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UPOV

INTERNATIONAL UNION FOR THE PROTECTION OF NEW VARIETIES OF PLANTS

GENEVA

Associated Document
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/12

"SPECIAL CHARACTERISTICS"

Section TGP/12.1.1: Characteristics Expressed in Response to External Factors: Disease Resistance

Document prepared by experts from the Netherlands

to be considered by the

Technical Working Party for Vegetables (TWV), at its thirty-seventh session to be held in Roelofarendsveen, The Netherlands, from June 23 to 27, 2003

SECTION 12.1.1

CHARACTERISTICS EXPRESSED IN RESPONSE TO EXTERNAL FACTORS; DISEASE RESISTANCE

1. The breeding for resistance to pests and diseases is an important part of many breeding programs. In vegetables more than 50 % of the breeding effort is devoted to resistance.

2. For farmers, having to cope with strong pressure to reduce the use of crop protecting chemicals, the availability of varieties that can resist diseases without protection by chemicals is crucial.

3. The correct description of the resistance characteristics in variety descriptions, breeder's catalogues etc. is considered very important. In many cases problems and legal cases were caused by insufficient description of the resistance.

4. The decreasing input from science on the taxonomy of the diseases and of the strains of diseases around the world is compensated by the input of phytopathologists from DUS testing institutes and seed companies..

5. More and more the breeding industry joins forces to fill this gap by combining their recourses, usually under the FIS/ASSINSEL (now IFS) umbrella.

6. Disease resistance characteristics may be used as characteristics in the framework of the DUS test for Plant Breeders' Rights, provided a number of criteria are fulfilled;

(a) it must be capable of precise definition;
(b) it must produce constant and repeatable results for existing varieties;
(c) it must allow uniformity requirements to be fulfilled;
(d) it must be clearly defined in the observation and evaluation of the results;
(e) for inclusion in the Test Guidelines it must allow a clear differentiation to be made in the collection of the species concerned;
(f) it must not lead to easy plagiaristic practices.

7. In general these requirements can be fulfilled but a number of requirements pose specific problems:

8. Ad (a) it must be capable of precise definition
I. The definition of the disease itself usually does not create problems, for the proper denomination internationally accepted standards may be used such as the American Phytopathological Society (APS) for fungi and bacteria and the International Committee for Taxonomy of Viruses (ICTV).

9. Ad (a) it must be capable of precise definition
II. The definition and denomination of the races and strains per disease pose a specific, more complicated problem as almost no longer any scientific work is done on this subject. This can result in confusing situations where the same race / strain could be named differently in

Europe and the USA p.e. *Fusarium oxysporum* f.sp. *lycopersici* (Fol) in tomato where race 1 in the USA is identical to race 0 in Europe. Also different races / strains may have the same name p.e. *Fusarium oxysporum* f.sp. *lycopersici* (Fol) in tomato where race 2 in the USA is different from race 2 in Europe. At the moment a joint effort is made by FIS/ASSINSEL (now IFS) on this subject with the aim to create one clear system of definition and nomination. The core of this system is the precise definition of a set of host differential lines/varieties with which the races / strains can be determined. The seed industry is willing to cooperate by maintaining the necessary stocks of seed for this purpose.

10. In annex (I) the definition of the various terms as developed and used by FIS/ASSINSEL (now IFS) is given. In Annex (II) a list of diseases where it is known that resistance breeding has been carried out. Comments on this list are welcome on the FIS/ASSINSEL (now IFS) web site.

11. Ad (a) The cooperation with breeders also results in better knowledge on the genetic background of the various forms of disease resistance. Knowing which genes are responsible for resistance and if it concerns a single gene or a combination of genes gives valuable information that will help to properly observe and evaluate the resistance.

12. Ad (b) it must produce constant and repeatable results for existing varieties;
Repeated tests and ring tests have shown that the stability of disease resistance, provided this was established on race / strain level is very good. In fact, as disease resistance is of crucial importance for the marketing of varieties, it is a primary selection criteria for companies to check the varietal stability.

