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INTERNATIONAL UNION FOR THE PROTECTION OF NEW VARIETIES OF PLANTS

GENEVA

TECHNICAL COMMITTEE

Sixteenth Session
Geneva, November 10 to 12, 1980

EASY MUTATIONS

Document prepared by the Office of the Union

1. At its fifteenth session (March 1980), the Technical Committee decided to discuss during its sixteenth session questions connected with easy mutations, on the basis of a paper to be prepared by the Chairman of the Technical Working Party for Ornamental Plants (document TC/XV/7, paragraph 43).

2. Annex I to this document contains the paper prepared by the Chairman of the Technical Working Party for Ornamental Plants and entitled: "Tests for Distinctness, Homogeneity and Uniformity: Problems with Mutations." A further paper, submitted by the Delegation of the United Kingdom to the twelfth session of the Technical Working Party for Ornamental Plants (Annex IX to document TW/36), and entitled "Distinctness in Vegetatively Propagated Plants," is attached as Annex II.

[Two Annexes follow]

TC/XVI/3

ANNEX I

PAPER PREPARED BY MR. A.J. GEORGE, CHAIRMAN OF THE TECHNICAL WORKING PARTY FOR ORNAMENTAL PLANTS

TESTS FOR DISTINCTNESS, HOMOGENEITY AND UNIFORMITY: PROBLEMS WITH MUTATIONS

A mutation has been defined as "A heritable change not ascribable to segregation or recombination". It may be a change in a single gene, a change in chromosome structure or number or it may involve re-arrangement of genetically differing tissues. Some mutations are unstable.

Each mutation is essentially an independent event. One which occurs frequently will tend to be associated with a different spectrum of other mutations on each occasion.

The effects of a mutation may be evident at once or they may be expressed only after some further change has occurred.

Mutations may be natural or induced. The mutation spectrum depends to some extent upon the agent used but the effect of artificial mutagens is essentially quantitative not qualitative. Irradiation is usually more effective than chemical mutagens and in most developed countries plant breeders can obtain access to irradiation facilities on a commercial basis. Treatment is relatively cheap, particularly in those species which can be irradiated as tissue cultures. Large numbers of plants carrying mutations may be available very quickly for screening.

There may be significant advantages over other methods of crop improvement in certain situations. Examples are:

(1) When seedlings have a long juvenile phase (e.g. trees)

(2) When a species is a highly heterozygous polyploid (e.g. Chrysanthemums, Dahlias).

(3) When one variety within a species is very much better than any other (e.g. Carnation 'William Sim')

(4) When precise cropping programmes demand a range of varieties with identical growth patterns (e.g. AYR chrysanthemums)

Useful sources of further information are:

IAEA TR 119, 1977 Manual on Mutation Breeding, Second Edition, IAEA Technical Report Series No. 119 IAEA Vienna.

C. Broertjes and A.M. van Harten, 1978, The Application of Mutation Breeding to Vegetatively Propagated Plants. Elsevier Amsterdam.

PROBLEMS: Some of these were discussed in a previous paper (UPOV/TW/36, Annex IX).[1] Further examples are given below.

(1) Competition to obtain priority in a potentially valuable mutation may lead to premature application for protection. Some secondary mutations are unmasked during tests and may lead to rejection : others remain hidden. Difficulties arise when genetic heterogeneity produces effects of similar magnitude to the normal phenotypic variation. A genetic origin presages problems of variety drift under the selection pressure of commercial propagation. To establish the true cause of this variation prolonged tests on clones derived from individual plants may be needed.

(2) If several examples of a major mutation occur at the same time commercialization may be advanced significantly by development of a multiclonal variety. If this is not detected in test the variety will drift in commerce as the relative proportion of different clones varies.

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[1] Annex II to this document

(3) Unstable mutations are sometimes detected in test, others only become evident later, perhaps when the variety is propagated on a large scale. By this time the reference material may not be reliable.

(4) Mutations which affect physiological characteristics may be extremely expensive to test. If costs are to be contained it may be necessary to ask the applicant to provide experimental evidence to support a claim for distinctness. This would penalize the smaller breeder.

SOLUTIONS? Following earlier discussions two ideas were thought to merit further study.

(1) Bulk applications - i.e. the breeder of a new hybrid should be able, within a specified time, to make a bulk application for mutants from it at reduced rate of fee.

