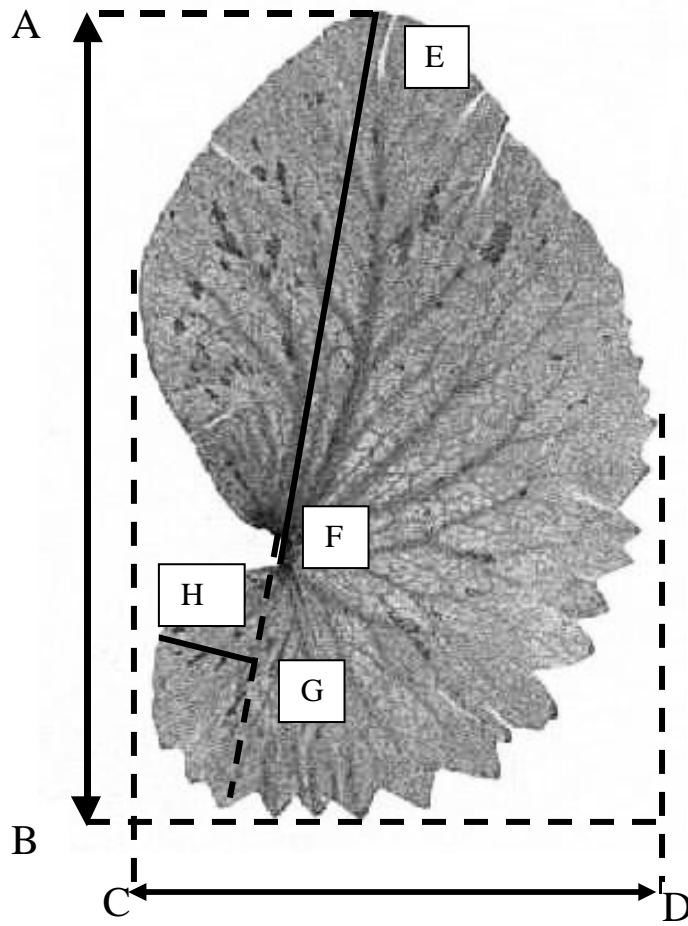
Ad. 18: Stipule: 'rabbit-eared' habit

'Rabbit-eared' stipules are parallel with pointed tips, rather than being divergent with rounded tips. The expression of 'rabbit-eared' stipule habit is part of a syndrome affecting flowers (flowers are reduced with raised standard base shape), foliage (leaflets and stipules are gracile, more pointed and reduced in area), and to a lesser extent stem habit.

If there is doubt about whether the stipules are 'rabbit-eared', then the occurrence of the syndrome in other parts of the plant will confirm its presence.

- Ad. 19: Stipule: length
- Ad. 20: Stipule: width
- Ad. 22: Stipule: length from axil to tip
- Ad. 23: Stipule: length from axil to base
- Ad. 24: Stipule: length of lobe below axil

Observations should be made on stipules which have been detached from the plant and flattened.



- A – B:** Stipule: length (19)
- C – D:** Stipule: width (20)
- E – F:** Stipule: length from axil to tip (22)
- F – G:** Stipule: length from axil to base (23)
- G – H:** Stipule: length of lobe below axil (24) (*perpendicular to the line E – G*)

Ad. 25: Stipule: flecking

Ad. 26: Stipule: maximum density of flecking

~~The observations should be made over the whole plant. Care has to be taken to ensure that foliage at the lowest nodes has not senesced before assessment. The plant should have at least eight nodes, since flecking in some varieties may not be expressed at lower nodes. Assessment should be made on the main stem only.~~

Assessment should be made on the main stem only. The presence of flecking on any stipule on the main stem means that flecking is present. It should be ensured that foliage at the lowest nodes has not senesced before assessment. The plant should have at least eight nodes, since flecking in some varieties may not be expressed at lower nodes.

Spontaneous mutation from flecked to non-flecked types, and also back mutation from non-flecked to flecked, can occur, but the rates of mutation are unknown.

To be provided

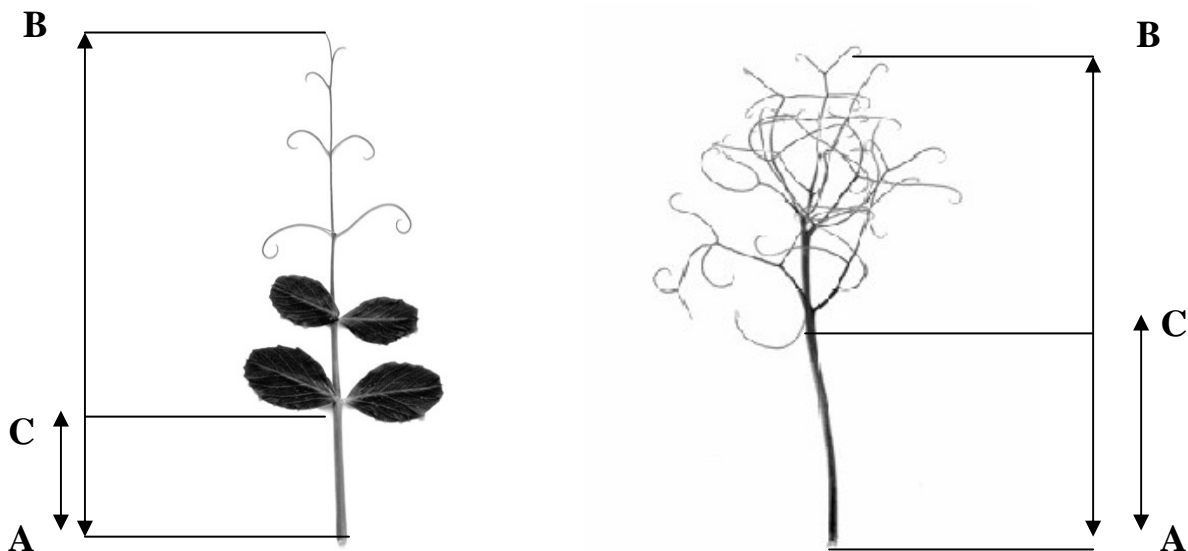
1	3	5	7	9
very sparse	sparse	medium	dense	very dense

Ad. 27: Petiole: length (from axil to the first leaflet or tendril)

Ad. 28: Petiole: total length (from axil to last tendril)

A – C: Petiole length from axil to the first leaflet or tendril (27)

A – B Total length of petiole including tendrils (28)



Ad. 29: Time of flowering

TWA: The time of flowering is when 30% of plants have at least one flower open
~~The observations should not be made before 30% of the plants have at least one flower open.~~

Ad. 32: Varieties without anthocyanin only: Flower: color of standard

The color of standard should be recorded on flowers which are fully opened, and fresh.

Ad. 33: Flower: width of standard

The standard should be detached from the flower and flattened on a hard, flat surface.

Ad. 34: Flower: shape of base of standard

The standard should be detached and flattened on a hard, flat surface



3
raised



5
level



7
arched

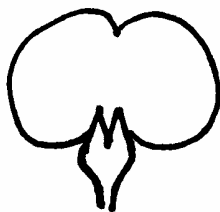


9
strongly arched

Characteristic 35. Flower: intensity of undulation of standard

The maximum expression on the plant should be recorded. Flowers recorded should be fully opened and not senescing.

Ad 37: Flower: shape of apex of upper sepal.