13. Ad (c) it must allow uniformity requirements to be fulfilled
Testing for disease resistance characteristics means introducing more variables in the trial; not only the development of the plants is subject to the environment, but also the quality of the inoculum, the inoculation and the interaction between symptom and development of the plant may cause variation within the trial. It has to be avoided that the heterogeneity introduced through the trial is blamed to the candidate variety.

14. Ad (d) it must be clearly defined in the observation and evaluation of the results
Following the provided explanations in the test protocols, ring tests have shown to give deviating results. These deviations were caused by variation in the climatic conditions under which the trials were carried out. Also different interpretation of the symptoms by different observers was noted. The conclusion of these trials was that only if a correct set of standards was included in the trial, the observations and evaluation of the results was harmonized. It was however observed that slight differences in the standards (between lot differences) could cause problems. The advise here is to develop a centralized set of standards per disease or per strain to avoid problems. The seed industry is willing to cooperate by maintaining the necessary stocks of seed for this purpose.

15. Ad (e) it must allow a clear differentiation to be made in the collection of the species concerned.
Disease resistance characteristics, properly tested, give per definition a clear differentiation in the variety collections. Therefore disease resistance characteristics are often used as grouping characteristics. The differentiation usually may take place even on race / strain level as many collections of varieties are known to show different resistance reactions to different races / strains of the disease. Also on race / strain level grouping may be done, provided the races / strains are properly identified. A specific problem are those diseases or race / strains of

diseases, where the difference between susceptible and resistant is not discontinuous, but in fact a scale of resistance can be observed ranging from absent to very weak to very strong. In the practice of the guidelines diseases that show this phenomenon are usually treated as discontinuous by defining a threshold dividing susceptible from resistant. This practice will have to be replaced by a more precise description of the different levels of uniformity. These levels have to be defined precisely and standards will have to be included in the tests to enable the differentiation between the different levels.

16. Ad (f) it must not lead to easy plagiaristic practices.
The breeding effort necessary to cross resistance in a susceptible variety is usually a complicated and time consuming job.

17. As additional points for consideration the following has to be taken into account:
(g) the availability of reliable inoculum and host differential set
(h) quarantine regulations
(i) the costs involved in disease resistance testing

18. Ad (g) the availability of reliable inoculum
In general a few institutes are still maintaining stocks of inoculum of most of the diseases that are used in breeding programs. In the explanation of the methods in the guidelines, the available information on these sources will have to be indicated. If inoculum from another source is used, a defined host differential set will have to be used to clearly identify the inoculum.

19. Ad (h) quarantine regulations
With a world wide organization as UPOV it is unavoidable that diseases that are of importance in a certain area, are unknown to cause problems in another part of the world and are there considered as quarantine diseases. Usually this means that the import of inoculum and the test itself is not possible. A good way to solve this kind of problems is to contact a DUS test authority elsewhere and ask them to carry out the test.

20. Ad (i) The costs and technical requirements of disease tests are for some DUS testing authorities impassable barriers to carry out these tests. Two options may be considered to overcome these problems:

- Another DUS testing authority may be asked to perform the necessary disease test(s).

- The applicant / breeder may be requested to carry out a blind disease test with coded samples including the candidate variety and a number of also coded control samples as susceptible and resistant controls on the basis of a clear control.

21. In order to take into account the given points of consideration, the explanation of the disease resistance characteristics, included in the guidelines have to be extended with the necessary information on
- the address(es) where inoculum may be obtained,
- the host differential set of varieties / lines to use to check the inoculum on correctness regarding the races / strains used,
- the address(es) where the differential set may be obtained
- the race / strain specific standard varieties to be included in the test
- the address(es) where the set of standard varieties may be obtained

Annex (I) Terminology in disease resistance

RESISTANCE:

Ability of a cultivar **to limit the development** of a given pest or pathogen through the whole or a part of a growing cycle.
Several resistance levels may generally be defined.