It is now suggested that this is inadvisable. The most serious criticism is that it would create a very undesirable precedent for special treatment of one kind of variety.

(2) Breeder descriptions - i.e. a breeder's description should be accepted, subject to proof of the existence of plant material, as evidence that a mutation exists in common knowledge.

This would relieve the test authority of the need to test non-commercial varieties submitted solely to establish their existence. It is a small part of the whole problem but the option should be available to breeders.

Such piecemeal solutions should be avoided whenever possible. Few of the difficulties with mutations are unique. A multi-clone chrysanthemum variety poses the same problems in test as a multi-line cereal. The same doubts arise when two mutations can only be separated by a difference in some obscure morphological character and when two cereal varieties can only be distinguished by biochemical analysis. The analogies can be multiplied.

Problems increase as the development of more precise experimental techniques permits reliable separations between populations of plants which are agronomically indistinguishable. The conflict between the botanical and agronomic concept of variety, which is inclusive and the concept developed in relation to breeders' rights, which is exclusive, is becoming more apparent.

Increasingly, technical developments call into question the validity of current concepts of "variety". In the context of the d.u.s. test the suggestion (TC/XIV/5, para. 26) that it may be "necessary to look for a more refined interpretation of the words "important characteristic" in Article 6 (1) (a) of the Convention" pinpoints the crucial question facing the Technical Committee. It is pointless to continue discussing mutation problems in the absence of any realistic basis for deciding whether a characteristic is important.

It is suggested that the discussion of mutations should be abandoned until the more fundamental problem has been solved and it can be seen what difficulties, if any, remain.

[Annex II follows]

DISTINCTNESS IN VEGETATIVELY PROPAGATED PLANTS

Discussion Paper Prepared by the Experts of the United Kingdom

This paper is a discussion of problems which have become apparent in tests and during the period of protection. Insofar as it impinges upon matters of policy or law there is no intention to do more than establish wider awareness of the existence of difficulties. The problems may be divided into three groups.

(a) Problems caused by phenotypic fluctuation

(b) Problems caused by genotypic variation

(c) Problems associated with the test procedures adopted by UPOV

1. FLUCTUATION

False results may be obtained in tests for distinctness if some sources of phenotypic fluctuation are not recognized. Examples are:

(A) PROVENANCE In many species the growing technique, the environment in which plant material has been produced and the criteria by which it has been selected may affect subsequent growth. Applicants are already required to inform the test authority of cultural treatments which may affect the growth in test of the planting material supplied but some of these are so much a matter of routine that their use may go unremarked.

If there is a risk that differences in pretreatment may invalidate comparisons between two varieties, planting material of both should be obtained from the same source at the same time. If the varieties are very close both may need to be held for one growing season at the test centre and then repropagated for tests.

(B) DEVELOPMENTAL CHANGE Many morphological characteristics of perennial plants change as a plant ages. The change may be conspicuous like the progress from juvenility to maturity or it may be more subtle. As a plant matures vigour declines, growth habit or leaf shape may change. It will often be important to compare plants of similar age.

Analogous changes occur in each growth cycle so that for some characteristics both the stage of development of the organ to be observed and the point in the growth cycle at which it was developed may require definition.

Colour is such a characteristic and in view of its importance for defining distinctness in ornamentals may be mentioned here as a special case. Experience suggests that great accuracy of colour measurement may be unproductive. When distinctness depends upon colour difference this is often defined more effectively by a generalized comparison, between the varieties concerned, of the way in which colour changes with time and varies from one part of the organ examined to another, than it is by precise evaluation of small differences at defined moments.

2. VARIATION

Mutations accumulate so that varieties become progressively more heterogeneous. Much of this heterogeneity is eliminated. Many mutations are lethal, others occur in cells which do not regenerate. Some produce obvious deleterious effects and are discarded by propagators. A few mutations are selected out and propagated to produce new varieties (sports). Heterogeneity within a variety results from the unselected residue.

The belief that vegetatively propagated varieties are genetically homogeneous clones is rarely correct. With respect to many characteristics they commonly exist as variable populations; with respect to others (generally those of major agronomic or commercial significance) they frequently exist as a cluster of clones or selections. This does not only affect tests for distinctness. It is also necessary to consider the implications for maintenance of variety integrity after tests have been completed. It must also be asked what effect mutations have upon the ability of the owner of a protected variety to sustain his rights against infringement or devaluation.

Some variations are expressed others are suppressed.

