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to the
General Introduction to the Examination
of Distinctness, Uniformity and Stability and the
Development of Harmonized Descriptions of New Varieties of Plants (document TG/1/3)

DOCUMENT TGP/10

“EXAMINING UNIFORMITY”

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Note for Draft version

Footnotes will be retained in published document

Endnotes are background information to assist in the consideration of this draft and will not appear in the final, published document

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SECTION 1: INTRODUCTION

1.1 According to Article 6(1)(c) of the 1961/1972 and 1978 Acts of the UPOV Convention, a variety is deemed uniform if it is “sufficiently homogeneous, having regard to the particular features of its sexual reproduction or vegetative propagation.” Article 8 of the 1991 Act deems that a variety is uniform if, “subject to the variation that may be expected from the particular features of its propagation, it is sufficiently uniform in its relevant characteristics”.

1.2 The “General Introduction to the Examination of Distinctness, Uniformity and Stability and the Development of Harmonized Descriptions of New Varieties of Plants” (document TG/1/3), hereinafter referred to as the “General Introduction”, Chapter 6.2, clarifies that “Relevant characteristics of a variety include at least all characteristics used for the examination of DUS or included in the variety description established at the date of grant of protection of that variety. Therefore, any obvious characteristic may be considered relevant, irrespective of whether it appears in the Test Guidelines or not”. [Hence, it is a matter for the authority to decide, in addition to those characteristics included in the UPOV Test Guidelines or national guidelines, which other characteristics it may include in its consideration of distinctness, which must also be considered for uniformity and stability.]^a

1.3 This document explains how the variation in the expression of relevant characteristics within varieties is used as the basis for the assessment of uniformity, and provides an overview of the two main approaches to the assessment of uniformity; namely off-types and standard deviations. Details on some of the techniques used in those approaches are provided in TGP/8 “Trial Design and Techniques Used in the Examination of Distinctness, Uniformity and Stability” (document TGP/8) [cross ref.]^b and cross references are made in the appropriate sections of this document.

SECTION 2: VARIATION IN THE EXPRESSION OF CHARACTERISTICS WITHIN VARIETIES

2.1 Introduction

The variation in the expression of relevant characteristics within varieties is the basis for the assessment of uniformity. This variation ~~is always present to some extent and~~^c has both genetic components and environmental components (e.g. temperature, light, soil etc.). The level of variation due to the environment depends on the interaction between individual plants and the environment and is influenced by the type of expression of the characteristic. The genetic component is mainly influenced by the features of propagation.

2.2 Type of expression of the characteristic

For quantitative and pseudo-qualitative characteristics, the level of variation due to the environment can differ from species to species and from characteristic to characteristic. As a general rule, the states of expression of qualitative characteristics are not influenced by the environment.^d

2.3 Features of propagation of the variety

2.3.1 With regard to genetic variation and the particular features of propagation of a variety:

(a) ~~within vegetatively propagated (e.g. apricot, avocado) and truly self-pollinated (e.g. rice, soybean, wheat) varieties~~, a low level of genetic variation is expected. Variation in the expression of characteristics within such varieties should result, predominantly, from environmental influences;^e

(b) ~~within mainly self-pollinated varieties~~, a low level of genetic variation caused by some cross pollination is accepted ~~(e.g. cotton, triticale)~~, but variation in the expression of characteristics within such varieties should result, predominantly, from environmental influences. More variation may be tolerated within mainly self-pollinated varieties than for vegetatively propagated and truly self-pollinated varieties;^e

(c) ~~within cross-pollinated varieties (including synthetic varieties)~~, a higher genetic variation is expected than for vegetatively propagated and self-pollinated varieties. Variation in the expression of characteristics within such varieties results from both genetic and environmental components. The overall level of variation is, therefore, generally higher within cross-pollinated and synthetic varieties than for self-pollinated and vegetatively propagated varieties;^e

(d) genetic variation ~~within~~ hybrid varieties depends on the type of hybrid (single- or multiple-cross), the level of genetic variation in the parental lines (inbred lines or others) and the system for hybrid seed production (mechanical emasculation, system of male sterility etc.). The tolerance limits for uniformity of hybrid varieties are set according to the specific situation resulting from genetic and environmental influences on the variation in the expression of characteristics.

2.3.2 As noted in Section 1 [*cross ref.*], the UPOV Convention requires consideration of the uniformity of a variety on the basis of "... the variation that may be expected from the

particular features of its propagation, ...”. Thus, the General Introduction, Chapter 6.4, explains “Where all the plants of a variety are very similar, and in particular for vegetatively propagated and self-pollinated varieties, it is possible to assess uniformity by the number of obviously different plants – “off-types” – that occur. However, where the level¹ of variation within a variety is greater, because of the features of its propagation, and in particular for cross-pollinated, including synthetic, varieties, the plants are not all very similar and it is not possible to visualize which plants should be considered as atypical or “off-types.” In this case the uniformity can be assessed by considering the level¹ of variation, observed across all the individual plants, to determine whether it is similar to comparable varieties”.