Back of flower standard



1
acuminate

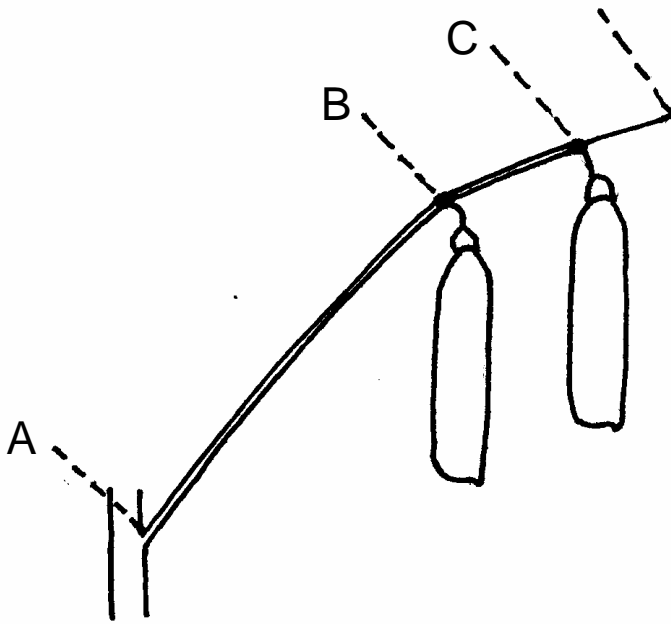


2
pointed



3
rounded

- Ad. 38: Peduncle: length from stem to first pod
Ad. 39: Peduncle: length between first and second pods
Ad. 40: Peduncle: length of spur



A – B = Peduncle: length from stem to first pod (38)

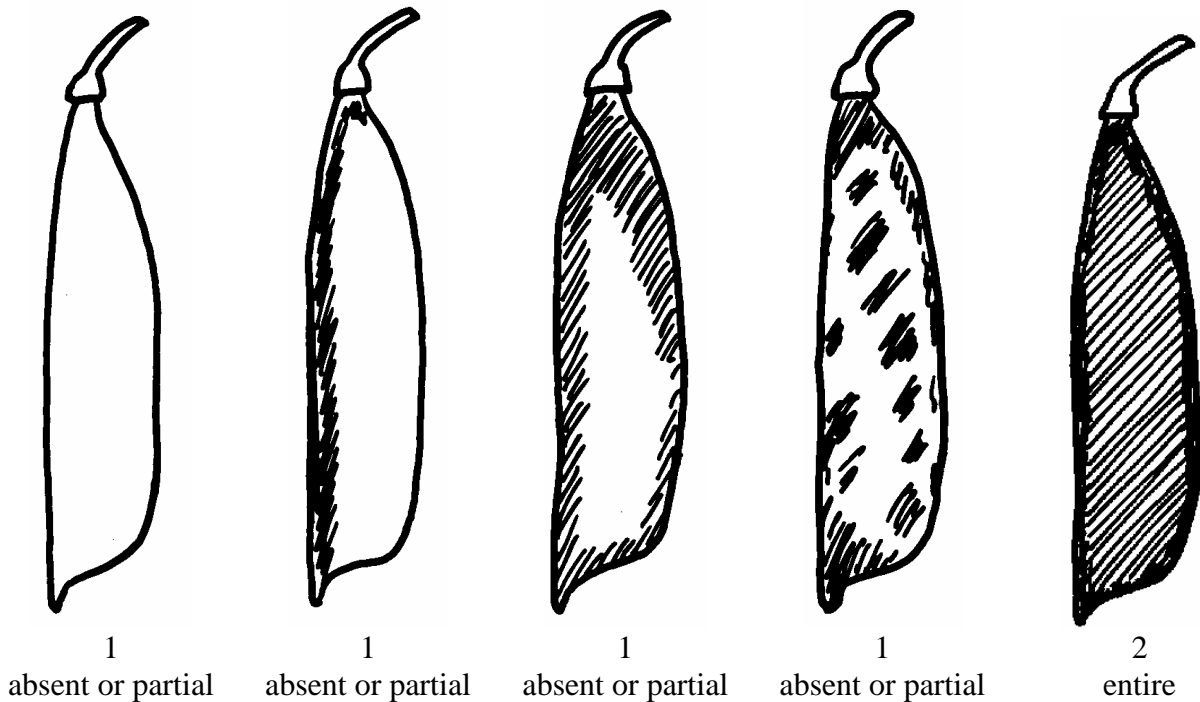
B – C = Peduncle: length between first and second pods (39)

C – D = Peduncle: length of spur (40)

Ad. 43: Pod: width

The observations should be made on well developed green pods; the width is assessed from suture to suture on unopened pods

Ad. 44: Pod: parchment



(1) The observations should be made on dry pods with the exception of 'Snap Peas'. Snap Peas (Sugar Peas with thickened pod walls) are best recorded when green, in order to minimize fungal infection which can prevent observation of the parchment.

(2) The pod should be opened along the suture without damaging the edges of the two valves. The distribution of sclerenchyma, which makes up the parchment, may either be observed by staining (a drop of Phloroglucinol dissolved in Ethanol followed by a drop of concentrated (37%) Hydrochloric Acid), or by reflecting light (preferably daylight) on the inside of the pod wall.

The expression of parchment is controlled by two genes p and v and has four phenotypes:

Genotype	Phenotype
P V	Parchment occurring as a strong thick entire layer
p V	Parchment reduced to a strip along upper and/or lower sutures
P v	Parchment reduced to either patches, or a very thin entire layer
p v	Parchment absent

The following spontaneous mutation rates are known to occur:

p to P	0.05 - 0.2%
v to V	0.3 - 3.0%

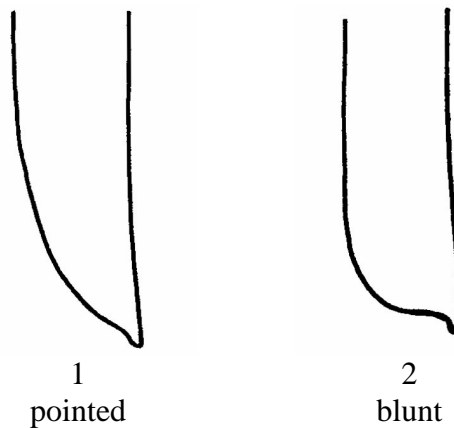
The effect of these spontaneous mutations will be to increase the levels of parchmented plants in parchment-free or partially parchmented types. Since both genes can mutate at the same time, this increase in plants with pod parchment can occur within a few generations.

Ad. 45: Pod: thickened wall (only varieties without entire parchment)

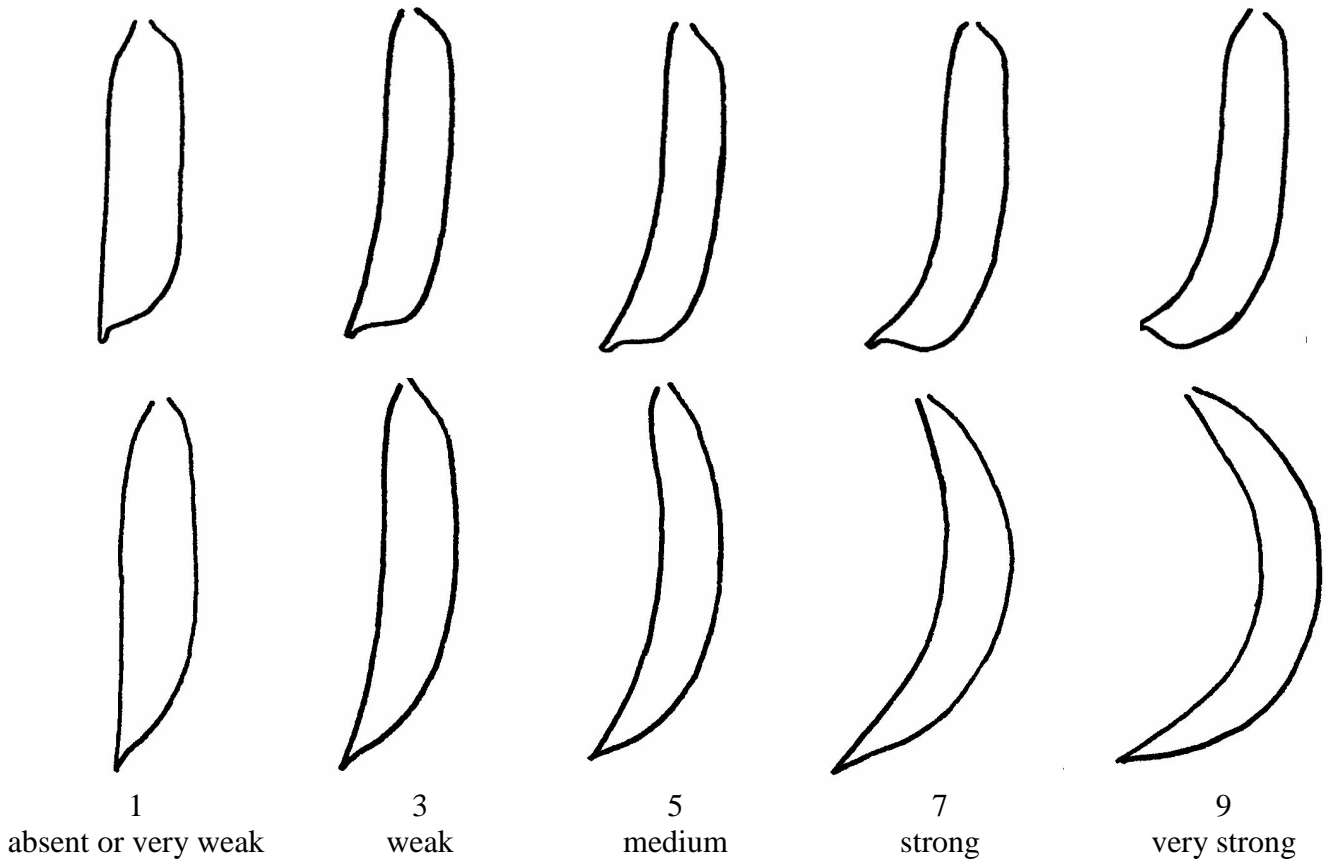
The observations should be made on well developed pods not showing any signs of senescence. Unopened harvested pods should be cut in cross section to examine pod wall thickness.

