GENETIC BASIS OF VARIETY REPRODUCTION IN THE PROCESS OF SEED-MULTIPLICATION OF CEREALS

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The investigated quantitative traits of common winter wheats for the size of variation coefficients are divided into three groups : (*a*) intensively modifying —the weight of a grains per line, a reproduction coefficient, the weight and number of grains per plant ; productivity tillering; (*b*) medium-modifying —weight and number of grains per ear ; (*c*) poorly-modifying—weight of 1000 grains and height of plants.

Samples from 100-800 lines of the varieties Moskovskaya 2453, PPG 186 and Mironovskaya 808 for the main quantitative traits of the yield elements, are characterised by higher genetic uniformity (homogeneity).

Samples from 100-200 lines completely reproduced all the traits of a higher main totality. This makes reasonable to use for the variety reproduction, a small number of plants in the primary chains of seed-farming.

A tendency observed, for some traits, to preserve the differences between average indices of samples, and the main totality cannot be used in respect of successive generations, because it is stipulated by modification variability and is quickly extinguished (dies down).

The occurrence of spontaneous hybrids and mutations in some lines shows that the varieties of winter wheats are characterised by hereditary variability, which at the low level of seed-farming, may lead to biological contamination and deterioration of a variety.

A variety in its mass consists of plants, uniform for its morphological traits and economical-biological properties. Plant uniformity, within a variety, is due to selection and is maintained by self-fertilization in self-fertilizing cultures, cross-fertilization in cross-fertilizing cultures and annual crosses in heterotic hybrids of the first generation.

A variety may be considered as a self-reproducing, relatively stable discrete biological system. The rate of the biological stability of a variety (plant uniformity) is determined by a constant mode of fertilization and the level of modification variability. The process of realization of a hybrid form into the variety goes in self-pollinators from heterozygosity to homozygosity on the basis of self-fertilization. Selection during self-pollination creates and fixes stable homozygous systems. Thats' why, self-fertilization, being a method, by which valuable economical-biological self-pollinators are selected, cannot be injurious. In the varieties of self-fertilizing cultures, depression, degeneration or aging do not occur under the influence of self-fertilization.

Any well-selected variety steadily maintains its hereditary qualities through a number of generations. But during reproduction and in the process of commercial utilization, economically-biological traits gradually reduce, and the variety is becoming worse (deteriorates). All kinds of the variety variability may be accurately scientifically investigated. The changes are due to the following main reasons :

(*i*) mechanical contamination and cross-pollination by other varieties, (*ii*) break-down and segregation, (*iii*) increase in plant diseases, and (*iv*) appearance of mutations.

Mechanical contamination and re-pollination by other varieties — This is one of the main and most dangerous reasons for deterioration of the varietal qualities. As a variety is a discrete biological system, its components (some individuals and their offsprings) may be not only interchanged, but also changed by others, during reproduction. Other components, able of independent reproduction of a qualitatively new biological system, may be involved in the given system after contamination.

The number of plants of the main variety and the admixture would be evidently determined by the ratio of their reproduction coefficients in a mutual sowing.

But if all the grown seeds are used every year for sowing, the complete ousting of admixtures is hardly expected. Even in the case, when the pressure of natural selection is the most strong, the reproduction coefficient falls to 1 (one grain gives only one grain), and the main variety reproduces with the same high coefficients; its complete ousting from the sowing is impossible.

As the less-yielding variety's admixture, in the sowings of a multiplying variety, in most cases, cannot be completely ousted under the influence of natural selection, and increases in the amount with each following sowing, contamination of seed-growing nursery gardens at the early stages of the variety reproduction, will be the most dangerous. That's why in all seed-growing nurseries, till the stage of superelite, no varietal contamination can be admitted, 100 per cent purity of varieties is necessary.

Biological contamination of varieties may also be due to natural cross-pollination. It is necessary to work out the standards of spatial isolation for seed-growing nurseries, for wheats. Observations showed, that various wheat varieties may be interpollinated at the distance above 100 m. It should be taken into account, that the admixture being involved in the sowing of the main variety, because of mechanical contamination, becomes the source of biological contamination.

Biological contamination of varieties may also occur as a result of the involvement of spontaneous hybridization of new forms, obtained due to mutations and splitting.

New formations, resulting from break-down (disintegration), may be caused by the heterotic conditions of a variety for one or the other trait (especially if it is polymerous) and by the mutation induction. New forms, appearing after the segregation, become the variety admixtures and often reproduce with the coefficient, similar to that of the main variety.

