PREVENTING CHIMERISM IN POTATO
(SOLANUM TUBEROSUM L.)

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SUMMARY

A fast neutron irradiation experiment using two different dose rates has been performed on the potato variety Desiree in order to obtain chimera-free mutants. Both tubers and tuber parts (cross sections) were de-eyed at different moments before and after irradiation. Adventitious sprouts successively developing on the callus in the holes of excised eyes were separated from the treated tubers and planted individually. So called ‘grouped’ sprouts were separated. Results indicated that (practically) chimera-free mutants can be obtained by de-eying tuber parts shortly before irradiation, by applying relatively high dose-rates and by taking adventitious sprouts which develop not earlier than three months after irradiation.

Separation of the grouped sprouts demonstrated that each part originated from a single original cell.

INTRODUCTION

Despite the fact that the potato has certain advantages for mutation breeding (FERWERDA, 1965; NAYAR and DAYAL, 1970), results sofar have not been too promising. Some authors mention a low mutation frequency and a limited mutation spectrum, both of which according to them are explained by a heavy intrasomatic selection supposed to operate especially in vegetative propagated plants (NAYAR, 1967, 1969). As to this last point, it is true that in crops such as potato multicellular organs (shoot apices) have to be used to induce mutations and since mutations are in principle one-cell events the chance of a mutated cell reaching the next generation is only small. Whether this in fact must be attributed to intrasomatic selection, diplontic selection or whatever it may be called, is a question on which opinions differ. We are inclined to agree with the views of those authors who think, that in many cases the effect of ‘real’ diplontic selection (i.e. a competition between mutated and non-mutated tissue in the treated generation) is only of limited importance and that most so-called examples of diplontic selection can be explained equally well or better in other ways e.g. by the normal ontogenetic development of the plant or by differential radiosensitivity (BALKEMA, 1971). For an extensive survey of literature on the subject, we also refer to this author.

Whatever the case may be, induction of artificial mutations in potato mostly leads

1 This article is dedicated to Dr F. P. Ferwerda who till September 1969 was in charge of potato mutation research at our Institute.
to a chimerical structure of the plant, which was proved already early by Asseyeva and Blagovidova (1935). The number of mutations scored depends to a large extent on the variety used, the number of characteristics studied, the dose of irradiation applied and the dose rates.

In potato the observed chimerism is mainly leading to either mericlinal or periclinal chimeras. In many cases, especially when non-visible characteristics are involved, this chimerism remains unobserved and many cause unpleasant surprises. Visible mutations can be detected relatively easy and either pure mutated plants or original plants can be obtained by a vegetative separation. Mutations are only transferred to the next vegetative generation when axillary buds develop or when adventitious buds can be induced in that part of the plant, where the mutation manifests itself.

Since axillary buds in potato reproduce the 3-layer structure of the mother plant (Klopper, 1965), periclinal climerism is maintained in the next (vegetative) generation. The method used most frequently to produce adventitious buds is the eye-excision in tubers as developed by Asseyeva (1927, 1931). Adventitious buds in that case develop from one or a number of cells which normally can all be traced back to the third germ layer (L3). Therefore only mutations which are present in this layer will be transferred to the following generation. From this point of view eye-excision may be considered a way to limit chimerism, which was established also by Miedema (1967). Whether mutation spectrum and frequency in plants derived from L3 tissue can be compared to those in plants developed from axillary sprouts, is studied in our Institute at present. Another way of limiting chimerism could be to work with relatively high dosages, e.g. 8 Krad of X-rays. In that case regeneration may come from one or only a very few cells of the irradiated shoot-apex, the others either being inactivated temporarily or killed completely. One might hope then, that the surviving cell carries the mutation and gives rise to plants which are completely mutated. However, the chance of negative side-effects increases considerably with higher dosages and one might also expect that sometimes the whole shoot-apex is killed, regeneration taking place from other regions with a lower mutation frequency or without any induced mutation at all.

It therefore seems useful to look for other methods which increase chances of an induced mutation to manifest itself in a greater part of the plant.

In view of this Ferwerda and co-workers have performed many experiments. As most of the results were either not published or if so, in internal reports, it seems rather logical to mention this work as an introduction to our current experiments.

Most potato mutation workers irradiate whole tubers or tuber halves (Heiken, 1960; Klopper, 1965; Nayar and Dayal, 1967) or rose- or apical ends (Howard, 1970). Due to the scatteredness of the eyes, however, to their different stages of development, to the presence of one main eye and two secondary eyes within each eyewall as well as to the apical and basal dominance, the pattern of which – in particular under the influence of irradiation – is not completely understood, irradiating tuber halves is not the best way to obtain reliable and comparable results, because each bud needs to receive an equal dose. This way unnecessary sources of chimerism are introduced. Also, regeneration may thus come from another eye, a fact which is hard to check. Treating apical ends may be somewhat more favourable, since apical dominance works stronger, one eye keeping the adjacent eyes at rest.