(A) EXPRESSED VARIATION The central problem is the position of the boundary between mutations which justify recognition of new varieties and those which do not.

There can be little doubt that a mutation which produces a major change in a characteristic of commercial value (eg flower colour) must be recognized as giving rise to a new variety, albeit one whose close relationship to its parest must be acknowledged in its name. Such characteristics are usually included in test guidelines and both the test criteria and commercial interests recognize the significance of the change. Problems occur when the same major change recurs with minor variations.

Mutations producing major changes in characteristics with no direct sales value are a more difficult group. It is probably fortunate that they are generally regarded by the finders as producing selections within the original variety and so rarely give rise to applications for protection. The marketable product from the selection will often be indistinguishable from that of the original variety: commercially it will need to carry the same name. For example, a mutation in an apple variety may produce a change in growth habit. Control of the sale of trees would not be difficult but unlicensed propagation by growers who only sold the fruit would be almost impossible to detect.

Marginal differences (so-called by growers) result from mutations which produce small changes in characteristics of commercial significance and from the recurring major changes referred to above. They also result from mutations affecting characteristics which have no practical significance. A marginal difference may not be accepted by the industry as justifying recognition of a new variety even though it may permit a mutant to be distinguished reliably and consistently from its parent in a test for distinctness. The extreme case of a marginal difference is, perhaps, seen in the triploid Poinsettia variety which was morphologically indistinguishable from an existing diploid.

Marginal differences are regarded in different ways depending upon who finds them. The breeder of the original variety will exploit them to upgrade it by eliminating minor faults. A propagator will exploit them to upgrade his stock of the variety relative to those of his competitors. If the variety is protected they may be exploited by a rival who wishes to avoid paying royalties.

All this serves mainly to highlight the difficulties in the way of finding a generally acceptable definition of the magnitude of change which justifies recognition of a mutant as a new variety. Part of the answer may lie in a shift of emphasis, away from distinctness as something to be determined in the controlled situation of a formal test, towards an acceptance that it must be possible to recognize a variety in the uncontrolled situation of commercial production if any grant of protection is to be sustained against infringement.

The foregoing discussion introduces two further questions to which practical answers may be possible in the short term.

(i) To what extent can progressive improvement be accepted in a protected variety? Progressive variety improvement by selection for small differences has always been a basic principle of good husbandry. Some drift in variety characteristics is inevitable in practice and the extent to which it can be accepted in a protected variety requires definition. When licences to propagate a protected variety are issued each propagator's stock tends to drift in a different direction: to keep them all in line would be formidably difficult.

In practice it seems reasonable to suggest that drift may be ignored unless

(a) it occurs in a grouping characteristic so that it invalidates the choice of control varieties in the original technical examination.

(b) it occurs in a characteristic named in the test report as critical for the separation of the variety from another.

(c) there is evidence that it is eroding the difference between the variety and any other that exists at the time of a maintenance check.

Grant holders might reasonably be expected to control drift within these limits and to require any licencees to do so. However, if the inevitability of some drift is accepted it becomes necessary to ask whether variety descriptions should be updated periodically to allow for it.

(ii) Is there any defence against the exploitation of mutations to devalue a grant of protection? Developments in mutation breeding make it easy to avoid paying royalties on protected varieties in some species. The number of such species is increasing but most problems are currently occurring in chrysanthemums where the effective life of a grant of protection can be reduced to as little as 2 to 3 years through development of marginally different clones by competitors of the original breeder.

To defend his rights the breeder may be forced to seek out and protect as many mutants as possible before he releases a new variety. This can be very expensive and may produce a heavy and pointless workload for the test authority. Such large scale submission of alternative mutants - ie mutants which will not be marketed - would only be acceptable, since there is no element of public benefit, if the test fee covered the whole cost of testing. What are the alternatives?

Definition of minimum distances between varieties has superficial attractions but soon leads to interminable discussions about the treatment of cumulative small differences. Generic protection, that is a grant of protection on a new seedling which covers all subsequent mutants, is unacceptable.

Breeder publication of descriptions of the alternative mutants could provide a way of establishing their existence in common knowledge. It would be necessary, however, for the breeder to retain plant material against future need by a test authority to use it as reference material in tests.