Segregation is well observed in nurseries, where offsprings of the first and the second years, are tested, each line and family must be thoroughly analysed. Sometimes, among the segregating families, more productive forms are observed as compared with the original variety. These may become the ancestors of new, more valuable varieties. Such forms are selected and sent to breeding nurseries for further study and reproduction.

In the primary chains of seed-farming, all the most effective means [individual selection, spatial isolation, dipping (picking), etc.] must be used; these means may completely eliminate diseases, and not admit their penetration through seeds into commercial sowings of a variety.

Spontaneous mutations may touch any morphological traits and economical-biological properties of the variety. Their number is comparatively small, but almost all of them are known to be injurious, i.e. disturb a form in course of natural and artificial selection biological system, which is the variety. Spontaneous mutations will reproduce in the mass of plants of the main variety as a usual variety's admixture mechanically contaminated. Because of modification and due to natural crosses it is very difficult to reveal and eliminate the mutations, especially those which deal with qualitative traits.

Due to the four reasons mentioned above, the varieties in industrial conditions decrease their economical-biological properties and deteriorate. To prevent this process, careful selection is used in primary seed-farming; the selected pure seeds are annually grown in order to substitute for large scale multiplication.

The selection efficiency depends, first of all, on the rate of hereditary, genetical changes between the individuals. In overwhelming majority of cases the hereditary variability of selected varieties is insignificant, it has not a mass, but an individual character and cannot be realised during seed-growing process, when not less than 40–60 per cent offsprings (families) serve as ancestors. Even in the most outstanding lines, their yielding advantages cannot be realised in the mass of selected plants.

The use of intervarietal variability is based on the individual selection of single, or not numerous plants. By this method, new varieties may be and, sometimes, are really created. But this work is rather related to selection work, but not to seed-farming.

From the aforesaid, it is quite evident that the tasks of selection and seed-farming are different. Seed-farming of these cultures is not the consequence of breeding work. Its task is the most complete realisation of the achievements of breeding work. Hence, selection in the seed-growing work with self-fertilizers is directed not to the improving, but to a more complete preservation of economical-biological traits of the cultivated (in agriculture) variety.

Seed-farming of cereals is conducted, in most cases, with the use of individual selection, according to a relatively short standard scheme; nursery for tests of the first-year offspring nursery, for tests of the second-year offspring, nursery for reproduction of superelite-elite. In this respect, the question of the scale of the primary seed-farming is of great importance.

A selected variety in self-pollinated crops derives from one elite plant and represents its multiplied progeny, consequently, it would be quite logical to suggest that its reproduction in the process of seed-growing is also possible from any strong plant, if it is not a mutant, a product of contamination or segregation (disintegration). Practically, for the foundation of a nursery to test the first-year offspring of any variety, several tens or hundreds of plants are always chosen. In each concrete case, establishing the number of selected plants, it is necessary, first of all, to take into account, whether a breeder or specialist, performing the primary seed-growing in a certain institution, has the possibility to observe each line and sort out nontypical and offsprings affected by diseases.

The question of the number of families, which should be kept in nurseries for tests of the 1st and 2nd-year progeny, and how rigid the sorting out should be, is of great importance. It is sometimes considered that more the offsprings are sorted out, the more effective is the primary seed-farming. But this conception has no theoretical and experimental basis. In the nurseries of primary seed-farming, the rigid sorting out of all hereditary deviations — nontypical for a given variety and affected by diseases lines and plants, must be carried out.

As far as the sorting out of negative modification deviations from the average productivity indeces is concerned, it is quite senseless in its nature. The presence of soil and other microdifferences, at any nursery, creates the modification variability; and consequently, many lines transfer for productivity from one class into another, when next year these are placed into changed growing conditions. The majority of lines, which have a decreased productivity, in nurseries for tests of the first-year offspring, restore it next year.

The modification variability is known to increase with increasing land in nurseries. This leads to an unwarranted (unjustified) high sorting out of the lines. That's why, it is not reasonable to lay a large number of lines in the nurseries for testing the first-year progeny, these should be distributed in a more levelled background, to intensify the sorting out of hereditary deviations and at the same time to diminish the sorting out of modification changes.

Nurseries for primary seed-growing, must be reliably spatially isolated from selection nurseries of a given culture, which are the centres of race formation of parasites and a constant source of mechanical and biological contamination of varieties.

The activity of the factors, causing varietal deterioration may be controlled and prevented during seed-farming. Seed-farming of self-pollinated crops must be based on the experimental data concerning the character of hereditary variability of varieties.