Ad. 46: Pod: shape of distal part (varieties without thickened pod wall only)

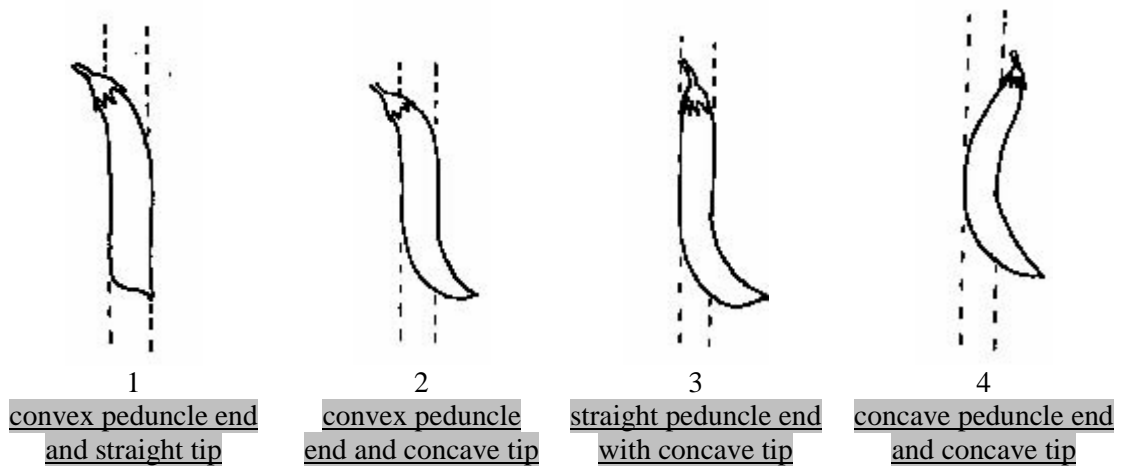
Observations should be made on several nodes of each plant when pods are fully developed, but before any senescence. Care should be taken when recording strongly curved pods, where the 'beak' is longer than the pod tip, or where parchment is not entire. **Some varieties have a blunt tip which is rounded, with the 'beak' higher up the pod.**



Ad. 48: Pod: degree of curvature



Ad. 50: Pod: type of curvature



Ad. 51: Pod: color

Peduncles, sepals and upper stems can appear a milky yellowish color in yellow podded varieties.

Blue-green pods are dark and slightly bluish. The color develops with time, and may be more accentuated in hotter, drier conditions.

Purple pods may be entirely purple or partially purple; occasionally the amount and distribution of anthocyanin may vary up the plant.

Ad. 53: Pod: suture strings (varieties with no or partial parchment only)

When temperatures exceed 20° C, the formation of suture strings is delayed. Observations should be made on fully developed pods.

Where suture strings are absent or partial and starch grains are compound, seed wrinkling in some seeds part of the population is much reduced; this expression is not considered to be a lack of uniformity; it may be affected by a penetrance factor and does not respond to selection.

Ad 57: Immature seed: intensity of green color

Immature seed color in some varieties with green cotyledons may appear creamy white before the seed is fully developed.

Characteristic 54. Pod: anthocyanin coloration of suture (varieties with anthocyanin only)

Characteristic 55. Pod: spots of anthocyanin coloration on outer wall (varieties with anthocyanin only)

The observations should be made over the whole plant when pods are well developed and are beginning to dry out.

Assessment of dry seed characteristics

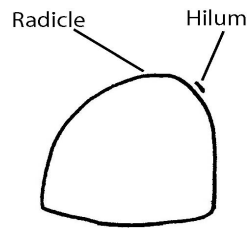
Seed should be mature and dry. and preferably not severely bleached, and the For varieties with anthocyanin pigment, tannins in the testa often darken with age, (usually after nine months) obscuring many characteristics. Recording of seed characteristics should therefore be carried out within nine months after of harvest. Assessment of some characteristics is difficult under artificial light, being easiest under conditions of bright natural daylight.

Ad. 58. Seed: predominant shape

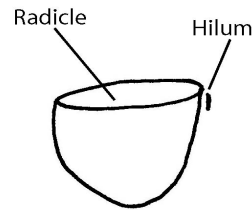
Seeds which grow nearest the peduncle end or the distal end of the pod ('end seeds') are rounded on the radicle or the distal (opposite to the radicle) surfaces and should be excluded from the assessment of shape.

Exclusion of 'end' seeds

Orientate the seed so that the hilum is at the upper right hand side with radicle and furca on top.



If the seed is rounded on the radicle surface only, it is an end seed growing nearest the peduncle end of the pod

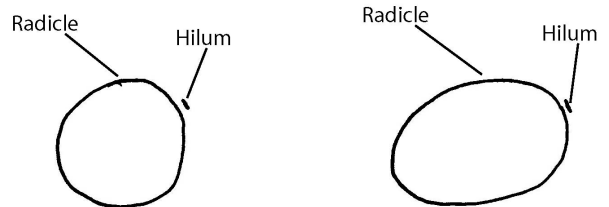


If the seed is rounded on the distal surface only, it is an end seed growing nearest the distal end of the pod

Seeds which are not rounded on the radicle or distal surfaces can be assessed for predominant shape: 'Golf ball' and other irregular dimpling should be ignored.

1. Spherical/ovoid

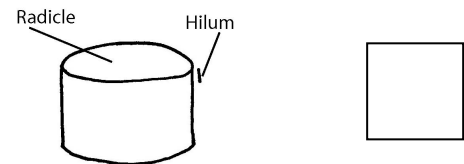
Seeds with no, or very weak, compression on the radicle and/or or the distal surfaces



2. Cylindrical

Seeds compressed on the radicle and distal surfaces. Square or rectangular (more or less straight-sided) in longitudinal section.

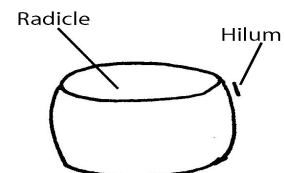
Round to boat-shaped in transverse section.



3. Flattened sphere

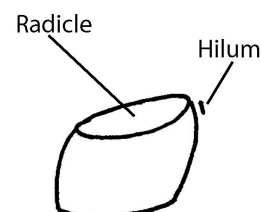
Seeds compressed on the radicle and distal surfaces. More or less rounded sides in longitudinal section.

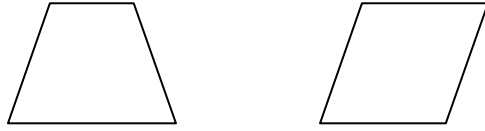
Round to boat-shaped in transverse section.



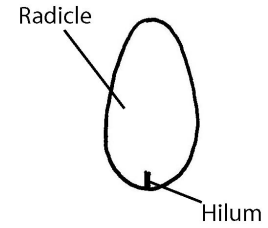
4. Rhomboid/trapezoid

Seeds irregularly compressed on the radicle and distal surfaces, but also irregularly compressed on the abaxial (external) surfaces of cotyledons).





Rhomboid or trapezoid with rounded sides in longitudinal section.