2.3.3 The assessment of uniformity by the off-type approach and by consideration of the level¹ of variation (“standard deviations approach”) is set out in Sections 4 and 5, respectively.

2.4 Segregating characteristics

2.4.1 The General Introduction, Chapter 6.4.3.4.1, explains that “For other than single-cross hybrids (e.g. three-way crosses or double crosses), a segregation of certain characteristics is acceptable if it is compatible with the method of propagation of the variety. Therefore, if the heredity of a clear-cut segregating characteristic is known, it is required to behave in the predicted manner. If the heredity of the characteristic is not known, it is treated in the same way as other characteristics in cross-pollinated varieties, i.e. relative tolerance limits, for the level¹ of variation, are set by comparison with comparable varieties, or types, already known [...]”.

2.4.2 In addition to the examples provided in the General Introduction for “other than single-cross hybrids” (three-way cross and double cross hybrids), in some cases, a segregation of certain characteristics is acceptable for synthetic varieties and for male sterile varieties maintained by near-isogenic maintainer lines (e.g. segregation of characteristics linked to male sterility), if it is compatible with the method of propagation of the variety.^f

2.4.3 Thus, for hybrids other than single-cross hybrids, for synthetic varieties and, in some cases, for varieties maintained by near-isogenic maintainer lines, a segregation for certain characteristics, in particular for qualitative characteristics, is acceptable if it is compatible with the expression of the parental lines and the method of propagating the variety.^f If the inheritance of a segregating characteristic is known, the variety is considered to be uniform if the characteristic behaves in the predicted manner. This can be determined by using a statistical method, such as one based on the χ^2 test (see document TGP/8)^g [cross ref.].

2.4.4 If the inheritance of a clear-cut segregating characteristic is not known, the observed segregation ratio should be described.

2.4.5 In quantitative characteristics, segregation in multiple-cross hybrids and synthetic varieties may result in a continuous variation. In such cases, uniformity is assessed as in cross-pollinated varieties, on the basis of standard deviations.

¹ The term “level of variation” is considered to be more appropriate than the term “range of variation”, which has been used in the General Introduction (see, for example, Chapter 6.4).

2.5 Summary

2.5.1 The type of variation in the expression of a characteristic within a variety determines how that characteristic is used to determine uniformity in the crop. In cases where it is possible to “visualize” off-types, the off-type approach is recommended for the assessment of uniformity. In other cases, the standard deviations approach is used. Thus, the uniformity of a variety may be determined by off-types alone, by standard deviations alone, or by off-types for some characteristics and by standard deviations for other characteristics. Those situations are considered further in Section 6.^h

2.5.2 The following table summarizes the common approaches for the assessment of uniformity, taking into account the method of propagation, type of expression of the characteristic and the method of observation. The most common approaches are listed first.

Method of propagation of the variety	Type of expression of characteristic		
	Qualitative (QL)	Pseudo-Qualitative (PQ)	Quantitative (QN)
Vegetatively propagated	<i>Off-types</i>	<i>Off-types</i>	<i>Off-types (visual observation)</i> <i>Standard Deviations (measurement)</i>
Self-pollinated	<i>Off-types</i>	<i>Off-types</i>	<i>Off-types (visual observation)</i> <i>Standard Deviations (measurement)</i>
Cross-pollinated	<i>Off-types</i>	<i>Off-types</i>	<i>Standard Deviations</i>
Single-cross hybrid (in-bred parent lines)	<i>Off-types</i>	<i>Off-types</i>	<i>Off-types (visual observation)</i> <i>Standard Deviations (measurement)</i>
Other hybrids	*	*	*

* To be considered according to the type of hybrid.

SECTION 3: METHOD OF OBSERVATION OF CHARACTERISTICS

3.1 Off-type approach

As with the observation of characteristics for distinctness (see document TGP/9 “Examining Distinctness” (document TGP/9), Section 4.2 [*cross ref.*]), qualitative and pseudo-qualitative characteristics are, in general, observed visually and off-types are determined by visual assessment. For vegetatively propagated and self-pollinated varieties there is very little variation within varieties and, as with the observation of characteristics for distinctness for such varieties, quantitative characteristics are commonly observed visually, with off-types being determined by visual assessment. In some cases, measurements may be taken from individual plants in order to assess off-types for quantitative characteristics. The use of visual observation and measurements for determining off-types is considered in Section 4 [*cross ref.*].

3.2 Standard deviations approach

3.2.1 As with the observation of characteristics for distinctness (see document TGP/9, Section 4.2 [*cross ref.*]), qualitative and pseudo-qualitative characteristics are, in general, observed visually.