TOLERANCE:

Ability of a cultivar **to tolerate the development** of a given pest or pathogen whilst displaying disorders that are without serious consequences for its growth, appearance and yield.

Annex (II) Disease resistances in vegetable crops

Adopted by the Working Group Established by the ISF Vegetable and Ornamental Section [1]

Table of Contents

For easy reference, amendments and additions to the previous version of the Recommended Codes (version 2.1) are highlighted in yellow

[1] In case of comments, please contact the ISF secretariat at isf@worldseed.org

***Alliums* (Leek and Onion)**

Scientific name	English common name	Local common name	Code
Viruses:			
Leek Yellow Stripe Virus	Leek yellow stripe		LYSV
Fungi:			
Alternaria porri	Purple blotch		Ap
Botrytis allii (ex *Botrytis aclada)*	Botrytis neck rot		Ba
Botrytis squamosa	Botrytis leaf blight		Bs
Fusarium oxysporum f.sp. *cepae*	Basal rot		Foc
Peronospora destructor	Downy mildew		Pd
Puccinia porri	Rust		Pp
Pyrenochaeta terrestris	Pink root		Pt
Sclerotium cepivorum	White rot		Sc

Beans (Dwarf French Bean and Climbing French Bean)

Scientific name	English common name	Local common name	Code
Viruses:			
Bean Common Mosaic Virus	Bean common mosaic		BCMV
Bean Common Necrotic Mosaic Virus	Bean common necrotic mosaic		BCNMV
Bean Golden Mosaic Virus	Bean golden mosaic		BGMV
Bean Yellow Mosaic Virus	Bean yellow mosaic		BYMV
Beet Curly Top Virus	Beet curly top		BCTV
Bacteria:			
Pseudomonas savastanoi pv. *Phaseolicola* (ex *Pseudomonas syringae* pv. *phaseolicola)*	Halo blight		Psp
Pseudomonas syringae pv. *Syringae*	Bacterial brown spot		Pss
Xanthomonas axonopodis pv. *Phaseoli* (ex *Xanthomonas campestris* pv. *phaseoli)*	Common or fuscous blight		Xap
Fungi:			
Aphanomyces euteiches	Root rot		Ae
Colletotrichum lindemuthianum	Anthracnose		Cl
Uromyces appendiculatus	Rust		Ua

Bottle Gourd

Scientific name	English common name	Local common name	Code
Fungi:			
Fusarium oxysporum f.sp. *lagenariae*	Fusarium wilt		Fol
Fusarium oxysporum f.sp. *niveum*	Fusarium wilt		Fon

***Brassicas* (Cabbage, Broccoli, Cauliflower, Chinese Cabbage…)**

Scientific name	English common name	Local common name	Code
Viruses:			
Cauliflower Mosaic Virus	Cauliflower mosaic		CaMV
Turnip Mosaic Virus	Turnip mosaic		TuMV
Bacteria:			
Pseudomonas syringae pv. *Maculicola*	Peppery leaf spot		Psm
Xanthomonas campestris pv. *Campestris*	Black rot		Xcc
Fungi:			
Albugo candida	White rust		Ac
Albugo macrospora	White rust		Am
Alternaria brassicae	Black leaf spot		Abe
Alternaria brassicicola	Black leaf spot		Aba
Erysiphe cruciferarum	Powdery mildew		Ec
Fusarium oxysporum f.sp. *conglutinans*	Yellows		Foc
Mycosphaerella brassicicola	Ring spot		Mb
Peronospora parasitica	Downy mildew		Pp
Phoma lingam	Black leg		Pl
Plasmodiophora brassicae	Clubroot		Pb
Verticillium albo-atrum	Verticillium wilt		Va
Verticillium dahliae	Verticillium wilt		Vd
Verticillium longisporum	Verticillium wilt		Vl
Insects:			
Plutella xylostella	Diamond back moth		Px
Trips tabaci	Thrips		Tt