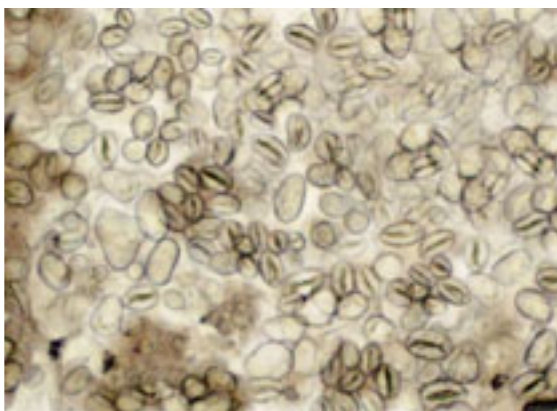
Narrow ovate in transverse section

5. Other

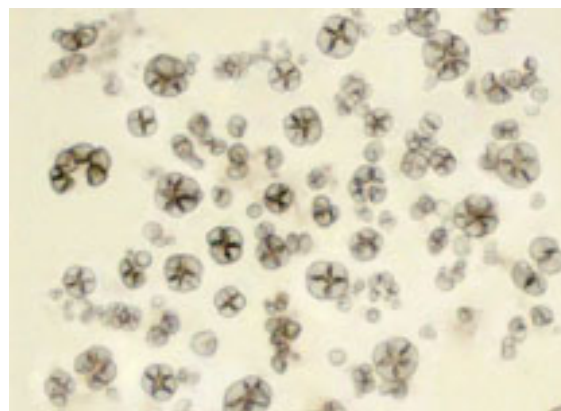
Seeds irregularly compressed; not one of the above shapes.

Ad. 59: Seed: type of starch grains

- (1) Following the removal of the testa, fine fragments of tissue should be extracted from the cotyledon and placed on a microscope slide. A droplet of water is added to the extracted tissue and another microscope slide is placed on top. The tissue and water mixture is then squashed gently between the two slides. Too much pressure during squashing results in fragmentation of the grains, too little pressure will not provide a layer thin enough for examination.
- (2) A microscope with transmitted light, using X16 eye-pieces and either X10 or X40 objectives, is most suitable for examination. For examination of compound grains the larger objectives will be required.
- (3) Simple grains resemble wheat seeds or coffee beans in shape, often with what looks like a suture line running along their length.
- (4) Compound grains look irregularly star-shaped and appear to be made of a number of segments. The center of the grains may appear cross-shaped.



1
simple



2
compound

Ad. 60: Varieties with cylindrical or flattened sphere shaped seeds and simple starch grains only: Seed: wrinkling of cotyledon

'Golf ball' and large dimples ~~are independent of wrinkling and~~ should be ignored in the assessment of cotyledon wrinkling.

Ad. 63: Seed: color of cotyledon

Following the removal of the testa, the seed is cut along the line of the cotyledon suture. Assessment of both external (abaxial) and internal (adaxial) surfaces of the cotyledon may be necessary. Immature seeds should be excluded from the assessment.

The expression varies with environmental conditions:

- bleaching, caused by sunlight or chemical changes in the plant, can remove color from seeds making it difficult to determine cotyledon color; cutting the seed in half enables the assessment of the internal color which may be less affected.
- color becomes dull with age, even if seed is stored in cold, dark conditions.
- color can darken in the presence of high amounts of Tragacanth oil occurring on the underside of the testa. This fades as the seed ages. Seeds with tannin may darken with age.
- orange cotyledons can be difficult to determine without reference to an example variety.

Ad. 66: Seed: hilum color

The hilum color can be influenced by the presence of tannin in the testa. The hilum area should be lightly polished with a cloth before recording, to remove any loose tissue present. Spontaneous mutation from melanin absent to melanin present has been reported in the literature for varieties with anthocyanin. The mutation rate is unknown.

Ad. 68: Seed: seed weight

Seed weight should be measured on at least two samples of 100 seeds. The observations should be made on harvest seed only. Immature and infected seeds should be excluded; the seed should be dry, (approximately 10-15% moisture content) at time of recording.

Ad. 69.1 – 69.4: Resistance to *Fusarium oxysporum* f. sp. *lisi* Races 1, 2, 5 and 6

Host differentials used for test:

Race 1: Line JI 1360 ex 'Dark Skinned Perfection' (resistant)
Line JI 1365 ex 'Little Marvel' (susceptible)

Race 2: Line JI 1364 ex WSU 23 (resistant)
Line JI 1363 ex WSU 28 (susceptible)

Race 5: Line JI 1364 ex WSU 23 (resistant)
Line JI 1365 ex 'Little Marvel' (susceptible)

Race 6: Line JI 1363 ex WSU 28 (resistant)
Line JI 1365 ex 'Little Marvel' (susceptible)

Isolates and isolate identity

Isolate identity is determined by testing against the host differential set described by Haglund and Kraft (1979). All isolates are derived from single spore cultures.

Isolates used in the test: Race 1: IPO culture collection no. 20379
 Race 2: WSU culture type 2
 Race 5: IPO culture collection no. 10279
 Race 6: WSU culture type 6

Maintenance of isolates

Maintain in a refrigerator at 4°C as a soil culture (loam) and pass through a susceptible variety every 2-3 years. Isolate identity is determined by testing against a host differential set.

Source for isolates:

Races 1 and 5:

Research Institute for Plant Protection (IPO)
PO Box 9060
NL-6700 GW Wageningen
The Netherlands

Races 2 and 6:

Washington State University,
Research and Extension Unit,
Mount Vernon, Washington 98273,
United States of America

Preparation of inoculum and assessment of disease

Cultures of the fungus are grown in liquid Czapek-Dox medium at 2°C in daylight conditions for 7 days. The liquid is continuously aerated by sterile air. The cultures are strained through muslin followed by centrifugation at 3,500 rpm for 10 minutes; the solution is diluted with distilled water to a concentration of 10⁶ spores/ml

Inoculation and assessment of disease Test plants and controls are raised in 8 litres of 1:1 peat and sand mixture and adjusted to pH 5.0. 1 litre of spore suspension is used. Two replicates of 10 plants are grown for assessment; a third replicate is grown if any problems arise.

After 3 weeks, or 4 - 5 node stage, the basal third of the seedling roots can be cut and dipped into the inoculum for 3-5 seconds before being transplanted. Four weeks after inoculation, surviving seedlings are recorded as resistant.

Composition of the Czapek-Dox liquid medium

2.0 g Sodium Nitrate
0.5 g Potassium Chloride
1.0 g Dipotassium Phosphate
0.5 g Magnesium Sulphate
0.01 g Ferrous Sulphate
30.0 g Saccharose

The above mixture is added to 1 litre of distilled water and poured into a flask; the solution is sterilized in an autoclave at 115°C for 20 minutes.

Genetic background

The expression of resistance to race 1 is controlled by the gene Fw and to race 2 by the gene Fnw; races 5 and 6 are controlled by single dominant genes but no symbols have been allocated.

Ad. 70: Resistance to *Erysiphe pisi* Syd.: Powdery Mildew

Host differentials

Line JI 502 ex 'Rondo' (susceptible)
Line JI 1559 ex WBH 1677 = 'Mexique-4' (resistant)

Isolates and isolate identity

No isolates are maintained as infection is natural

Genetic background

Two recessive genes confer resistance: er1 and er2

'Rondo' is susceptible (Er1 Er2)
'Mexique-4' is resistant (er1 er2)

Assessment of disease

Infected foliage surfaces are white and powdery. Tissue beneath the infected areas may turn purplish followed by the production of black fruiting structures. Badly infected tissue remains soft and fails to dry out naturally.

In resistant plants, infection is absent or localized in very small patches

Ad. 71: Resistance to Race C of *Ascochyta pisi* Lib. Ascochyta Leaf and Pod Spot

Host differentials:

Line JI 502 ex 'Rondo' (resistant)

Line JI 394 ex 'Kelvedon' Wonder (susceptible)

Isolates and isolate identity

Isolate used in the test: Tezier Strain

Isolate identity is determined by testing against a host differential set.

Maintenance of isolates

Maintain on Mathur medium at ambient temperature. Isolate identity is determined by testing against a host differential set.

Source for isolates:

GEVES SNES

Station Nationale d'Essais de Semences

Rue George Morel, B.P.24

49071 Beaucouzé Cedex France

Preparation of inoculum

Add 0.4% Tween 80 wetting agent to aid dispersal of spores. Remove hyphal fragments by straining solution through muslin. Concentration of 10^6 spores/ml

Inoculation and assessment of disease

Grow seedlings in glasshouse under natural daylength at 20°C and high humidity. Spray inoculum on young seedlings 10-15 days after emergence; mist spray 2 or 3 times per day for 15 minutes. Alternatively, inoculation can be made at the apex of enclosed leaves. This method does not require conditions of high humidity.