3.2.2 In the case of the standard deviations approach, the choice of visual observation or measurements for quantitative characteristics, may take into account the following factors:

(a) visual observations are generally quicker and cheaper than measurements but, because they are based on the expert’s judgement, they have a particularly important requirement for training and experience to ensure that observations by a DUS examiner for a characteristic are consistent and that repeatability between observers can be achieved; visual observations are appropriate if the resultant data fulfill the conditions for calculation of the^h mean and standard deviation:

(b) measurements may be required in order to provide the appropriate precision for the assessment of variation

SECTION 4: UNIFORMITY ASSESSMENT ON THE BASIS OF OFF-TYPES

4.1 Introduction

The General Introduction, Chapter 6.4, states that “Where all the plants of a variety are very similar, and in particular for vegetatively propagated and self-pollinated varieties, it is possible to assess uniformity by the number of obviously different plants – “off-types” – that occur”. This section considers the use of the off-type approach. In general, off-types are observed visually, although this section also considers the reference in the General Introduction to¹ the possibility of off-types being determined on the basis of measurements.

4.2 Determination of Off-types by visual assessment

4.2.1 Introduction

The General Introduction states the following with respect to the observation of characteristics for uniformity using the off-type procedure:

“6.4.1.1 Determination of Off-Types by Visual Assessment

A plant is to be considered an off-type if it can be clearly distinguished from the variety in the expression of any characteristic of the whole or part of the plant that is used in the testing of distinctness, taking into consideration the particular features of its propagation. This definition makes it clear that, in the assessment of uniformity, the standard for distinctness between off-types and a candidate variety is the same as for distinctness between a candidate variety and other varieties (see [General Introduction]¹ Chapter 5, section 5.5.2).”

Thus, the following aspects are relevant for determining off-types:

- (a) the standard for distinctness between a candidate variety and any other variety, taking into consideration the particular features of its propagation; and
- (b) the expression of any characteristic of the whole or part of the plant used in the testing of distinctness;

4.2.2 Guidance for determining Off-types

4.2.2.1 The same principles used for the determination of distinctness between varieties should be applied to the determination of individual off-type plants within a variety for the assessment of uniformity. Thus, in order to identify any plant as an off-type plant, that plant should be clearly distinguishable from the plants which form the variety, taking into consideration the particular features of its propagation.

4.2.2.2 The guidance in this document is intended to identify factors to be taken into account for the determination of off-types in order that there can be a harmonized approach. This guidance demonstrates the need for the DUS examiner to have a good level of experience within the genus or species concerned, or within a similar genus or species.

4.2.2.3 In cases where it is evident that the atypical expression of a plant has a genetic basis and where the plant is clearly distinguishable from the plants which form the variety, taking into consideration the particular features of its propagation, it can be considered to be an off-type.

4.2.2.4 A difference in the expression of a characteristic may occur on one part of the plant, but not consistently throughout the plant. The genetic causes of such atypical expression include mutations, chimeras and transposons. It may be observed that one part of the plant might be atypical: for example, a single green shoot where all the other shoots are red, a single green shoot in a variegated variety, a part of the plant with spotting or flecking. The DUS examiner must decide in such cases whether, for example, a plant with one green shoot is an off-type. In that respect, atypical expression in a relevant characteristic caused by genetic factors, such as mutation, on any part of the plant are very likely to lead to the whole plant being considered an off-type. However, in some cases, the presence or absence alone of atypical expression for a characteristic may not be sufficient and the frequency and proportion of the atypical expression may also need to be considered (e.g. a single fruit with atypical expression in a relevant characteristic caused by genetic factors in a tree, may not result in an off-type plant).^k

~~4.2.2.5 An off type plant could be indicated by the nature, type and frequency of the variation in expression. Thus, in some cases, the simple presence or absence of atypical expression of a characteristic may be enough to indicate whether a plant is an off type. In other cases, the presence or absence alone of atypical expression of a characteristic may not be sufficient and the frequency of the atypical expression may also require consideration. For example, if there were only one plant with a green shoot in a variegated variety, then that plant might be considered to be an off type. However, if all plants had at least one green shoot, then that may be considered to be the typical expression of the variety. The situation becomes more difficult when, for example, most of the plants have a few green shoots, but some do not. [A second example can be seen in apple fruit coloration and patterning. The fruit color, color intensity, amount of overcolor and pattern of overcolor can have atypical expression present, but it is the frequency of the variation which requires consideration.] All plants of the variety in the trial must be able to be described in the same way according to the UPOV Test Guidelines. If this is not possible then the plants in the trial do not form a uniform variety.~~^l

4.2.3 Investigating plants with atypical expression

4.2.3.1 In cases of doubt with regard to whether a plant is an off-type, in particular where the DUS examiner has limited experience with the genus or species, an important first step is to consult other DUS examiners and the breeder. Consultation with ~~other DUS examiners,~~^e panels of experts, botanists, botanical gardens, plant collectors etc. may also be helpful.

