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IOM/III/5
ORIGINAL: French/English
DATE: August 3, 1987

INTERNATIONAL UNION FOR THE PROTECTION OF NEW VARIETIES OF PLANTS

GENEVA

THIRD MEETING WITH INTERNATIONAL ORGANIZATIONS

Geneva, ~~October 21 and 22, 1987~~

New Dates: October 12 and 13, 1987

DEFINITION AND EXAMINATION OF HYBRID VARIETIES

Document prepared by the Office of the Union

1. At its nineteenth session, the Administrative and Legal Committee of UPOV examined a motion of ASSINSEL on the definition of maize hybrids.

2. It was agreed that, for the twentieth session of the Committee, the Delegation of France would prepare a document on the definition and examination of hybrid varieties. At the twentieth session that document was discussed, and the Committee decided that it should be presented to the international organizations for their information.

3. The document is reproduced overleaf.

DEFINITION AND EXAMINATION OF HYBRID VARIETIES

Article 6 of the International Convention for the Protection of New Varieties of Plants of December 2, 1961, and of the revised text of October 23, 1978, states the conditions required for a variety to be protected. The provisions relating to the concepts of distinctness, homogeneity and stability are as follows:

> "Whatever may be the origin, artificial or natural, of the initial variation from which it has resulted, the variety must be clearly distinguishable by one or more important characteristics from any other variety whose existence is a matter of common knowledge at the time when protection is applied for ... The characteristics which permit a variety to be defined and distinguished must be capable of precise recognition and description."
>
> "The variety must be sufficiently homogeneous, having regard to the particular features of its sexual reproduction or vegetative propagation."
>
> "The variety must be stable in its essential characteristics, that is to say, it must remain true to its description after repeated reproduction or propagation or, where the breeder has defined a particular cycle of reproduction or multiplication, at the end of each cycle."

Article 7 states for its part that:

> "Protection shall be granted after the examination of the variety in the light of the criteria defined in Article 6. Such examination shall be appropriate to each botanical genus or species."
>
> "For the purposes of such examination, the competent authorities of each member State of the Union may require the breeder to furnish all the necessary information, documents, propagating material or seeds."

These two articles highlight three groups of concepts:

First group: Distinctness, important characteristic, i.e. two concepts which suppose the existence of a description of the material corresponding to the variety.

Second group: Judgement of homogeneity, having regard to the particular features of the sexual reproduction or vegetative propagation system of the variety.

Evaluation of stability throughout reproductions or multiplications or at the end of each particular cycle of reproduction or multiplication defined by the breeder.

The wording used to define these concepts suggests that the evaluation of homogeneity and stability may be adapted to the type of variety or the reproductive system of the variety under examination.

Third group: Examination procedure appropriate to each botanical genus or species, which implies the furnishing of relevant information or of the propagating material or seeds necessary for the examination.

Moreover, it is well known that the description of a self-pollinated pure line variety is not drawn up in the same way as the description of a cross-pollinated variety. The layout of the tests, the number of plants observed depend on the type of variety being examined:

- pure line,
- clone,
- population,
- hybrid,
- etc.

It is not the purpose of this note to restate the features distinguishing the various types of varieties. It is sufficient to recall that the homogeneity of the material belonging to a pure line variety or a clone, or to a parental component maintained through forced self-pollination, is real whereas it is relative or aleatory for several other types, e.g. population varieties, synthetic varieties or double-cross hybrid varieties. Compared to that of a self-pollinated variety or a clone variety, the description of a cross-pollinated variety is in general:

- either reduced,
- or less precise.

The Case of the Hybrid Varieties of Maize

Hybrid varieties of maize are characterized by the fact that they are produced from inbred lines, maintained through forced self-pollination and behaving like pure lines:

- very great number of homozygous characteristics,
- high level of homogeneity,
- high level of stability.

The degree of homozygosity increases at each generation as in the case of a pure line.

The greater is the homogeneity of the parental lines, the greater will be the homogeneity of the single-cross hybrid, which is composed of plants that are all identical, although heterozygous.

The greater is the homogeneity of a given material, the easier will be its description and distinction.

At the limit, the observation of single-cross hybrid material may be sufficient as in the case of a self-pollinated variety or a clone variety. The problem is completely different, however, for three-way and double-cross hybrids, which contain segregating material.

Another fact which cannot be contested is that the morphology and physiology of the plants of a hybrid are governed by the genetic determinism of the characteristics carried and transmitted by the lines. Some are monogenic, the other polygenic, either dominant or recessive. Dominance, in certain cases, may be reversed, depending on the association of lines. Dominance may also be incomplete.

These conclusions are drawn from the laws of heredity and are no more challenged today.

All these phenomena are known by breeders and experts in variety description. The greater is the use of a given group of lines, the better will these phenomena be known.

The good knowledge of the genetic background of the inbred lines in the form of genetic maps or acquired empirically through well-based experience enables the characteristics of a hybrid to be predicted, in general terms, even before the crosses are made. The originality of improvement breeding in maize relies first of all on the breeding of new lines that are themselves original and have a good combining ability. The creation of a hybrid variety then becomes no more than a programmed, predetermined scheme that may perhaps be elaborate but is implemented according to the laws of heredity and the in-built constraints of any seed production programme.

On the basis of this knowledge and these facts, the methodology for examining the distinctness, homogeneity and stability of single-cross and three-way hybrid varieties which starts from the parental components appears to be as rational as, or indeed more rational than, any other methodology. This seems to be the view embedded in the motion of the Maize Section of ASSINSEL. This is also the examination methodology adopted by the French competent authorities.