Plants are assessed about 5 days after inoculation. Infection is very clear when present: necrotic lesions are slightly sunken, brown and sharply delineated. Lesions are circular on pods and elongated on stems. Two replicates of 10 plants are grown; a third replicate is grown if any problems arise.

Genetic background:

The expression of resistance to Race C (also known as BP2) is controlled by a single dominant gene Rap2. Five pathotypes and four resistance genes are known.

Ad. 72.1 and 72.2: Resistance to *Pseudomonas syringae* pv. *pisii* Races 2 and 4.

Host differentials used for test

Race 2: Line JI 2430 ex 'Kelvedon Wonder' (susceptible)
Line JI 2438 ex 'Partridge' (susceptible)
Line JI 2431 ex 'Early Onward' (resistant)
Line JI 2439 ex 'Fortune' (resistant)

Race 4: Line JI 2430 ex 'Kelvedon Wonder' (susceptible)
Line JI 2431 ex 'Early Onward' (susceptible)
Line JI 2438 ex 'Partridge' (resistant)
Line JI 2439 ex 'Fortune' (resistant)

Since the method for testing all races is the same, the following Host Differentials are available

HOST DIFFERENTIAL	RACE						
	1	2	3	4	5	6	7
Line JI 2430 ex 'Kelvedon Wonder'	S	S	S	S	S	S	S
Line JI 2431 ex 'Early Onward'	S	R	S	S	R	S	R
Line JI 2432 ex 'Belinda'	R	S	R	S	S	S	R
Line JI 2435 ex 'Hurst Greenshaft'	R	S	S	R	R	S	R
Line JI 2436 ex 'Vinco'	R	R	R	S	R	S	R
Line JI 2437 ex 'Sleaford Triumph'	R	S	R	R	R	S	R
Line JI 2439 ex 'Fortune'	R	R	R	R	R	S	R

Isolates and isolate identity

The following isolates are used for testing:

RACE	ISOLATE
1	299A
2	202
3	870A
4	895A
5	974B
6	1704B
7	2491A

Isolate identity is determined by serological reactions (Taylor 1972; Taylor and Dye 1972) and by their pathogenicity to one or more host differential cultivars.

Source for isolates:

Horticultural Research International
Wellesbourne
Warwick
CV35 9EF
United Kingdom

Maintenance of isolates

Bacteria are stored either as lyophilized cultures in sealed vials at ambient temperature or as frozen suspensions at -80°C. Isolate identity is determined by serological reactions and by their pathogenicity to one or more host differential cultivars.

Preparation of the inoculum

Bacteria are grown on plates of King's Medium B for 24-48 hours at 25°C. Bacteria are scraped from the culture surface for inoculation

Inoculation and assessment of disease

10-14 day old seedlings, grown under glass at 20°C, are inoculated into young growing tissue of the stem at the axil with the stipule. The tip of a sterilized entomological mounting pin is scraped along the culture surface and stabbed into the plants at the two youngest nodes (2 inoculations / plant).

Plant reactions are recorded 5-10 days after inoculation as either resistant or susceptible. Susceptible response is expressed as water soaked tissue around the point of inoculation; resistant response is expressed as a localized necrotic reaction

Two replicates of 10 plants are inoculated for each race; a third replicate is grown if any problems arise.

Genetic background

Races 2 and 4 are controlled by different single dominant genes. No gene symbols have been assigned. Resistance to Race 6 is known in accessions of *Pisum abyssinicum*.

Ad. 73: Resistance to Seed-borne Mosaic Virus Strain P1

Host differentials

Strain P1: Line JI 363 ex 'Lincoln' (susceptible)
 Line JI 968 = WL 1779 = PI 193835 (resistant)

Isolates and isolate identity

Isolates used in the test: PSbm P1 Versailles Strain

Isolate identity is determined by reaction to antiserum in serological tests and by reaction with a set of host differential cultivars.

Maintenance of isolates

Symptomatic leaves or shoot tissue of infected seedlings are used to prepare inoculum, and are stored dry at -18°C.

Source for isolates:

GEVES SNES
Station Nationale d'Essais de Semences
Rue George Morel, B.P.24
49071 Beaucouzé Cedex France

Preparation of inoculum

Infected dry plant tissue is ground in a phosphate buffer (pH 8.5, 0.005M).

Inoculation and assessment of disease

Inoculum is applied after a dark period (early morning), to Carborundum powder dusted leaves of 10-14 day old seedlings. Inoculated plants are maintained at 24°C and 14,000 Klux. Care is taken to avoid too much damage of the tissue to prevent necrosis. Two replicates of 10 plants are grown; a third replicate is grown if problems arise.

Susceptible plants are stunted and have rolling of the leaf margins, with or without leaf mosaic. The presence of infection in the plant is detected by ELISA test.

Genetic background:

Resistance is pathotype specific, with single recessive genes for each pathotype. There are 4 known genes for resistance. The gene sbm-1 controls resistance to the P1 Strain.

Ad. 74: Resistance to Bean Yellow Mosaic Virus

Host differentials

Line JI 502 ex 'Rondo' (susceptible)
Line JI 394 ex 'Kelvedon' Wonder (resistant)

Isolates:

Isolate used in the test: Versailles Strain

Maintenance of isolates

Isolates are stored as infected dry tissue at +5°C or infected tissue at -18°C.

Source for isolate

GEVES SNES
Station Nationale d'Essais de Semences
Rue George Morel, B.P.24
49071 Beaucouzé Cedex France

Preparation of inoculum

Infected dry tissue is ground in a phosphate buffer (pH 8.5, 0.005M).

Inoculation and assessment of disease

Plants are grown under glass at 20°C and supplementary lighting to provide a 14-16 hour daylength; (supplementary illumination 500 watts/m²). At the 2-3 leaf stage the isolate is added to the plant following abrasion with Carborundum powder.

Assessment of disease

Ten days after the inoculation, whether or not symptoms exist. Two replicates of 10 plants are grown; a third replicate is grown if problems arise.

Genetic background

Resistance is conferred by the gene *mo*.

Ad. 75: Resistance to Pea Enation Mozaic Virus

Host differentials

'Dark Skinned Perfection' (susceptible)
'Perfected Freezer 60' (resistant)

Isolates

Isolate PEM-3 is readily mechanically transmissible, is stable during long-term maintenance (i.e. has not produced variants), and is representative of PEMV occurring naturally in North America and Europe (i.e. glasshouse inoculations produce results agreeing with those obtained by natural field inoculations).

Isolates of PEMV tend to be monotypic; thus similar results should be possible with other isolates from North America or Europe.

Maintenance of Isolates

Symptomatic leaves or shoot tissue of infected seedlings are used to prepare inoculum; lyophilized infected tissue is stored at -20°C. The virus remains viable for more than 5 years under these storage conditions.

Source for isolates

USDA ARS,
Dept. of Botany Plant Pathology,
Oregon State University,
Corvallis
Oregon 97331-2902
U.S.A.

Preparation of inoculum

Grind desiccated infected tissue (1:50, w/vol) in phosphate buffer (pH 8.5 0.05M), allow to re-hydrate for 5 minutes before grinding again. Crude extract is applied to carborundum-dusted young leaves.

Inoculation and assessment of disease

Apply inoculum to first fully-expanded true leaves, lightly dusted with 400-mesh carborundum. Maintain inoculated plants at 20 to 25°C and 11,000 Lux. (Use of plants after 2- to 3-leaf stage produces unreliable results.)

Symptoms consisting of stunting, mosaic, and leaf-shape deformity typically develop 10 to 15 days after inoculation. Non-inoculated control plants are essential for establishing the effects of viral inoculation. For homozygous lines, 20 to 50 inoculated seedlings should accurately determine resistance or susceptibility of genotype.

Genetic background

A single dominant gene, En confers tolerance to PEMV infection (i.e. the gene enables plants to grow and produce well when virus-infected). Expression of PEM symptoms is dependent upon numerous factors, including inoculum concentration, plant age at infection, plant-growth environment, and perhaps gene interactions.

