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TECHNICAL WORKING PARTY FOR FRUIT CROPS

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DISEASE RESISTANCE CHARACTERISTICS IN TEST GUIDELINES FOR FRUIT CROPS

Document prepared by an expert from the European Union

1. At its forty-first session, held in Cuernavaca, Morelos State, Mexico, from September 27 to October 1, 2010 the Technical Working Party for Fruit Crops (TWF) noted the importance of disease resistance as a breeding aim and its importance for variety registration purposes, but clarified that such factors did not directly affect the suitability of disease resistance as a DUS characteristic. With regard to examining disease resistance as a DUS characteristic, the TWF noted that it was important to recall that authorities could arrange for tests to be conducted by specialized laboratories and could also use cooperation with other UPOV members in order to address situations where the DUS testing center did not have suitable facilities for conducting the test, or was prevented from conducting such tests because of phytosanitary restrictions. It agreed that it would be useful to prepare a document setting out such issues and invited Mr. Sergio Semon (European Union) to prepare such a document. In order to advance consideration of the issue, the TWF agreed that a first draft of that document should be circulated to the TWF by correspondence by June 30, 2011, with 4 weeks for comments and that a document should be provided to the Office of the Union 6 weeks before the forty-second session of the TWF (see document TWF/41/30 Rev. "Revised Report", paragraph 53).

2. The Annex to this document considers issues related to the possible inclusion of disease resistance characteristics in Test Guidelines for fruit crops.

[Annex follows]

ANNEX

ISSUE RELATED TO THE POSSIBLE INTRODUCTION OF DISEASE RESISTANCE CHARACTERISTICS IN TEST GUIDELINES FOR FRUIT CROPS

Introduction

1. The TWF, at its forty-first session, held in Cuernavaca, Morelos State, Mexico, from September 27 to October 1, 2010, considered document TWF/41/21 "Revision of Document TGP/12: Disease Nomenclature and Disease Resistance Characteristics" and noted that breeding developments, for example with regard to Plum Pox Virus in Apricot and Apple Scab in Apple, could mean that disease resistance characteristics would become of increasing relevance for Test Guidelines for some fruit crops in the future. It was also noted that the Test Guidelines for Japanese Pear (document TG/149/2) contained a characteristic for resistance to black spot (*Alternaria kikuchiana* Tanaka) (see document TWF/41/30 Rev. "Revised Report", paragraph 52).

State of breeding for disease resistance in fruit

2. Recent advances in disease resistance breeding have been documented in particular for the following fruit species:

- Apple and Pear
  - Scab (*Venturia inaequalis*)
  - Powdery mildew (*Podosphaera leucotricha*)
  - Fireblight (*Erwinia amylovora*)

- Peach and apricot
  - Plum pox virus / sharka
  - Powdery mildew (*Podosphoera clandestina*)

3. In the case of powdery mildew resistance in peach, the determinant of whether a variety is resistant or not is based on a monogenic trait under introgression. Three-month-old potted plants are inoculated with the disease under greenhouse conditions, and the assessment of the response of the infection to this disease is carried out in the greenhouse and subsequently under orchard conditions. A DNA-fingerprinting characterization procedure is also being developed.

4. In the case of scab resistance in apple, the level of resistance is based upon an interaction between the plant host and the scab races. The resistance is increased if a QTL (quantitative trait locus) is associated with a major gene resistance.

5. In the case of plum pox virus (PPV) resistance in Apricot, this is determined on the genetic level although this characterization still needs to be perfected. In spite of the fact that molecular markers can give an indication of whether a variety is resistant or not, the phenotype still needs to be expressed in order to quantify the level of resistance. Genes from other related *Prunus* species like almond have also been introgressed into apricot in order to increase the level of resistance. Plum pox resistance in apricot is one of the host/pathogen combinations where there is the most advanced level of breeding at the moment, and there are

already cases of new apricot varieties which are being marketed as resistant to PPV, but the Community Plant Variety Office of the European Union (CPVO) does not have any instances of candidate varieties filed for Community rights which the breeder claims should be specifically tested for this disease as part of the DUS examination. There have been no claims for testing disease resistance in other fruit species within the Community rights system.

6. *Prunus* rootstock interspecifics are claimed to be resistant to some of the pests and diseases affecting them as are certain soft fruit species (e.g. low incidence of blueberry rust and anthracnose in Blueberry, tolerance of *Phytopthora* spp and *Rubus* bushy dwarf virus in raspberry), although the techniques related to these are less visible and there is not an industry push to create specifically resistant varieties, which is certainly the case for Apple, Pear, Peach and Apricot highlighted above. In Kiwifruit there is currently a lot of breeding effort being done in New Zealand and other countries to create resistance to *Pseudomonas syringae* pathovar *actinidiae* (Psa), since the industry had been severely affected in the last couple of years by the spreading infection of this pathogen.

Implications for DUS testing and Test Guidelines

7. Some disease resistant varieties in fruit already exist and it is evident that as breeding and its associated techniques (such as mutagenesis, transgenics and cisgenics) develop, there will be more and more of these which will be created. This is a natural response to a demand from growers in order that they can reduce losses in yield and make savings in chemical inputs, but also from the consumer in that the reduction of chemicals is better for the environment by creating natural resistance, thereby creating the perception of a more healthy fruit for consumption.