(B) SUPPRESSED VARIATION results from the occurrence of mutations whose effect is not expressed until some secondary change has occurred. A different environment may be needed or another mutation may be necessary to uncover the first one. Examples of difficulties caused in tests for distinctness are:

(i) Where regional test facilities have been established for a species a difference which can be seen clearly in the country of origin of a mutation may not be evident in the environment of the test centre. Should an "ad hoc test facility" be set up to determine the reality of the difference? Should protection be restricted to those countries in which the variation is expressed? Mutations affecting skin colour in apples are a case in point.

(ii) Many cultivars of ornamentals are chimaeras. In tissue culture it may be possible to produce non-chimaeral clones with the same morphological characteristics. It may soon be necessary to decide whether this constitutes distinctness.

3. PROCEDURAL PROBLEMS

The requirements of species propagated by seed have perhaps had an undue influence in the development of methods for the determination of distinctness in tests. This sometimes causes problems with vegetatively propagated plants, especially ornamentals. Some examples are given below.

(A) REFERENCE COLLECTIONS In many groups of vegetatively propagated plant varieties are so numerous and individual plants so long-lived that maintenance of an effective reference collection is impractical. Difficulties increase where regional test facilities have been established if common knowledge differs between participating states. In species which have to be re-propagated at frequent intervals control of variety drift in any reference collection would be, in itself, a major task.

Many older varieties exist as a series of selections. If such a variety is included in a reference collection it may be necessary to have several of these selections so that the right one can be used in tests. Otherwise it will be essential to specify which selection is used.

Protection cannot be extended to any significant proportion of the range of vegetatively propagated species unless the idea of comparison against a reference collection is abandoned wholly or in part. If nothing else the cost would be prohibitive. Examination by panels of independent experts may need to be used more widely (though these bring problems of their own) and the panels may need to become more

international in membership if cooperation in testing is to be effective. Sometimes a modified patent-type examination may be appropriate.

(B) EXAMPLE VARIETIES Without a reference collection it becomes difficult to describe the characteristics of new varieties in terms of scales defined by example varieties. There will often be a need to define the working standards for the scales of variation in other ways. These standards will often need to be published as part of the guideline if it and any variety description based on it are to be intelligible.

(C) COMPLEX CHARACTERISTICS There are three types:

(i) Combinations groups of minor characteristics, often showing little individual variation, but which taken together produce a feature of major importance. The outline of the chrysanthemum leaf is an example.

(ii) Sets occur when successive organs of the same type show a progressive change in some characteristic. Leaf shape in varieties of Platanus x acerifolia is an example.

(iii) Patterns are distinctive spatial arrangements of discontinuous characteristics, for instance the colour markings in Streptocarpus flowers. All such complexes can be broken down into simple components but the result is always cumbersome and often meaningless. When complex characteristics are important for variety description and recognition the guideline should specify the method by which they should be recorded and should make reference to the essential nature of these records as part of the variety description.

(D) COMPLEX TAXA Varieties of ornamentals are often selected for different uses from a common pool of genetic variability. There will be some multi-purpose varieties but each use tends to accumulate its own cluster of varieties. Frequently the states of many characteristics do little more than re-define, more or less imprecisely, the cultural uses of the varieties.

Wide ranging cross-fertility within a genus (eg Berberis) or family (eg Orchidaceae) produces an analogous problem when a very wide range of variation must be encompassed within each characteristic.

There seems little alternative but to accept that in such groups the guideline can never be much more than a list of the characteristics which ought to be examined on each variety and will have little value as a basis for variety description.

(E) UNUSUAL PLANTS In taxa of minor interest long periods may elapse between successive applications for protection. Expertise will be lost in the interval so that it may be advisable with such groups to ignore the current trend within UPOV to reduce the length of guidelines and to make them, instead, as complete as possible so that potentially useful characteristics are not overlooked at a later date. When a test is conducted it may be important to supplement the description with detailed notes about the standards used to determine the states of expression of the characteristics. Diagrams, photographs and herbarium specimens may all be useful in ensuring that the test may be repeated, if necessary, after an interval of several years.

(F) STATISTICAL METHODS These have been little used in testing distinctness of vegetatively propagated varieties but the situation may change with more widespread recognition that such varieties are rarely homogeneous for all characteristics. If the use of statistical methods is envisaged it will be vital to eliminate provenance effects and developmental differences from the material under test. In addition it must be remembered that a grant of rights can only be sustained against infringement if it is possible to recognize the variety in commerce. This may not be possible if the criteria for distinctness in test rely too heavily on statistical methods.

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