KEY FOR THE GROWTH STAGES
 CLÉ POUR LES STADES DE CROISSANCE
 SCHLUESSEL FUER DIE ENTWICKLUNGSSTADIEN

Key Clé Schlüssel	General Description	Description générale	Allgemeine Beschreibung
0	<u>Germination</u>	<u>Germination</u>	<u>Keimung</u>
00	Dry seed	Graine sèche	Trockenkorn
10	<u>Seedling growth</u>	<u>Croissance de la plantule</u>	<u>Wachstum des Keimlings</u>
16	Young seedling with first scale leaf developed	Jeune plantule avec première feuille à écailles développée	Junger Keimling mit ersten entwickelten Schuppenblättern
18	Young seedling with second scale leaf developed	Jeune plantule avec deuxième feuille à écailles développée	Junger Keimling mit zweiten entwickelten Schuppenblättern
20	First pair of stipules at the third node fully opened	Première paire de stipules au niveau du troisième noeud complètement ouverte	Erstes Paar Nebenblätter am dritten Knoten voll geöffnet
22	Stipules at the fourth node fully opened	Stipules au niveau du quatrième noeud complètement ouverts	Nebenblätter am vierten Knoten voll geöffnet
25	Stipules at the fifth node fully opened	Stipules au niveau du cinquième noeud complètement ouverts	Nebenblätter am fünften Knoten voll geöffnet
28	Stipules at the sixth node fully opened	Stipules au niveau du sixième noeud complètement ouverts	Nebenblätter am sechsten Knoten voll geöffnet
30	<u>Vegetative growth</u>	<u>Croissance végétative</u>	<u>Vegetatives Wachstum</u>
31	Stipules at the seventh node fully opened	Stipules au niveau du septième noeud complètement ouverts	Nebenblätter am siebenten Knoten voll geöffnet
34	Stipules at the eighth node fully opened	Stipules au niveau du huitième noeud complètement ouverts	Nebenblätter am achten Knoten voll geöffnet
40	Stipules at the tenth node fully opened	Stipules au niveau du dixième noeud complètement ouverts	Nebenblätter am zehnten Knoten voll geöffnet
n	Stipules at the Nth node fully opened	Stipules au niveau du N-ième noeud complètement ouverts	Nebenblätter am N-ten Knoten voll geöffnet
200	<u>Reproductive stage</u>	<u>Stade de reproduction</u>	<u>Generatives Stadium</u>
200	Initiation of first flower	Apparition de la première fleur	Beginn der ersten Blüte
206	Development of first flower bud enclosed in stipules	Développement de la première fleur, mais à l'intérieur des stipules	Entwicklung der ersten in Nebenblätter eingeschlossenen Blütenknospe
208	Development and sometimes elongation of peduncle	Développement et parfois allongement du pédoncule	Entwicklung und manchmal Verlängerung des Blütenstandstiels

Key Clé Schlüssel	General Description	Description générale	Allgemeine Beschreibung
210	Emergence of first flower bud from stipules	Apparition du premier bourgeon à fleurs hors des stipules	Erscheinen der ersten Blütenknospe aus den Nebenblättern
212	Emergence of standards from the calyx	Apparition des étendards hors du calice	Erscheinen der Fahne aus dem Kelch
214	Opening of the standards and emergence of the wings	Ouverture des étendards et apparition des ailes	Oeffnen der Fahne und Erscheinen der Flügel
216	Slight opening of the wings to show the keel	Légère ouverture des ailes découvrant la carène	Leichtes Oeffnen der Flügel und Erscheinen des Kieles
218	Standards usually fully opened	Etendards généralement complètement ouverts	Fahnen normalerweise voll geöffnet
220	Standards beginning to crumple at the margins	Etendards commençant à se friper sur les bords	Fahnen beginnen am Rand zu kräuseln
222	Standards and wings showing signs of withering	Etendards et ailes présentant des signes de flétrissure	Fahnen und Flügel weisen Zeichen des Welkens auf
224	Emergence of the first flat pod	Apparition de la première gousse aplatie	Erscheinen der ersten flachen Hülse
226	Elongation of the flat pod with clearly visible ovules	Allongement de la gousse aplatie avec des ovules nettement visibles	Verlängerung der flachen Hülse mit deutlich sichtbaren Samenanlagen
230	Swelling of the ovules and slight swelling of the pod wall	Gonflement des ovules et léger renflement de la paroi de la gousse	Schwellen der Samenanlagen und leichtes Schwellen der Hülsenwand
235	Green seed rounded becoming slightly firm; pods almost fully swollen or developed	Graine verte arrondie devenant légèrement ferme; gousses presque entièrement formées ou développées	Grüner rundlicher Samen wird leicht fest; Hülse fast vollkommen geschwollen oder entwickelt
240	Green seed firm, becoming starchy; pods fully developed or swollen	Graine verte ferme, devenant amylacée; gousses pleinement développées ou gonflées	Grüner Samen fest; wird leicht stärkehaltig; Hülsen voll entwickelt oder geschwollen
245	Green seed becoming pale, testas tough; pod beginning to lose color	Graine verte devenant pâle, téguments épais; gousse commençant à se décolorer	Grüner Samen wird blass, Samenschale fest; Hülse beginnt Farbe zu verlieren
250	Stem and lower foliage becoming yellowish	Tige et feuillage inférieur devenant jaunâtre	Stengel und niedrige Blätter werden gelblich
255	Seed drying and becoming yellowish green; pod becoming wrinkled	Dessèchement de la graine devenant vert jaunâtre; gousse commençant à se rider	Samen trocknet und wird gelblichgrün; Hülse wird schrumpfig
260	Lower foliage becoming dry at margins	Feuillage inférieur devenant sec sur les bords	Untere Blätter werden am Rand trocken
265	Seed yellowish green; pods wrinkled, pale green	Graine vert jaunâtre; gousses ridées vert pâle	Samen gelblichgrün; Hülsen schrumpfig, blassgrün

Key Clé Schlüssel	General Description	Description générale	Allgemeine Beschreibung
270	Lower foliage becoming dry and papery	Feuillage inférieur devenant sec et semblable à du papier	Untere Blätter werden trocken und papierartig
275	Seed yellowish-white and rubbery; pods wrinkled and yellowish-green	Graine blanc jaunâtre et caoutchouteuse; gousse ridée et de couleur vert jaunâtre	Samen gelblichweiss und gummiartig; Hülsen schrumpfig und gelblichgrün
280	Stem drying out, becoming yellowish green	Dessèchement de la tige devenant vert jaunâtre	Stengel trocknet aus, wird gelblichgrün
285	Lowest pods yellowish-brown, dry and papery	Gousses inférieures de couleur brun jaunâtre, sèches et semblables à du papier	Unterste Hülsen gelblich-braun, trocken und papierartig
290	Stem becoming stiff and brittle and appearing yellowish-white	Tige devenant érigée et fragile, et de couleur blanc jaunâtre	Stengel wird steif und zerbrechlich und erscheint gelblichweiss
300	Lower and middle nodes with dry papery foliage; lower pods dry and papery	Feuillage sec et semblable à du papier sur tous les noeuds inférieurs et médians; gousses inférieures sèches et semblables à du papier	Untere und mittlere Knoten mit trockenen, papierartigen Blättern; untere Hülsen trocken und papierartig
305	All nodes with dry papery foliage; lower and middle pods dry and papery	Feuillage sec et semblable à du papier sur tous les noeuds; gousses inférieures et médianes sèches et semblables à du papier	Alle Knoten mit trockenen, papierartigen Blättern; untere und mittlere Hülsen trocken und papierartig
310	All nodes with dry papery foliage and pods; seed drying but not hard	Feuillage et gousses secs et semblables à du papier sur tous les noeuds; graine se desséchant, mais non dure	Alle Knoten mit trockenen, papierartigen Blättern und Hülsen; Samen trocknet, ist aber noch nicht hart
320	Hard dry seed	Graine dure et sèche	Harter trockener Samen

9. Literature

Biddle, A.J., Knott, C.M., 1988: "The Pea Growing Handbook," Sixth edition. Ed. G.P. Gent. Processors and Growers Research Organisation, Peterborough, UK

Blixt, S., 1972: "Mutation Genetics in Pisum," *Agri. Hort. Genet.*, 30, pp. 1-293

Blixt, S., 1974: "The Pea," in *Handbook of Genetics*, Ed.R.C. King, Plenum Press, New York

Blixt, S., 1977: "The Gene Symbols of Pisum," *Pisum Newsletter*, 9 (suppl.)

Casey, R., Davies, D.R., CAB International 1993: "Peas: Genetics, Molecular Biology and Biotechnology," *Biotechnology in Agriculture Series*, No. 10.

Cousin, R., 1974: "Les pois. étude génétique des caractères, classification, caractéristiques variétales portant sur les variétés inscrites au catalogue officiel français," Institut national de la recherche agronomique, Paris.

