IMPROVEMENT OF THE SELECTION VALUE OF GENE dgl THROUGH RECOMBINATION

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Gene dgl of the Pisum genome causes a degeneration of the leaflets and stipules during ontogenesis. Mutant expression is progressive during ontogeny. The first foliage leaves of mutant plants are normal. A few weeks later brown spots appear on the leaflets and stipules which become progressively larger. Finally the leaves are dark brown and dry and incapable of photosynthesis. Since, during development, the newly formed leaves are normal and functional, the plants are capable of producing some seed but only between 5 and 55% of the control values of the mother variety over 15 generations (Fig. 1).

The X-ray induced mutant 142B of our collection, homozygous for dgl, contains at least one mutant gene more. The small pods of these plants have a characteristic grey-brown color which is genetically conditioned. In crossing experiments the two characters could be separated from each other, demonstrating that two different genes are involved rather than a pleiotropic effect of one gene. Thus, the genotypic constitution of mutant 142B is as follows:

-dgl for leaf degeneration,
-gbp for grey-brown pod color,
-possibly a third gene causing a reduced internode length.

The seeds are very small, probably as a consequence of the poor photosynthetic efficiency. When grown Ln West Germany, the vitality of the mutant varied from year to year in response to differing environmental conditions, but the effect of dgl was always clearly visible. In Egypt and India, however, the mutant phenotype failed to express.

Mutant 142B was crossed with the fasciated mutant 489C of our collection homozygous for more than 20 mutant genes. Six different recombinants, homozygous for dgl from 142B and for different genes or gene groups from 489C, were selected in F2 and developed into pure lines. Another three dgl recombinants were selected from a cross of mutant 142B with the non-fasciated, tall recombinant R 142F, the origin of which likewise traces to hybridizations between 142B and 489C. These nine dgl recombinants were studied with regard to their seed production in relation to the productivity of the parental mutant 142B. We sought to learn whether the strongly negative selection value of dgl is a characteristic feature of that gene or whether it can be overcome by combining dgl with specific other mutant genes of the genome. Most of the recombinants were tested over several generations; the results are given in the righthand part of Fig. 1.

