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The stability of an L3 mutant potato chimera

H. W. HOWARD

Plant Breeding Institute, Trumpington, Cambridge, England

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Summary

A study of the progeny of a periclinal chimera of the type L1 green: L2 green: L3 yellow, which could be recognised by the occurrence of yellow areas in the middle of the leaflets, showed a high rate of change to L1 green: L2 green: L3 green. This is explained as being caused by L3 cells at axillary meristems being replaced by the products of division of L2 cells due to occasional tangential divisions by the latter. The results add confirmation to the hypothesis that many bud-sports in potatoes which are now L1 normal: L2 + L3 mutant, arose as L1 normal: L2 mutant: L3 normal.

Introduction

Howard et al (1963) found it impossible to obtain a stable L1, 3x: L2, 6x: L3, 3x *Solanum demissum* periclinal chimera; there was a strong tendency for the progeny of such chimeras to change to L1, 3x: L2, 6x: L3, 6x. This replacement of L3 by L2 cells in such chimeras suggested that many bud-sports in potatoes for leaf shape which were originally L1 normal: L2 mutant: L3 normal would be expected when examined experimentally to be L1 normal: L2 + L3 mutant. This hypothesis was found to be true for dock-leaf *Majestic*, ivy-leaf *Doon Star*, wilding *Redskin* and feathery wilding *Majestic* (references in Howard, 1970a) and also for subdivided-leaf *President* (Heiken et al., 1963). Some L1 normal: L2 mutant: L3 normal chimeras, however, do remain true to type; these include holly-leaf *Majestic* (Howard, 1970b). The discovery of a chimera of the type L1 green: L2 green: L3 yellow has now given material in which the frequency of the replacement of L3 by L2 can be easily estimated.

Material

The plants which were suspected of being L1 green: L2 green: L3 yellow were found in the tuber progeny of material descended from an Andigena × Tuberosum hybrid, H26A, which was originally a sectorial chimera with one sector of the stem L1 green: L2 + L3 yellow and another L1 + L2 + L3 green (Howard, 1971). They were suspected of being L2 green: L3 yellow because the distribution of green and yellow areas in the leaflets (Fig. 1) is typical in many dicotyledonous families for such chimeras in which L2 and L3 have different genotypes (Dermen, 1960; Tilney-Bassett, 1963).

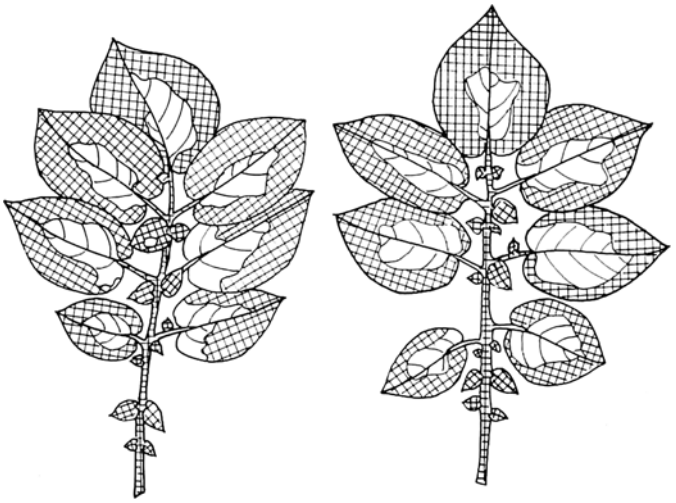

Fig. 1. Two leaves of a L1 green: L2 green: L3 yellow plant. Cross-hatched areas, green; white areas, yellow.

Eye-excision results

Eyes were excised from 24 half-tubers of plants suspected of being L2 green: L3 yellow. Only three of them produced plants, of which two were all yellow and one all green. Because plants obtained after eye-excision are formed by adventitious buds originating in layers tracing back to L3 (Howard, 1970b), the production of two all yellow plants shows that L3 was yellow in the plants from which the tubers were obtained; the one all green plant was to be expected because there is a high frequency of replacement of L3 by L2 (see next section).

Frequency of change of L3 yellow to L3 green

Plants grown from the tubers produced by six plants which had leaflets with yellow middle areas were examined (Table 1). About one third were like their parents and in about two thirds there had been a change to full-green leaflets. One plant was a sectorial (mericlinal) chimera.

Examination of the plants with yellow-centred leaflets, with the exception of the one sectorial plant, showed no evidence for replacement of yellow L3 by green L2 at the stem apices. There was, as is shown in Fig. 1, considerable variation as to the amount of green and yellow areas in individual leaflets but there were no leaves which had full-green leaflets. Folioles were, however, usually full-green. It thus seems, as originally suggested by Howard et al. (1963), that it is at axillary meristems that a new L3 may be derived from L2 cells.

Table 1. Frequency of plants with yellow centres of leaflets and plants with all green leaflets in the tuber progeny of yellow-centred plants.

Parent	Number of progeny with	
	yellow-centred leaflets	all green leaflets
A	2	10
B	7	4
C	2	9
D	3	4
E*	$2\frac{1}{3}$	$10\frac{2}{3}$
F	6	12
Total	$22\frac{1}{3}$	$49\frac{2}{3}$

* Progeny of E contained one plant which had five leaves with yellow centred leaflets and eight leaves with all green leaflets.

Discussion

The results given in Table 1 refer to only a single genotype and it might be that in other genotypes there is not such a high frequency of replacement of L3 by cells from L2. The results for holly-leaf *Majestic* (Howard, 1970b) showed no replacement; this, however, is probably exceptional in that the mutation causes a very big reduction in leaflet size. There could therefore be competition between normal and mutant cells with normal cells having a big advantage: on the other hand there is no replacement in this chimera of L2 by L3.

Another explanation of the results in Table 1 would be a high rate of reverse mutation from yellow to green. There is no evidence for such a suggestion. The leaflets of all yellow plants do not show any green areas.

As suggested earlier the replacement probably takes place during the development of axillary meristems. There is anatomical evidence for occasional cell divisions with tangential instead of the usual radial walls in such meristems. This would lead to a 'two-layered L2' in which the inner layer became L3. Such changes are also known in chimeras of other species of plants; the change was called reduplication by Bergann and Bergann (1959).

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