Fourmant, R., 1956: "Les variétés de pois cultivés en France," Institut national de la recherche agronomique, Paris.

Hagedorn, D.J., 1984: "Compendium of Pea Diseases," The American Phytopathological Society, Minnesota, LISA.

Hedrick, U.P., 1928: "The Vegetables of New York," Vol. Part I: Peas. New York Agricultural Experiment Station Albany, New York, USA

Khvostova, V.V., 1983: "Genetics and Breeding of Peas," Amerind Publishing Co. Pvt. Ltd. New Delhi

Lamprecht, H., 1974: "Monographie der Gattung Pisum," Steiermarkische Landesdruckerei, Graz 1974

Makasheva, R.Kh., 1983: "The Pea," Amerind Publishing Co. Pvt. Ltd., New Dehli

Marx, G.A., 1977: "Classification, Genetics and Breeding," in 'The Physiology of the Garden Pea' (J.F. Sutcliffe and J.S. Pate, eds.) pp. 21-44. Academic Press. London and Orlando

Murfet, I.C., 1976: "Physiological genetics of flowering in 'Physiology of the garden pea'," Academic Press 1976

Murfet, I.C. 1985: in 'CRC Handbook of Flowering' Ed. A.H. Halevy, CRC Press, Boca Raton, IV, pp. 97-126

Murfet, I.C., Reid, J.B., 1985: "The control of flowering and internode length in Pisum," in "The Pea Crop - a basis for improvement" Eds. Hebblethwaite, Heath, Dawkins. Butterworths, London, 6, pp. 67-80

Wellensiek, S.J., 1925*: "Genetic monograph on Pisum," *Bibl. Genetica*, 2, pp. 343-476

10. Technical Questionnaire

TECHNICAL QUESTIONNAIRE	Page {x} of {y}	Reference Number:
		Application date: (not to be filled in by the applicant)
TECHNICAL QUESTIONNAIRE to be completed in connection with an application for plant breeders' rights		
1. Subject of the Technical Questionnaire		
1.1 Botanical name	<input type="text" value="Pisum sativum L."/>	
1.2 Common Name	<input type="text" value="Peas"/>	
2. Applicant		
Name	<input type="text"/>	
Address	<input type="text"/>	
Telephone No.	<input type="text"/>	
Fax No.	<input type="text"/>	
E-mail address	<input type="text"/>	
Breeder (if different from applicant)	<input type="text"/>	
3. Proposed denomination and breeder's reference		
Proposed denomination (if available)	<input type="text"/>	
Breeder's reference	<input type="text"/>	

TECHNICAL QUESTIONNAIRE	Page {x} of {y}	Reference Number:
-------------------------	-----------------	-------------------

#4. Information on the breeding scheme and propagation of the variety

4.1 Breeding scheme

Variety resulting from:

4.1.1 Crossing

- (a) controlled cross []
(please state parent varieties)
- (b) partially known cross []
(please state known parent variety(ies))
- (c) unknown cross []

4.1.2 Mutation []
(please state parent variety)

4.1.3 Discovery and development []
(please state where and when discovered and how developed)

4.1.4 Other []
(please provide details)

.....

4.2 Method of propagating the variety

Authorities may allow certain of this information to be provided in a confidential section of the Technical Questionnaire.

TECHNICAL QUESTIONNAIRE	Page {x} of {y}	Reference Number:
-------------------------	-----------------	-------------------

5. Characteristics of the variety to be indicated (the number in brackets refers to the corresponding characteristic in Test Guidelines; please mark the note which best corresponds).

Characteristics	Example Varieties	Note
5.1 Plant: anthocyanin coloration (1)		
absent	Avola, Solara	1 []
present	Pidgin, Rosakrone	9 []
<i>TWA: delete 5 no reliable information given by the applicant or not used for planning the trial</i>		
5.2 Stem: number of nodes up to and including first fertile node (5)		
very few	Kelvil	1 []
few	Miragreen, Waverking	3 []
medium	Markana, Susan	5 []
many	Cooper	7 []
very many	Regina	9 []
5.3 Foliage: color (8)		
yellow green	Pilot	1 []
green	Avola, Progreta	2 []
blue-green	Polar	3 []
5.4 Leaf: leaflets (10)		
absent	Hawk, Solara	1 []
present	Avola, Rhea	9 []
5.5 Stipule: 'rabbit-eared' habit (18)		
absent or very weak	Avola, Maro	1 []
moderately expressed		2 []
strongly expressed	Ibiza, Progreta	3 []

TECHNICAL QUESTIONNAIRE	Page {x} of {y}	Reference Number:
-------------------------	-----------------	-------------------

Characteristics	Example Varieties	Note
5.6 Stipule: flecking (25)		
absent	Lisa, Tafila	1 []
present	Avola, Maro	9 []
<i>TWA: retain 5.18 (now 5.9) To keep Time of flowering. Very important for planning the growing trial; TWV agreed to delete from TQ</i>		
5.7 Time of flowering (29)		
<i>very early</i>	<i>Tempo</i>	1 []
<i>early</i>	<i>Smart, Sparkle</i>	3 []
<i>medium</i>	<i>Carlton, Waverex</i>	5 []
<i>late</i>	<i>Cooper, Purser</i>	7 []
<i>very late</i>	<i>Livioletta</i>	9 []
5.8 Plant: maximum number of flowers per node (non-fasciated varieties only) (30)		
one	Progress No. 9, Tyla	1 []
two	Banff, Cooper	2 []
three	Nettuno, Ultimo	3 []
four or more		4 []
5.9 Flower: color of wing (varieties with anthocyanin only) (31)		
White with pink blush	Golf	1 []
pink	Rosakrone	2 []
reddish purple	Assas	3 []

TECHNICAL QUESTIONNAIRE	Page {x} of {y}	Reference Number:
-------------------------	-----------------	-------------------

Characteristics	Example Varieties	Note
<i>TWA: delete 5.21 (now 5.12) no reliable information given by the applicant or not used for planning the trial</i>		
5.10 Flower: shape of base of standard (34)		
strongly raised		1 []
raised	Progreta, Picar	3 []
medium	Markado, Solara	5 []
arched	Avola, Copper	7 []
strongly arched	Boah Tyr, Kennedy	9 []
<i>TWA: delete no reliable information given by the applicant or not used for planning the trial</i>		
5.11 Pod: length (at second flowering node) (42)		
very short	Vermio, Cepia	1 []
short	Progreta, Solara	3 []
medium	Copper, Jof	5 []
long	Hurst Grren Shaft, Protor	7 []
very long	Roi de Carouby	9 []
<i>TWA: delete no reliable information given by the applicant or not used for planning the trial</i>		
5.12 Pod: width (at second flowering node) (43)		
very narrow	Disco	1 []
narrow	Picar, Ultimo	3 []
medium	Progreta, Solara	5 []
broad	Final, Kahuna	7 []
very broad	Kennedy	9 []
5.13 Pod: parchment (44)		
absent or partial	Sugar Ann	1 []
entire	Avola, Solara	2 []

TECHNICAL QUESTIONNAIRE	Page {x} of {y}	Reference Number:
-------------------------	-----------------	-------------------

Characteristics	Example Varieties	Note
5.14 Pod: thickened wall (varieties with no or partial parchment only) (45)		
absent	Nofila, Reuzensuiker	1 []
present	Cygnnet, Suggar Ann	9 []
5.15 Pod: shape of distal part (varieties without thickened pod wall only) (46)		
pointed	Jof, Oskar	1 []
blunt	Avola, Solara	2 []
5.16 Pod: color (51)		
yellow	(Orlex)	1 []
green	Avola	2 []
blue-green	Miracle, Miragreen	3 []
purple	Blauschokker	4 []
5.17 Pod: suture strings (varieties with no or partial pod parchment) (53)		
absent or rudimentary	Nofila, Sugar Lace	1 []
present	Reuzensuiker, Crispi	2 []
5.18 Pod: number of ovules (56)		
few	Pegas, De Grace	3 []
medium	Hawk, Backgammon	5 []
many	Karisma	7 []7
5.19 Pod: intensity of green color of immature seed (57)		
light	Ultimo, Solara	3 []
medium		5 []
dark	Dark Skin Perfection, Hawaii	7 []

TECHNICAL QUESTIONNAIRE	Page {x} of {y}	Reference Number:
-------------------------	-----------------	-------------------