4.2.3.2 It is important to mark the plant or plant part which is atypical, so that the development of the plant/plant part can be observed over time. It can also be helpful to photograph the plant/plant part at suitable times, in particular where the expression is likely to have a short duration, e.g. characteristics concerning the flower.

4.2.3.3^m In cases where there is still uncertainty at the end of a growing cycle about whether or not a plant is an off-type, in particular concerning the genetic basis or otherwise of atypical expression, the variety could be observed in a further growing cycle. [This can be carried out on the existing material for a second cycle, or on new material ~~and is not specifically intended as a test for stability.~~ⁿ Depending on the features of propagation of the variety, a further growing cycle may allow the atypical plant or part of the plant to be propagated and compared with typical plants of the variety. Depending on the circumstances, a new batch of typical plants might be requested from the breeder and/or a new generation of plants might be

obtained from propagation of typical plants in the DUS trial. Depending on the circumstances, new plants or plant material may be requested from the breeder and/or plants may be propagated from existing DUS trial material.⁹ That would also allow measures to be taken concerning the phytosanitary status of the material, if that was considered to be a possible cause of the atypical expression. In cases where a new batch of plants is requested, a sample of the original material should be retained, where possible, to check the conformity of the new material with the original material.⁹

4.3 Determination of Off-types using measurements

4.3.1 The General Introduction states the following:

“6.4.1.2 Determination of Off-Types Using Measurements

Most characteristics of self-pollinated and vegetatively propagated varieties are observed visually, or by making a single measurement in a group of plants. However, where appropriate, methods of handling measurements from individual plants, in order to assess off-types in truly or mainly self-pollinated varieties and vegetatively propagated varieties, are set out in document TGP/10, “Examining Uniformity”.

4.3.2^P Notwithstanding Chapter 6.4.1.2 of the General Introduction, it has not been considered appropriate to consider methods of handling measurements from individual plants in order to assess off-types in truly or mainly self-pollinated varieties and vegetatively propagated varieties.

4.4 Acceptable number of Off-types

4.4.1 Self-pollinated, vegetatively propagated and single-cross hybrid varieties^q

4.4.1.1 The General Introduction, Chapter 6.4.1.3, explains that “The acceptable number of off-types tolerated in samples of various sizes is often based on a fixed “population standard” and “acceptance probability”. The “population standard” can be expressed as the maximum percentage of off-types to be accepted if all individuals of the variety could be examined. ~~The probability of correctly accepting as uniform a variety with the population standard of offtypes is called the “acceptance probability”.~~ The “acceptance probability” is the minimum probability of accepting as uniform a variety with the population standard of off-types.^{2 r}

4.4.1.2 As explained in Section 2 [*cross ref.*], the off-type approach is the common method of assessing uniformity in self-pollinated and vegetatively propagated varieties. However, the General Introduction, Chapter 6.4.1.3.2, explains that “For the purpose of DUS testing, mainly self-pollinated varieties are those that are not fully self-pollinated but are treated as self-pollinated for testing. For these, as well as for inbred lines of hybrid varieties, a higher tolerance of off-types can be accepted, compared to truly self-pollinated and vegetatively propagated varieties [...]”. Nevertheless, where appropriate, the same tolerance may be used.

² This explanation of the term “acceptance probability” is considered to be more appropriate than the explanation for “acceptance probability” which has been used in the General Introduction (see, for example, Chapter 6.4.1.3).

4.4.1.3 An additional tolerance of off-types can be accepted for clear cases of out-crossed plants in inbred lines as well as plants obviously resulting from the selfing of a parent line in single-cross hybrids.

4.4.1.4 The UPOV Test Guidelines recommend for a particular type(s) of variety a general, i.e. “fixed”, population standard and acceptance probability and provide the maximum acceptable number of off-types for an appropriate sample size. The population standard and acceptance probability, together with an appropriate sample size, are selected on the basis of experience, in particular with reference to other UPOV Test Guidelines for comparable types of variety.^s

4.4.1.5 In the absence of UPOV Test Guidelines, an appropriate population standard and acceptance probability, together with the maximum acceptable number of off-types for an appropriate sample size, are selected on the basis of experience, in particular with reference to UPOV Test Guidelines for comparable types of variety.