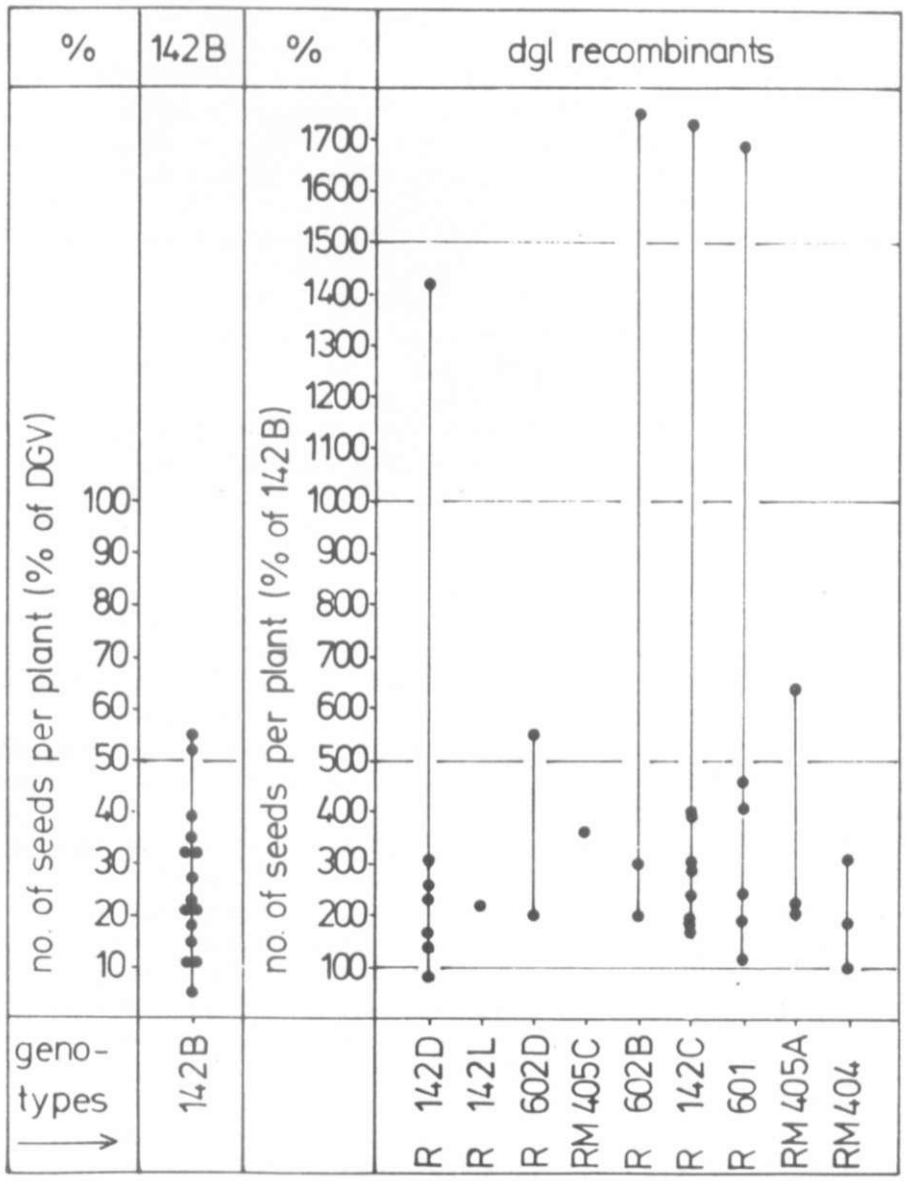

Fig. 1. Seed production of mutant 142B, homozygous for gene dgl, and of 9 different dgl recombinants. Each dot represents the mean value for one generation. The means are related either to the control values of the mother variety 'Dippes Gelbe Viktoria' (DGV) or to those of mutant 142B = 100% (dgl recombinants).

The graph shows that all the dgl recombinants studied were considerably more productive than the original dgl mutant in most generations tested. Extraordinarily high values were obtained for the following genotypes:

-R 142D- dgl and gbp (from 142B)
- short II for strongly shortened internodes (from 489C)
- a gene for linear stem fasciation with reduced penetrance (from 489C)

-R 142C- dgl and gbp_ (from 142B)
- weak stem fasciation with reduced penetrance (from 489C)

-R 601 - dgl and gbp_ (from 142B)
- long I for increased internode length (from 489C)
- weak stem fasciation (from 489C)
- smaller leaves (from 489C)

-R 602B- dgl and gbp (from 142B)
- weak stem fasciation (from 489C)

All these genotypes, as well as 142B, matured earlier than 'Dippes Gelbe Viktoria' (DGV).

In 1981 the yield of these four genotypes greatly surpassed their parental mutant 142B. That summer mutant 142B had a very low yield, only 5% of the control values of DGV. The four recombinants, however, varied between 1400 and 1750 percent of the corresponding values of 142B.

Clearly, dgl expression is highly dependent on environmental factors. Climatic conditions in Germany during May and June, 1981, were very unfavorable for mutant 142B. This, however, does not mean that gene dgl itself reacted negatively to these conditions. On the contrary, certain dgl recombinants reacted positively. Moreover, recombinants R 142C, R 142D, and R 602D had normal leaves in Varanasi, India.

Our results demonstrate that the selection value of mutant genes depends not only on specific environmental factors but also to a high degree on the overall genotypic constitution of the plants, the influence being positive or negative. Although dgl is not of any agronomic interest, similar improvements have been attained with genes of direct value for pea breeding, for instance with gene efr conditioning earliness (1).

1. Gottschalk, W. 1983. Int. J. Appl. Radiation. Isot. 34:827-832.

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