Characteristics	Example Varieties	Note
5.20 Seed: type of starch grains (59)		
simple	Maro, Soalra, Adagio	1 []
compound	Avola, Polar	2 []
<i>TWA: delete no reliable information given by the applicant or not used for planning the trial)</i>		
5.21 Seed: color of cotyledon (63)		
green	Avola, Solara	1 []
yellow	Hardy, Caractacus	2 []
orange	Oliver	3 []
5.22 Seed: marbling of testa (varieties with anthocyanin only) (64)		
absent	Rif, Rhea	1 []
present	Assas, Birdie	2 []
5.23 Seed: violet or pink spots on testa (varieties with anthocyanin only) (65)		
absent	Rif, Birdie	1 []
faint	Assas, Susan	2 []
intense	Arvika, Rhea	3 []
5.24 Seed: hilum color (66)		
not black-colored	Avola, Birdie	1 []
black colored	Nofila, Rif	2 []
5.25 Seed: weight (68)		
very low	Ultimo	1 []
low	Hawk, Iceberg	3 []
medium	Mammoth Melting Sugar, Toskana	5 []
high	Kennedy, Maro	7 []
very high	Bamby, Cratos	9 []

TECHNICAL QUESTIONNAIRE	Page {x} of {y}	Reference Number:
-------------------------	-----------------	-------------------

6. Similar varieties and differences from these varieties

Please use the following table and box for comments to provide information on how your candidate variety differs from the variety (or varieties) which, to the best of your knowledge, is (or are) most similar. This information may help the examination authority to conduct its examination of distinctness in a more efficient way.

Denomination(s) of variety(ies) similar to your candidate variety	Characteristic(s) in which your candidate variety differs from the similar variety(ies)	Describe the expression of the characteristic(s) for the similar variety(ies)	Describe the expression of the characteristic(s) for your candidate variety
<i>Example</i>	<i>Time of flowering</i>	<i>early</i>	<i>medium</i>

Comments:

TECHNICAL QUESTIONNAIRE	Page {x} of {y}	Reference Number:
-------------------------	-----------------	-------------------

7. Additional information which may help in the examination of the variety

7.1 In addition to the information provided in sections 5 and 6, are there any additional characteristics which may help to distinguish the variety?

Yes [] No []

(If yes, please provide details)

7.2 Are there any special conditions for growing the variety or conducting the examination?

Yes [] No []

(If yes, please provide details)

7.3 Other information

TWA: To check if 7.3 is useful for DUS purposes to differentiate so many types of use.

Use

- fresh market []
- canning []
- freezing []
- dry seed for human consumption []
- dry protein []
- forage []
- other (please specify) []

.....

Resistance to disease	Resistant	Susceptible	Not tested
Fusarium Wilt (Race 1) (Common Wilt)	[]	[]	[]
Fusarium Wilt (Race 2) (Near Wilt)	[]	[]	[]
Fusarium Wilt (Race 5)	[]	[]	[]
Fusarium Wilt (Race 6)	[]	[]	[]
Powdery mildew	[]	[]	[]
Ascochyta (leaf and pod spot) Race C	[]	[]	[]
Pea bacterial blight (Pseudomonas) (specify races/pathovars)	[]	[]	[]
Pea Seed-borne Mosaic Virus (P1 strain)	[]	[]	[]
Bean Yellow Mosaic Virus (BYMV)	[]	[]	[]
Pea Enation Mosaic Virus (PEMV)	[]	[]	[]

Resistance to other diseases
 (please give details below)

.....

TECHNICAL QUESTIONNAIRE	Page {x} of {y}	Reference Number:
-------------------------	-----------------	-------------------

8. Authorization for release

(a) Does the variety require prior authorization for release under legislation concerning the protection of the environment, human and animal health?

Yes [] No []

(b) Has such authorization been obtained?

Yes [] No []

If the answer to (b) is yes, please attach a copy of the authorization.

TECHNICAL QUESTIONNAIRE	Page {x} of {y}	Reference Number:
-------------------------	-----------------	-------------------

9. Information on plant material to be examined or submitted for examination.

9.1 The expression of a characteristic or several characteristics of a variety may be affected by factors, such as pests and disease, chemical treatment (e.g. growth retardants or pesticides), effects of tissue culture, different rootstocks, scions taken from different growth phases of a tree, etc.

9.2 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 the plant material has undergone such treatment, full details of the treatment must be given. In this respect, please indicate below, to the best of your knowledge, if the plant material to be examined has been subjected to:

- | | | |
|---|---------|--------|
| (a) Microorganisms (e.g. virus, bacteria, phytoplasma) | Yes [] | No [] |
| (b) Chemical treatment (e.g. growth retardant, pesticide) | Yes [] | No [] |
| (c) Tissue culture | Yes [] | No [] |
| (d) Other factors | Yes [] | No [] |

Please provide details for where you have indicated "yes".

.....

9.3 Has the plant material to be examined been tested for the presence of virus or other pathogens?

Yes []

(please provide details as specified by the Authority)

No []

10. I hereby declare that, to the best of my knowledge, the information provided in this form is correct:

Applicant's name

Signature

Date

Ad 13 Leaflet: size (surface area)
Ad 14 Leaflet: length
Ad 15 Leaflet: width
Ad 16 Leaflet: distance from widest point to base
Ad 19 Stipule: length
Ad 20 Stipule: width
Ad 21 Stipule: size (surface area)
Ad 22 Stipule: length from axil to tip
Ad 24 Stipule: lobe below axil
Ad 27 Petiole: length (from axil to first leaflet or tendril)
Ad 28 Petiole: total length (from axil to last tendril)
Ad 38 Peduncle: length from stem to first pod
Ad 39 Peduncle: length between 1st and 2nd pods
Ad 40 Peduncle: length of spur
Ad 42 Pod length
Ad 43 Pod width

Measurement of images using computer

Use of automated measurement techniques should be compared directly with manually recorded methods, on the same material, to ensure the results are consistent.

Automated measurement techniques are particularly useful for simple measurement of surface area, length, width, length of curved objects (midline or outline), width of asymmetrical plant parts or accurate measurement at particular points i. e. one third from base etc.

Orientation of plant parts (see next page), use of a measurement scale and standardized recording formats are requirements for automated measurement.

An image library, which is collected for automated recording, is useful for data checking and for testing new automated measurement characteristics.

Automatically recorded measurements can be processed in the same way as data recorded manually and can be entered directly into statistical programs for further analysis.

Object orientation for Automated Image Measurement

Plant parts which are measured by computer need to be oriented in a standard manner so that measurements made in different places achieve consistent results.

Plant parts are oriented by finding their geometrical major axis, and rotating them so that this is horizontal. The major axis may be defined as the longest line that can be drawn (on the plant part) through the centroid (centre of gravity). Major axis calculations are a standard routine in image analysis (Glasbey & Horgan 1995)

The major axis calculation may be modified where the plant parts being measured are highly curved e.g. in some pea pods; in such cases only the pixels in the middle third of the pod are used in the calculation.

For further information see Glasbey, C.A. and Horgan, G.W. (1995). Image analysis for the Biological Sciences. Wiley

UK proposes that the following text be added to a TGP document

The major axis may be defined as the line along which the mechanical moment of inertia is a maximum. If we consider the means, variances and covariance of the coordinates (i, j) of all the n pixels within the object outline, i.e.

$$\begin{aligned}\bar{i} &= \frac{1}{n} \sum i \\ \bar{j} &= \frac{1}{n} \sum j \\ U &= \frac{1}{n} \sum (i - \bar{i})^2 \\ V &= \frac{1}{n} \sum (j - \bar{j})^2 \\ W &= \frac{1}{n} \sum (i - \bar{i})(j - \bar{j})\end{aligned}$$

then the centroid or centre of gravity of the objects is at (\bar{i}, \bar{j}) , U and V are the variances of the i and j coordinates respectively, and W is their covariance.

We define the major axis to be the line passing through the centroid with an angle

$$\phi = \frac{1}{2} \tan^{-1} \left(\frac{2W}{V - U} \right) \quad \text{if } V > U$$

or this expression plus $\frac{1}{2} \pi$ (90°) if $U > V$.

We take the \tan^{-1} function to produce output in the range $-\frac{1}{2} \pi$ to $\frac{1}{2} \pi$ (-90° to 90°), and angle ϕ to increase horizontally from the horizontal. If $U=V$ (as it would be for a disc or square) the orientation is undefined, but this should not occur for the elongated type of plant parts which need to be oriented.

[End of document]