4.4.1.6 Larger ~~plant numbers~~ sample sizes may be appropriate for the assessment of varieties which are more likely to contain off-types (e.g. varieties resulting from mutation, containing transposons, variegated varieties etc.), in order to allow a suitable assessment of uniformity. ~~potential off types. Some UPOV Test Guidelines for vegetatively propagated varieties recommend a population standard of 1% and an acceptance probability of at least 95%, with 1 off type plant permitted for a sample size of between 6-35 plants. A larger sample size could be selected from within the same range for the same number of off types. This provides the benefits of a larger sample without increasing the number of permitted off types and, thereby, increasing the risk of accepting a non uniform variety. Small plant numbers which do not allow any off types have the risk that the occurrence of any chance mutation may cause the rejection of the variety.~~^c

4.4.1.7 Detailed guidance on the use of the off-type approach, including tables of maximum acceptable numbers of off-types for given sample sizes corresponding to fixed population standards and acceptance probabilities, is provided in document TGP/8 [cross ref.].^l

4.4.2 Cross-pollinated varieties

In some cases of cross-pollinated varieties, in particular for qualitative and pseudo-qualitative characteristics, the great majority of individuals of a variety may have very similar expression, such that plants with a clearly different expression can be detected as off-types (e.g. root color in fodder beet, root color in fodder radish). In such cases the off-type procedure is appropriate. The number of off-types of a candidate variety should not significantly exceed the number found in comparable varieties already known. Thus, the population standard should reflect the ~~number of off types~~ level of uniformity^c found in comparable varieties.

4.5 **Setting standards for new types and species**

4.5.1 As explained in Section 4.4.1.5 [cross ref.], in the absence of UPOV Test Guidelines, an appropriate population standard and acceptance probability, together with the maximum acceptable number of off-types for an appropriate sample size, are selected on the basis of experience, in particular with reference to UPOV Test Guidelines for comparable types of variety. Comparable types of variety may relate to varieties of a species belonging to the same genus, or may relate to varieties of a different genus. In that respect, it should be

recalled that the uniformity requirement is based on the features of propagation of the variety and, therefore, comparable varieties should be those which have the most similar features of propagation (see Section 2.3 [*cross ref.*]). In particular, varieties of the same genus or species which have different features of propagation (e.g. vegetatively propagated varieties and cross-pollinated varieties) need to be considered separately with regard to uniformity standards. In the case of interspecific and intergeneric hybrids, the “parent” species and genera should, in particular, be considered with regard to comparable varieties. The breeder is likely to be an important source of information concerning the features of propagation of the variety and can provide information in the Technical Questionnaire or by other means concerning the breeding method used. (see also document TGP/13 “Guidance for New Types and Species”).

4.5.2 ~~[Setting the uniformity standard too low could have the consequence of protecting a variety with a large variation in the expression of its characteristics, thereby making it more difficult to establish distinctness for subsequent candidate varieties of that new species or type.]^u~~ – Setting the uniformity standard too high could lead to the rejection of a variety which, because of its features of propagation, could not be expected to meet that standard.

4.6 Plants which are not considered as Off-types

4.6.1 Atypical plants which are not considered to be Off-types

4.6.1.1 It is important to differentiate between genetic causes of atypical expression in plants or parts of plants, such as mutation and cross-pollination, and external factors such as environment, disease and cultural practice. Where the atypical expression of a plant or a part of the plant does not have a genetic basis, the plant should not be considered to be an off-type. Examples of external factors which may cause atypical expression include:

- (a) positional effects:
 - exposure to different levels of light or temperature (e.g. due to different positions in the plot) can produce different colors, different levels of anthocyanin, or different levels of variegation;
 - variations in fertility, pH or moisture across the plot or, in the case of pot-grown plants, between pots;
- (b) infection by disease;
- (c) pest infestation;
- (d)^v physical damage (e.g. due to environmental conditions (sun, wind, precipitation, frost), chemical application (e.g. herbicide scorch) etc.);
- (e)^v lack of pollination; (e.g. in strawberry, poor and uneven pollination can result in misshapen fruit);
- (f) graft incompatibility (e.g. Graft incompatibility in *Gymnocalycium mihanovichii* (Chin Cactus) can change the color of the scion); and
- (g) ~~propagation effects conditions or treatments experienced by plant material prior to supply for testing, e.g. quarantine requirements, in vitro propagation propagation effects; (e.g. positional effects according to the part of the mother plant from which the material is taken)^{w, e}.~~

4.6.1.2 The General Introduction, Chapter 6.5, explains that “The test material may contain plants that are very atypical or unrelated to those of the variety. These are not necessarily

treated as off-types, or part of the variety, and may be disregarded, and the test may be continued, as long as the removal of these very atypical or unrelated plants does not result in an insufficient number of suitable plants for the examination, or make the examination impractical. In choosing the term ‘may be disregarded,’ UPOV makes it clear that it will depend on the judgment of the crop expert. In practice, in tests conducted with a small number of plants, just one single plant could interfere with the test, and therefore should not be disregarded.”. For example, a plant that does not belong to the species of the candidate variety may be considered not to be an off-type and might be disregarded. In cases where the atypical plants are of the same species as the candidate variety it is more difficult to decide that the plants are very atypical or unrelated.