The visual observation and the description of the hybrid material, systematically made for all crosses, are made for a great number of hybrids only for the purposes of verifying the existence of the expected facts.

The originality of the parental components--when assessed without ambiguity on the basis of minimum distances for distinctness purposes that are sufficiently large--and the formula determine the originality of the hybrid. The minimum distances between parental components must be such that they lead to differences at hybrid level.

The methodology developed in France tends to retain only those differences or combinations of differences at parent level which lead to real and provable differences at hybrid level. (See the list of characteristics at annex). This method seems to be as reliable as the method in which significant differences at the 1% probability level are established on the basis of observations on individual plants.

This methodology has the following advantages:

- The work is done on homogeneous[1] and stable material;

- A strict control of the stability of the variety is made on the basis of the stability of its components and the crossing scheme;

- All varieties whose formula includes components that are clearly distinguishable by at least one polygenic characteristic or by several monogenic characteristics are systematically eliminated from the programme of direct comparisons between "candidate hybrid material" and known material;

- Direct comparisons are limited to cases of doubt which necessitate a detailed study of all characteristics to establish if a sufficiently important characteristic enables the candidate hybrid material to be distinguished.

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[1] A lack of homogeneity in a parental line being examined for the first time leads in France to the rejection of the application for protection of the hybrid.

Any other method would imply the need to grow a whole series of varieties for each maturity group and to observe and measure the plants as is done for fodder crops or other cross-pollinated population or synthetic varieties; that would be heavy, expensive and, in practice, not more reliable.

The eventual direct comparison limited to the hybrid material which is not distinguishable through the examination of the components and the formulas is after all comparable to the methodology using comparisons within great groups of predetermined characteristics.

The distinctness, homogeneity and stability tests are just one aspect of a general examination.

Although this is not clearly said, it is also the philosophy applied in other countries for the control of homogeneity and stability of the basic material used in seed production also corresponds to a coherent procedure at the level of the whole variety and seed business of a country.

That procedure relies on a perfect knowledge of the basic genetic material and would not be applicable without a perfect homogeneity and stability of the inbred material used.

The control of pollination in the production of hybrid plants must be absolute because any foreign pollen would introduce some heterogeneity with unpredictable consequences.

Unfortunately, this is not the case for synthetic varieties, or for varieties that are called hybrids but derive in fact from parental material that is not fixed:

- The homogeneity and stability of such material are aleatory:

- The control of pollination is only partially mastered;

- Depending on the species, the production of seeds requires one or more multiplications of the first hybrid generation, leading to the commercialization of a pseudo-F2 or F3, sometimes even F4, depending on the varietal type and the species.

Transposition of the Examination Method to Species Other than Maize

This method may be transposed to all other hybrid varieties deriving from fixed inbred lines, whatever the species, e.g. to sunflower or grain-sorghum.

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Its efficency is maximum with three-way and double-cross hybrids.

It may be applied to hybrid varieties of vegetables deriving from fixed parental lines.

This of course supposes that the formulas and components are submitted.

For the species which are the subject of an important breeding activity and of a great number of applications for protection or registration in a national list of varieties, it is at present the only way of conducting a national examination of distinctness, homogeneity and stability that is efficient, complete and applicable to a great number of varieties within a short period of time (two years) and does not hamper the genetic progress because of inability to distinguish varieties.

The situation is much less favorable for cross-pollinated population or synthetic varieties.

[The list of characteristics follows]

HIERARCHICAL CLASSIFICATION OF CHARACTERISTICS - MAIZE LINES

The classification is based on the evaluation of the genetical determinism of the characteristics and their fluctuation in response to variations in the environment.

FIRST GROUP OF CHARACTERISTICS

A clear distinction established on the line for any one of the characteristics listed below is considered to generate sufficient distinctness at the level of the hybrids.

Examples

Male flowering: time of beginning (significant difference at 1% threshold)

Tassel: attitude of lateral branches (difference of 2 UPOV states of expression, 3 - 7 notation)

Plant: height (significant difference at 1% threshold)

Grain: type (difference of 2 UPOV states of expression)

SECOND GROUP OF CHARACTERISTICS

A clear distinction established on the line for at least two of the characteristics listed below is required to generate sufficient distinctness at the level of the hybrids.

Examples

Tassel: compactness of main axis (difference of 2 UPOV states of expression, 3 - 7 notation)

Ear: length of peduncle (difference of 2 UPOV states of expression)

Ear: anthocyanin coloration of silks (difference of 2 UPOV states of expression)

Ear: anthocyanin coloration of cob (absence/presence)

Tip of grain: color (difference of 2 UPOV states of expression)

THIRD GROUP OF CHARACTERISTICS

A clear distinction established on the line for at least three of the characteristics listed below, is required to generate sufficient distinctness at the level of the hybrids.

Examples

Leaf:

- First leaf: anthocyanin coloration (difference of 2 UPOV states of expression)

- Attitude in central third of plant (difference of 2 UPOV states of expression)

Stem: anthocyanin coloration of internodes (difference of 2 UPOV states of expression)

Ear: length of sheath (difference of 2 UPOV states of expression)

Ear: color of side of grain (difference of 2 UPOV states of expression)

The above lists are given as illustration; the classification of characteristics has not yet been finally adopted.

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