Carrot

Scientific name	English common name	Local common name	Code
Fungi:			
Alternaria dauci	Late leaf blight		Ad
Alternaria radicina	Black rot		Ar
Cercospora carotae	Early leaf blight		Cc
Erysiphe heraclei	Powdery mildew		Eh
Pythium sulcatum	Cavity spot		Ps
Pythium ultimum	Cavity spot		Pu
Pythium violae	Cavity spot		Pv
Insects:			
Psila rosae	Carrot fly		Pr
Nematodes:			
Meloidogyne incognita	Root-knot		Mi
Meloidogyne javanica	Root-knot		Mj

Celery and Celeriac

Scientific name	English common name	Local common name	Code
Viruses:			
Celery Mosaic Virus	Celery mosaic		CeMV
Fungi:			
Fusarium oxysporum f.sp. *apii*	Fusarium yellows and wilt		Foa
Septoria apiicola	Late blight		Sa

Corn Salad

Scientific name	English common name	Local common name	Code
Fungi:			
Perenospora valerianella	Downy mildew		Pv

Cucumber and Pickling Cucumber

Scientific name	English common name	Local common name	Code
Viruses:			
Cucumber Mosaic Virus	Cucumber mosaic		CMV
Cucumber Vein Yellowing Virus	Cucumber vein yellowing		CVYV
Cucumber Yellowing Stunting Disorder Virus	Cucumber yellowing		CYSDV
Papaya Ringspot Virus	Papaya ringspot		PRSV
Watermelon Mosaic Virus	Watermelon mosaic		WMV
Zucchini Yellow Mosaic Virus	Zucchini yellows		ZYMV
Bacteria:			
Pseudomonas syringae pv. *Lachrymans*	Angular leaf spot		Psl
Fungi:			
Cladosporium cucumerinum	Scab and gummosis		Ccu
Colletotrichum orbiculare (= *Colletotrichum lagenarium*)	Anthracnose		Co
Corynespora cassiicola	Corynespora blight and target spot		Cca
Erysiphe cichoracearum	Powdery mildew		Ec
Fusarium oxysporum f.sp. *cucumerinum*	Fusarium wilt		Foc
Pseudoperonospora cubensis	Downy mildew		Pc
Sphaerotheca fuliginea	Powdery mildew		Sf

***Cucurbita spp.* (Squash, Pumpkin and Zucchini)**

Scientific name	English common name	Local common name	Code
Viruses:			
Cucumber Mosaic Virus	Cucumber mosaic		CMV
Papaya Ringspot Virus	Papaya ringspot		PRSV
Watermelon Mosaic Virus	Watermelon mosaic		WMV
Zucchini Yellow Mosaic Virus	Zucchini yellows		ZYMV
Fungi:			
Erysiphe cichoracearum	Powdery mildew		Ec
Fusarium oxysporum f.sp. *cucumerinum*	Fusarium wilt		Foc
Fusarium oxysporum f.sp. *melonis*	Fusarium wilt		Fom
Fusarium oxysporum f.sp. *niveum*	Fusarium wilt		Fon
Fusarium solani f.sp. *cucurbitae*	Foot and root rot		Fsc
Sphaerotheca fuliginea	Powdery mildew		Sf

Eggplant

Scientific name	English common name	Local common name	Code
Bacteria:			
Ralstonia solanacearum	Bacterial wilt		Rs
Fungi:			
Fusarium oxysporum f.sp. melongenae	Fusarium wilt		Fom
Verticillium albo-atrum	Verticillium wilt		Va
Verticillium dahliae	Verticillium wilt		Vd
Nematodes:			
Meloidogyne incognita	Root-knot		Mi