4.6.2 Within-plant variation which does not indicate an Off-type plant

4.6.2.1 It is important to recognize that variation within a plant may not be an indication of a lack of uniformity, particularly if the within-plant variation is consistent between plants. Within-plant variation can be caused by an external influence (e.g. light levels of the inner and outer plant) or can be genetically based. For example, in a zonal Pelargonium variety there may be variation in the number of white stripes on red florets. Within each plant there may be some flowers with almost no white stripes, some flowers with approximately half the surface area white and half red, and some flowers that have more white than red. Although the flowers in each plant do not have an identical color pattern, if the variation in striping is consistent in all plants, then the variety can be considered uniform. In the case of Regal Pelargonium, if non-fully purple petals are present on all plants at the same frequency, then this does not indicate a lack of uniformity. However, plants which have a significantly different frequency of non-fully purple petals may be off-types. ~~A second example can be seen in apple fruit coloration and patterning. The fruit color, color intensity, amount of overcolor and pattern of overcolor can have atypical expression present, but it is the frequency of the variation which requires consideration.~~^{x,y}

4.6.2.2 When assessing whole-plant characteristics, the expert should be careful not to focus on the individual plant parts. An example could be a variety with a prostrate growth habit, but where some of the shoots are erect in similar frequency on all plants. The shoots which are erect would not be considered as an indication of an off-type plant, provided the different expression did not have a genetic basis, for example as a result of a somaclonal mutation within the plant.

4.6.3 Further investigation

Determining whether an atypical plant or within-plant variation should be considered to constitute an off-type plant may require further investigation (see Section 4.2.3 [cross ref.]).

SECTION 5: UNIFORMITY ASSESSMENT ON THE BASIS OF STANDARD DEVIATIONS

5.1 Introduction

The General Introduction, Chapter 6.4, explains that, in cases where there is a high level¹ of variation in the expressions of characteristics for the plants within a variety, it is not possible to visualize which plants should be considered as off-types and the off-type approach for the assessment of uniformity is not appropriate. It clarifies that in such cases, uniformity can be assessed by considering the overall level¹ of variation, observed across all the individual plants, to determine whether it is similar to comparable varieties. In this approach, relative tolerance limits for the level¹ of variation are set by comparison with comparable varieties, or types, already known (“standard deviations approach”). The standard deviations approach means that a candidate variety should not be significantly less uniform than the comparable varieties.

5.2 Determining the acceptable level of variation

5.2.1 The comparison between a candidate variety and comparable varieties is carried out on the basis of standard deviations, calculated from individual plant observations. Comparable² varieties are varieties of the same type within the same or a closely related species that have been previously examined and considered to be sufficiently uniform.

5.2.2 UPOV has proposed several statistical methods for dealing with uniformity in measured quantitative characteristics. One method, which takes into account variation between years, is the Combined Over Years Uniformity (COYU) method. The comparison between a candidate variety and comparable varieties is carried out on the basis of standard deviations, calculated from individual plant observations. ~~This COYU procedure calculates a tolerance limit on the basis of comparable varieties and uniformity is assessed using a relative tolerance limit based on varieties within the same trial with comparable expression of characteristics~~ This COYU procedure calculates a tolerance limit for each characteristic on the basis of varieties within the same trial with comparable expression for that characteristic.^{aa}

5.2.3 Details of the COYU method are provided in document TGP/8 [cross ref.].

5.2.4 Information on other appropriate statistical methods ~~(e.g. 1.26 x standard deviations, 1.6 x variance, long term LSD)~~^{bb} is provided in document TGP/8 [cross ref.].

5.3 Setting standards for new types and species

As explained in Section 5.1 [cross ref.], in cases where the off-type approach is not appropriate, relative tolerance limits for the level¹ of variation are set by comparison with comparable varieties, or types, already known (“standard deviations approach”). The standard deviations approach means that a candidate variety should not be significantly less uniform than the comparable varieties. Comparable varieties may relate to varieties of a species belonging to the same genus, or may relate to varieties of a different ~~[, but closely related,]~~^{cc} genus. In that respect, it should be recalled that the uniformity requirement is based on the features of propagation of the variety and, therefore, comparable varieties should be those which have the most similar features of propagation (see Section 2.3 [cross ref.]). In particular, varieties of the same genus or species which have different features of propagation (e.g. vegetatively propagated varieties and cross-pollinated varieties) need to be considered

separately with regard to uniformity standards. In the case of interspecific and intergeneric hybrids, the “parent” species and genera should, in particular, be considered with regard to comparable varieties. The breeder is likely to be an important source of information concerning the features of propagation of the variety and can provide information in the Technical Questionnaire or by other means concerning the breeding method used (see also document TGP/13).