8. There may come a point when breeders will request that disease resistance tests form a part of the Test Guidelines for a few fruit species, since this a reflection of where breeding effort is being done. This is already a common practice in the vegetable sector, where disease resistance tests make up several characteristics in the Test Guidelines for important economically crops such as Lettuce, Tomato, French bean, Melon, Pepper, etc. Vegetable seed companies in many cases concentrate their breeding efforts on these traits, and in several instances new varieties are solely different from other varieties of common knowledge purely due to resistance to a particular disease.

9. Reasons given to delay or avoid the introduction of disease resistance tests in fruit are:

(i) For most crops there are already plenty of morphological characteristics on which distinctness can be found, so this would unnecessarily increase the workload.

(ii) The skill and expertise required to undertake disease resistance tests comes at a high cost, which is probably substantially more than any of the other characteristics in the Test Guidelines. Positive testing by inoculation under controlled conditions (as to be found in certain vegetable Test Guidelines) therefore seems the only logical approach but it is one that would incur significant additional laboratory costs. Some examination authorities are therefore unlikely to make the capital investment to set up the processes (laboratory, equipment, etc) for disease resistance testing – however, bilateral agreements could be a possibility where one testing authority subcontracts this work to another qualified.

(iii) Phytosanitary legislation may prevent the entry of inoculums of the disease within the borders of the State of the relevant examination authority – although as in (ii) above, bilateral agreements could be a viable solution (an example of this could be the testing of different strains scab in the European Union, since under EU legislation expensive facilities would be required). The effect of possible infection of neighboring plants, particularly by quarantine organisms, if not checked properly before planting the candidate variety in the DUS trial field, is an important issue to take into account.

(iv) There is no methodology existing on how disease resistance tests could be observed for fruit. Furthermore, the length of the growing period of the candidate variety needs to be taken into consideration. The disease and its symptoms would need to be clearly described, and it would have to be decided as to whether there was complete susceptibility or complete resistance for any particular disease, or whether there are also intermediate levels of resistance. Investigation would be required on pathotyping, determining the acceptable level of variation in outcomes from one test to another and between laboratories, to establish protocols for ranking symptom expression, and for the differences that might constitute distinctness when looking across the scale from absolute resistance, to some disease susceptibility, to complete susceptibility. Most disease resistances are not an absolute, but rather gradients of susceptibility. Breeders are no longer focusing on one resistance gene but are pyramiding monogenic/polygenic/quantitative resistance/tolerance genes. If disease resistance is added, then some breeders feel a number of classes should be evaluated rather than a yes/no evaluation. For example, there is currently no consensus about the effective evaluation methods for powdery mildew and fireblight. For scab, an infection with different strains can be a feasible method, although it would be challenging to evaluate the results.

(v) The creation of disease resistant fruit varieties could bring associated complications if such varieties are deemed to be mutations or essentially derived varieties. Although in principle it could stimulate breeding effort for the creation of new varieties, over time there could be a danger that the only claimed distinctness difference is based upon the disease resistance; if this then becomes the major breeding goal, then the decisions for the examiner to declare a candidate variety distinct will become harder and harder.

Conclusions

10. Disease resistance is becoming an increasingly important breeding aim, and a basic element for judging upon the value of the variety concerned. In fruit species, resistance features could be of relevance, in case no other suitable morphological characteristics would be found for examining distinctness. Although the situation in the fruit sector is not as developed for disease resistance as in the vegetables, over time there could be a shift that way. However, if taken into consideration for the DUS test, a resistance characteristic must fulfill the UPOV criteria to be included into Tests Guidelines, in the same way as conventional characteristics have to as well. These criteria are explained in detail in TGP/12/1 “Guidance on Certain Physiological Characteristics”. In this respect it is not certain that these criteria would

be fulfilled for fruit species, nor at this point in time is there a particular need to include such characteristics into fruit Test Guidelines coming up for revision or creation.

11. From information gathered from fruit breeders and researchers, they consider that for some of them disease resistance will form an important part of their future varietal creation strategy. Since the current breeding efforts for disease resistance on fruit are based on crossings and seedling selections, due to the genetic recombination this infers, it is unlikely that in the near future any claimed disease resistant variety will be solely distinct upon that characteristic (a mutant variety which is resistant seems improbable). Current candidate seedling fruit varieties are sufficiently different based on the existing list of characteristics, therefore many breeders are reluctant to add more parameters to the list of characteristics in the Test Guidelines, especially since this will most likely lead to an increase of time and money. If anything, many fruit breeders propose that the current list of characteristics in UPOV Test Guidelines be extended to include traits such as taste, texture, storability, productivity, etc. which although they can be considered as VCU characteristics, are a true reflection of the predominant selection criteria for new varieties; as long as such traits fulfill the UPOV criteria of a characteristic, they could be acceptable, and furthermore there exist effective techniques in the marketplace in order to be able to properly measure and quantify them.

12. Therefore, at the moment there is no pressing need to adopt disease resistance testing within the fruit Test Guidelines, although their possible use could be limited to exceptional situations where the applicant declares that this would be the only distinguishing characteristic from an existing variety of common knowledge; thus the claimed disease resistance could be used as an additional characteristic on a case-by-case basis, once a recognized test methodology has been described, and with any extra costs linked to test being borne by the applicant. Notwithstanding, examiners and authorities should be attentive to the market and breeding effort being made in that direction in order that disease resistance test methods can be developed in good time is there is a sudden influx of fruit varieties being applied mostly for those distinguishing characteristic.

[End of Annex and of document]