Lettuce

Scientific name	English common name	Local common name	Code
Viruses:			
Beet Western Yellows Virus	Yellows		BWYV
Cucumber Mosaic Virus	Cucumber mosaic		CMV
Lettuce Big Vein Virus	Big vein		LBVV
Lettuce Mosaic Virus	Lettuce mosaic		LMV
Tomato Spotted Wilt Virus	Spotted wilt		TSWV
Bacteria:			
Pseudomonas cichorii	Bacterial rot		Pc
Rhizomonas suberifaciens	Corky root		Rs
Xanthomonas campestris pv. *Vitians*	Bacterial spot		Xcv
Fungi:			
Bremia lactucae	Downy mildew		Bl
Insects:			
Macrosiphum euphorbiae	Potato aphid		Me
Myzus persicae	Green peach aphid		Mp
Nasonovia ribisnigri	Lettuce leaf aphid		Nr
Pemphigus bursarius	Lettuce root aphid		Pb

Melon

Scientific name	English common name	Local common name	Code
Viruses:			
Cucumber Mosaic Virus	Cucumber mosaic		CMV
Melon Necrotic Spot Virus	Melon necrotic spot		MNSV
Papaya Ringspot Virus	Papaya ringspot		PRSV
Watermelon Mosaic Virus	Watermelon mosaic		WMV
Zucchini Yellow Mosaic Virus	Zucchini yellows		ZYMV
Fungi:			
Erysiphe cichoracearum	Powdery mildew		Ec
Fusarium oxysporum f.sp. *melonis*	Fusarium wilt		Fom
Pseudoperonospora cubensis	Downy mildew		Pc
Sphaerotheca fuliginea	Powdery mildew		Sf
Insects:			
Aphis gossypii	Cotton aphid		Ag

Peas

Scientific name	English common name	Local common name	Code
Viruses:			
Bean Leaf Roll Virus	Pea leafroll and pea top yellows		BLRV
Bean Yellow Mosaic Virus	Bean yellow mosaic		BYMV
Pea Enation Mosaic Virus	Pea enation mosaic		PEMV
Pea Seedborne Mosaic Virus	Pea seedborne mosaic		PSbMV
Bacteria:			
Pseudomonas syringae pv. *Pisi*	Bacterial blight		Psp
Fungi:			
Aphanomyces euteiches	Aphanomyces root rot		Ae
Ascochyta pisi	Ascochyta leaf and pod spot		Aps
Ascochyta pinodella (= Phoma medicaginis var. *Pinodella)*	Leaf spot and foot rot		Apn
Erysiphe pisi	Powdery mildew		Ep
Fusarium oxysporum f.sp. *pisi*	Near wilt		Fop
Fusarium solani	Fusarium root rot		Fs
Mycosphaerella pinodes (= perfect stage of *Ascochyta pinodes)*	Ascochyta blight		Mp

Pepper

Scientific name	English common name	Local common name	Code
Viruses:			
Bell Pepper Mottle Virus	Bell pepper mottle		BePMV
Cucumber Mosaic Virus	Cucumber mosaic		CMV
Pepper Mild Mottle Virus	Pepper mild mottle		PMMV
Pepper Mottle Virus	Pepper mottle		PepMoV
Potato Virus Y	Potato virus Y		PVY
Tobacco Etch Virus	Tobacco etch		TEV
Tobacco Mild Green Mosaic Virus	Tobacco mild green mosaic		TMGMV
Tobacco Mosaic Virus	Tobacco mosaic		TMV
Tomato Mosaic Virus	Tomato mosaic		ToMV
Tomato Spotted Wilt Virus	Tomato spotted wilt		TSWV
Bacteria:			
Ralstonia solanacearum	Bacterial wilt		Rs
Xanthomonas vesicatoria *(*ex *Xanthomonas campestris* pv. *vesicatoria)*	Bacterial spot		Xv
Fungi:			
Fusarium oxysporum f.sp. *capsici*	Fusarium wilt		Foc
Leveillula taurica	Powdery mildew		Lt
Phytophthora capsici	Buckeye fruit and root rot		Pc
Nematodes:			
Meloidogyne arenaria	Root-knot		Ma
Meloidogyne incognita	Root-knot		Mi
Meloidogyne javanica	Root-knot		Mj