SECTION 6: COMBINING ALL OBSERVATIONS ON A VARIETY^{dd}**6.1 Introduction^e**

The uniformity of a variety is assessed by the observation of individual plants for all relevant characteristics. In some crops, all of those characteristics are observed on all plants in the test. In other crops, some of those characteristics are observed on different samples of the variety. Furthermore, for some crops the assessment of uniformity may be on the basis of off-types for certain relevant characteristics and on the basis of standard deviations for other relevant characteristics. Therefore, specific guidance for the assessment of uniformity based on the observation of all the relevant characteristics need to be defined. Some of the possible situations are described below:

6.2 Off-types only: all characteristics observed on the same sample

An off-type plant may be obviously different from the variety on the basis of one or several characteristics, but it will only be counted as one off-type plant, irrespective of the number of characteristics for which it has an obviously different expression. In cases where the assessment of uniformity is on the basis of off-types for all characteristics, and is by visual observation of all plants in the test, off-type plants can be marked as soon as an “off-type” expression is observed for at least one characteristic. It is not necessary to observe the off-type plant after that time. Additional off-type plants might be identified at a later stage of the test after the observation of further characteristics. The total number of off-types is determined after the observation of all relevant characteristics, and the uniformity of the variety is assessed by reference to the sample size and the population standard.

6.3 Off-types only: characteristics observed on different samples

In many cases, uniformity is assessed by observations on different samples of plants or parts of plants. For example, for uniformity in wheat (see UPOV Test Guidelines for Wheat: TG/3), some characteristics are observed on a sample of 2,000 plants, whilst some other characteristics are observed on a sample of 100 parts of plants taken from 100 plants. Off-type plants observed in the plot of 2,000 plants can be excluded from further observations. For the plant parts taken from 100 plants, it is not normally possible to trace back the plant part to the original plant in the plot. Therefore, the sample of 100 plant parts needs to be considered to be independent from the 2,000 plants. Another independent sample of the variety is observed for seed characteristics. In such cases, a uniformity assessment should be carried out on all the independent samples, using the appropriate population standard. A variety should be considered to be uniform if the uniformity requirements are fulfilled in all samples.

6.4 Off-types and standard deviations

In some cases, the uniformity of a variety may be determined on the basis of off-types for some characteristics and standard deviations for other characteristics. For example, in carrot (see UPOV Test Guidelines for Carrot: TG/49), many root characteristics are observed visually. Those root characteristics are visually observed on the same sample of 200 plants and off-types are determined on the basis of all the visually observed root characteristics. Certain root characteristics can be observed visually or by measurement: root length, root width and root weight. Where measurements are used for those characteristics, the UPOV Test Guidelines recommend that the measurements are based on 60 plants. In this situation,

the standard deviation approach is applied individually for each of the three measured characteristics. The sample of 60 roots will not contain any roots which have been identified as off-types by visual observation. However, because the observations on leaves is made before the observations on the roots, the sample of 60 leaves taken for the measurement of leaf length could contain leaves of plants which are off-type plants on the basis of root characteristics. A variety should be considered to be uniform if the uniformity requirements are fulfilled in all samples.

<u>Abbreviations:</u>	CAJ:	Administrative and Legal Committee
	TC:	Technical Committee
	TC-EDC:	Enlarged Editorial Committee
	TWA:	Technical Working Party for Agricultural Crops
	TWC:	Technical Working Party on Automation and Computer Programs
	TWF:	Technical Working Party for Fruit Crops
	TWO:	Technical Working Party for Ornamental Plants and Forest Trees
	TWV:	Technical Working Party for Vegetables

- ^a Wording proposed by the TWA. The TWV, TWO and TWF noted the proposed change of wording by the TWA but expressed a preference for the sentence to be deleted completely.
- ^b All instances of “[cross ref.]” will be deleted on adoption of the document.
- ^c Deletion proposed by the TWA, TWV, TWO and TWF.
- ^d The TWA, TWV, TWO and TWF agreed that the final sentence should read “As a general rule, the states of expression of qualitative characteristics are not influenced by the environment.” on the basis that document TGP/9/1 Draft 10 states that “2.3.4.2 [...] as a general rule, the states of expression of qualitative characteristics are not influenced by the environment (see General Introduction, Chapter 4.4.1) [...]”.
- ^e Edited text, proposed by the TC-EDC.
- ^f Text proposed by TWA, TWV, TWO and TWF, as modified by TC-EDC.
- ^g Amended text proposed by the TWC.
- ^h New text proposed by the TWC.
- ⁱ Additional text proposed by the TC-EDC.
- ^j The TWA, TWV, TWO and TWF proposed that (old Section 4.2) “Plants which are not considered as Off-types” should be moved to end of Section 4 (see Section 4.6).
- ^k New text proposed by the TWF.
- ^l The TWF proposed that the paragraph should be deleted after the addition of the new text for Section 4.2.2.4. (The TWA proposed to delete “[A second example can be seen in apple fruit coloration and patterning. The fruit color, color intensity, amount of overcolor and pattern of overcolor can have atypical expression present, but it is the frequency of the variation which requires consideration.]”. The TWV and TWO proposed to defer to the views of the TWF on the suitability of the sentence “[A second example can be seen in apple fruit coloration and patterning. The fruit color, color intensity, amount of overcolor and pattern of overcolor can have atypical expression present, but it is the frequency of the variation which requires consideration.]”. The TWV proposed to revise the example of a plant with a single green shoot in order to provide a more realistic example and to add that the “atypical” parts of plants concerned, if propagated, should produce plants which were true-to-type. The TWO proposed to retain the “green shoot” example, but to explain that it would be necessary for the “atypical” parts of plants concerned, if propagated, to produce plants which were true-to-type and to note that, in most cases, it was unlikely that that would be the case.)
- ^m In 2006, the TWF and TWO proposed a subdivision into two paragraphs, one dealing with growing of a further generation and another with the examination of new plant material. (Note: no change has been made because the first sentence covers the existing single paragraph).
- ⁿ The TWA and TWV proposed to delete the sentence. The TWO and TWF proposed to retain the sentence, once amended by the deletion of “and is not specifically intended as a test for stability”.
- ^o New text proposed by the TWO and TWF.
- ^p At the TC-EDC meeting on January 9, 2007, Mr. Niall Green agreed to develop a text for this section. Mr. Green has since commented that “In a measured characteristic which could not easily be observed visually, it may be possible to identify an outlier in the data. However, the technical expert would have to consider whether the outlier value could be considered to be a clear off-type; this would not always be easy. It becomes more complicated if there are several (sometimes different) outlying values. Although there are

