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## GENETICS

### Conditioned Lines of Flax

It was reported[1] that when different combinations of nitrogen, phosphorus and potassium fertilizer treatments were applied to plants of a single inbred variety of flax the large differences in plant size produced by the treatments were transmitted unchanged to their offspring and to the second and third generations. When a small type so obtained was crossed reciprocally with a large type the effect was transmitted through the male parent almost to the same extent as through the female. When the two types were reciprocally grafted, both types were identifiable in the stock and scion. It was concluded from this that the environment had induced at least semi-permanent changes in the nucleus or cytoplasm or in both. The following summarizes some of the results from further experiments, carried out in 1958, on the second, third and fourth generations of two extreme types, *NK* and *NPK*. *NK* refers to the descendants of plants treated in 1954 with nitrogen and potassium, and *NPK* to the descendants of plants treated in 1954 with nitrogen, phosphorus and potassium.

In the fourth generation the *NPK* plants were still several times the size of the *NK* plants and there was no evidence over all four generations that the difference between them was diminishing. Seed taken from the stock and scion of the reciprocal grafts of *NPK* and *NK* made in the previous year again produced plants of these two distinct types, and they were identical with plants grown from seed from ungrafted plants, or from plants with scions grafted on to like stocks. In all cases the plants were highly uniform, and the two types would appear therefore to be very stable.

Further reciprocal crossings of the two types show the transmission to be equilinear. It seems that the small deviation towards the female parent previously reported was a maternal effect due to those crosses being made between types growing in their respective environments in which they were conditioned. The $F_2$ showed more variability than the $F_1$ though no significant increase was obtained with the somewhat limited number of plants grown. A more extensive study is proceeding.

The $F_1$'s may show dominance depending on the environment in which they are grown, but heterosis occurred only in the $F_1$ seed weight. These departures from the mid-parent value do not necessarily mean that the primary effect of the environmental conditioning has been the induction of chemical changes on the chromosomes giving rise to genes with dominance relations. Purely quantitative cytoplasmic differences, for example, if transmitted equally through the male and female gametes, could produce an $F_1$ which differed from the mean of the parents in certain environments, and this may be more marked in some characters due to the interplay of physiological processes. Even so, whether the primary differences have arisen in the cytoplasm or in the nucleus they, together with the external factors, form the genic environment and it is the interaction between them all that must be resolved in a final analysis.

There was a significant difference between the log growth-rates of the two types but not between the log growth-rates of plants having the different fertilizers applied directly to them, although the final weight difference was of the same order in both sets. There are, therefore, fundamental metabolic differences between the two conditioned types, such as might be found between two different genotypes.

The first generation of a diallel cross between *NK* and *NPK* conditioned types and four other varieties, two of which were flax and two linseed, was analysed for a number of characters. They included plant weight, side-shoot weight, centre-shoot weight, height and length of side shoots. The most revealing picture was given by the array covariance/variance graphs using the method of genetic analysis of diallel tables of Jinks[2] and Hayman[3]. With each character, the points for the *NK* and *NPK* types on the graph were close together, although the points representing the other varieties changed their positions with the different characters analysed. It would appear from this that the *NK* and *NPK* types are identical in having similar dominant genes. They were also found to be identical in showing the same non-allelic interaction with one of the linseed varieties in side-shoot weight. Interpreted in another way, suppose the variety which was conditioned were entered twice in the diallel table, then a constant amount added to all the cells of the male and female arrays of one of the entries, to represent the larger (*NPK*) type, would give just such a result, for the addition of a constant amount would make no difference to the array variance or covariance. The similarity between the two types in showing no dominance or interaction differences might be taken as further evidence for the absence of residual genetic variability in the conditioned variety, but complete additiveness in effect of the factors responsible for the difference need not necessarily be expected in all environments for the reasons given above.

Finally, the range of types produced by the different combinations of fertilizer treatments of which the *NK* and *NPK* types are the extremes, resembles the continuous range of variation that might be expected from a genetically determined quantitative character, but the relationship between the two systems involved is as yet unknown.

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