Radish

Scientific name	English common name	Local common name	Code
Viruses:			
Turnip Mosaic Virus	Turnip mosaic		TuMV
Bacteria:			
Pseudomonas syringae pv. *Maculicola*	Peppery leaf spot		Psm
Fungi:			
Fusarium oxysporum f.sp. *raphani*	Yellows		For
Rhizoctonia solanea	Rhizoctonia scurf		Rs

Spinach

Scientific name	English common name	Local common name	Code
Viruses:			
Cucumber Mosaic Virus	Cucumber mosaic		CMV
Fungi:			
Albugo occidentalis	White rust		Ao
Cladosporium variabile (= *Heterosporium variabile*)	Leaf mold		Cv
Fusarium oxysporum f.sp. *spinaciae*	Fusarium wilt		Fos
Peronospora farinosa f.sp. *spinaciae*	Downy mildew		Pfs

Sweet Corn

Scientific name	English common name	Local common name	Code
Viruses:			
Maize Dwarf Mosaic Virus	Maize dwarf mosaic		MDMV
Bacteria:			
Erwinia stewartii	Stewart's wilt		Es
Fungi:			
Exserohilum turcicum (ex *Setosphaeria turcica*)	Northern leaf blight		Et
Puccina sorghi	Common rust		Ps
Ustilago maydis	Common smut		Um

Tomato

Scientific name	English common name	Local common name	Code
Viruses:			
Cucumber Mosaic Virus	Cucumber mosaic		CMV
Tomato Spotted Wilt Virus	Spotted wilt		TSWV
Tomato Yellow Leaf Curl Virus	Tomato yellow leaf curl		TYLCV
Tomato Mosaic Virus	Tomato mosaic		ToMV
Bacteria:			
Clavibacter michiganensis subsp. *Michiganensis*	Bacterial canker		Cmm
Pseudomonas syringae pv. *Tomato*	Bacterial speck		Pst
Ralstonia solanacearum	Bacterial wilt		Rs
Xanthomonas vesicatoria (ex *Xanthomonas campestris* pv. *vesicatoria)*	Bacterial spot		Xv

Fungi:			
Alternaria alternata f.sp. *lycopersici*	Alternaria stem canker		Aal
Cladosporium fulvum	Leaf mold		Cf
Fusarium oxysporum f.sp. *lycopersici*	Fusarium wilt		Fol
Fusarium oxysporum f.sp. *radicis-lycopersici*	Fusarium crown and root rot		For
Leveillula taurica	Powdery mildew		Lt
Oidium lycopersicum (now *Oidium neolycopersici*)	Powdery mildew		Ol
~~*Phytophthora capsici*~~	~~Buckeye fruit and root rot~~		~~Pc~~
Phytophthora infestans	Late blight		Pi
Phytophthora parasitica	Buckeye fruit and root rot		Pp
Pyrenochaeta lycopersici	Corky root rot		Pl
Stemphylium botryosum f.sp. *lycopersici*	Gray leaf spot		Sbl
Stemphylium floridanum	Gray leaf spot		Sf
Stemphylium solani	Gray leaf spot		Ss
Verticillium albo-atrum	Verticillium wilt		Va
Verticillium dahliae	Verticillium wilt		Vd
Nematodes:			
Meloidogyne arenaria	Root-knot		Ma
Meloidogyne incognita	Root-knot		Mi
Meloidogyne javanica	Root-knot		Mj

Watermelon

Scientific name	**English common name**	**Local common name**	**Code**
Fungi:			
Colletotrichum lagenarium	Anthracnose		Cl
Fusarium oxysporum f.sp. *niveum*	Fusarium wilt		Fon
Sphaerotheca fuliginea	Powdery mildew		Sf

Wax Gourd

Scientific name	**English common name**	**Local common name**	**Code**
Fungi:			
Fusarium oxysporum f.sp. *lagenariae*	Fusarium wilt		Fol
Fusarium oxysporum f.sp. *niveum*	Fusarium wilt		Fon

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