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- statistical methods which could be used, there would not be one method that could apply to all cases. On balance it might be better not to try and define this, so I propose that the information is not included.”
- ^q Amended text proposed by the TWV, TWO and TWF.
- ^r Amended text and footnote proposed by the TWC.
- ^s The TWA, TWV, TWO and TWF agreed to retain the original text. The TWC clarified that its concern with regard to the current wording of the first sentence was that it could be interpreted as meaning an “appropriate sample size” for the “‘fixed’, population standard and acceptance probability”. However, on the basis that it would be sufficiently clear for readers of TGP/10 that the meaning was an “appropriate sample size” for a particular type(s) of variety, the TWC agreed to accept the current text of 4.4.1.4.
- ^t The TWA, TWV, TWO and TWF agreed that the text “[The sample size and maximum acceptable number of off-types must be selected with care in order to produce a good test.]” should be deleted. The TWC agreed to the deletion of the final sentence on the basis that document TGP/8 would explain the requirements for selecting the sample size and maximum acceptable number of off-types in order to produce a good test of uniformity.
- ^u The TWA proposed to add the text from TGP/13/1 Draft 9, Section 2.5.3 for consideration by the TC (shown in square brackets). The TWV and TWO noted that the setting of a “low uniformity standard” in terms of acceptable numbers of off-types would not make it any more difficult to establish distinctness for subsequent candidate varieties of a new species or type. Therefore, in its proposed form, the statement was not applicable for self pollinated, vegetatively propagated or single-cross hybrid varieties. However, it noted that it could be more difficult to establish distinctness for subsequent candidate varieties of a new species or type if an insufficient number of characteristics was considered for DUS. With regard to cross pollinated varieties, the TWV noted that the statement should be checked in relation to its applicability for COYD if it was used as the basis for examining distinctness, if that method used only the average value for a variety of each characteristic. With regard to the statement that “Setting the uniformity standard too low could have the consequence of protecting a variety with a large variation in the expression of its characteristics, thereby making it more difficult to establish distinctness for subsequent candidate varieties of that new species or type”, in relation to COYD, the TWC noted that there would need to be an investigation to establish if that statement was appropriate. It also noted that COYD might not be an appropriate tool for distinctness for new types and species where there were very few varieties. The TWF proposed not to add the text proposed by the TWA.
- ^v New text proposed by the TWV, TWF and TWO.
- ^w Amended text proposed by the TWF.
- ^x New text proposed by the TWF.
- ^y Deletion proposed by TC-EDC, on the basis that the matter is covered by Section 2.2.2.4.
- ^z The TWA, TWV, TWO and TWF proposed to retain the word “comparable”. (The TC had proposed to replace “comparable” with another term such as “comparator”, “established” etc. on the basis that “comparable” means that it *can* be compared, rather than *should* be compared. Office note: the term “comparable” means “suitable for comparison” / “similar, like” (Merriam Webster’s Collegiate Dictionary): the term “comparable” is used in Section 5.1 and in the General Introduction (see Chapter 6.4.2) with that meaning.)
- ^{aa} Amended text proposed by the TWC.
- ^{bb} The TWC proposed to delete “(e.g. 1.26 x standard deviations, 1.6 x variance, long term LSD)” on the basis that other statistical methods may be considered more appropriate at the point of adoption of TGP/8 and/or would allow a future update of statistical methods by revision of TGP/8, without the need for a revision of TGP/10.
- ^{cc} The TWV, TWO and TWF proposed to delete “[, but closely related,]”.
- ^{dd} The TWC proposed that, if possible, a more suitable title should be developed.

[End of document]