The task of our investigations was: to find out the nature of intervarietal variability of quantitative traits in winter common wheats, in order to determine the degree of genetic heterogeneity in varieties; to establish the number of lines, necessary for the reproduction of a variety type; to determine the degree of the influence on the progeny of the best and worst lines, different intensities obtained in those changes in economically important traits, which are clearly expressed at the moment of selection.

Three wheat varieties: Moskovskaya 2453, PPG 186 and Mironovskaya 808 were studied. These varieties differ in their eco-geographical origin, the methods of breeding and the duration of cultivation in agriculture.

The sowing was conducted at the Breeding-Genetics Stations, named after P. I. Lisitsyn, of Timiryazev Agricultural Academy, Moscow, in 1966–1969 according to usual methods. Plants of each line were harvested and separately analysed. The number of plants, height, number of productive stems, weight of grains and the number of grains per line were recorded; then average means of productivity elements of the lines were calculated, such as: weight and number of grains in an ear, weight and number of grains per plant, weight of 1000 grains, productive tillering.

For these traits (for each separately) the sorting out was conditionally conducted with the intensitivity of 25, 50 and 75 per cent. The obtained data were statistically analysed. In our experiment a relative mistake of selection average means for all the traits was < 2. Excellent and good accuracy of the average means of the traits, obtained in our experiment, and the narrow limits of confidential intervals for the average of traits for all the varieties, lead us to suggest that the studied varieties of winter wheats are reproduced for the yield structural elements upon the laying of 125 - 200 lines in breeding and seed nurseries.

It may be proved, that there is no danger of impoverishment of the variety's heredity with a decrease in the number of selected initial elite plants. The most of lines (75–90 per cent) were distributed for all traits in 4–5 central classes of the variation row (scale) with the total number of classes 7–20. Thus, a decrease of the number of lines in the primary seed-farming chains till 125–200, does not violate the genetic structure of the variety in self-fertilizing plants; at the same time, a careful estimation and selection of plants, which may be conducted thanks to a decrease in the number of lines, will enable to reject plants with hereditary deviations.

Since, the variability limits of the quantitative traits for varieties are rather large, the impression is that in genetical terms, the varieties are extremely heterogenous. That's why some investigators make a conclusion about the extreme effectiveness of intervarietal selections, creation of improved seed elite and the easiness of selection of new varieties from the old ones. The influence of selection of best lines upon the increase in the variety productivity, was studied. The selection of lines was conducted for each trait, taken separately (the sorting out intensivity was 25, 50 and 75 per cent), and its effectiveness in the posterity was defined by means of comparison of the whole totality with the samples of best and worst lines. In the year, when the selection was made, in the variety Moskovskaya 2453 the weight of grains in each line with the samples from 437, 291, 146 best families exceeded the control (all 583 lines) by 12.5; 24.3 and 39.9 per cent respectively; and in the sorted out lines 39.9, 146, 291 and 437 it delayed for productivity by 37.4, 24.4 and 13.4 per cent respectively as compared with the families of the main productivity. In the variety PPG 186—in the samples from 384, 256 and 128 best lines the harvest exceeded control (512 lines) by 10.7, 21.9, and 34.2 per cent, and the worst families were less yielding by 35.1, 21.9 and 11.4 per cent respectively as compared with the control, the difference was significant at the level of significance of 0.1 per cent. Analogous results were obtained for the variety Mironovskaya 808. After re-sowing, made next year, these differences were smoothed down. In the samples approximately of 800, 600, 500, 400, 300, 200, 100 lines the same average yield was obtained from each plant. This indicates that groups of the lines may completely reproduce given varieties for a studied trait. For the studied varieties we failed to select the lines which could be high- or low-yielding during three years. Consequently, during selection in seed-growing nurseries not hereditary best lines, but positive modifications are selected, the appearance of which is due to the variability of traits. In the number of grains per ear, in the year of selection, samples of all three varieties differed significantly from the control; differences between them were 5.5 - 18.5 per cent — in the group of best lines; and 16.7 - 6.1 per cent—in the group of worst lines. During next two years, all groups of lines had significantly the same numbers of grains per ear.

The weight of 1000 grains is scored with the highest accuracy, and it is easier to reveal genotypic differences for this trait than for the others. The study of the influence of selection for the weight of 1000 grains in winter wheats also gave no ground to think, that the sorted out lines remain the worst in the progeny. For example, in the variety Moskovskaya 2453 at the year of sorting out, the weight of 1000 grains of, on average, 146 worst lines was by 3.8 per cent less than in control (583 lines). During next two years these differences completely disappeared.

The data obtained for the other studied traits — the reproduction coefficient, number and weight of grains per plant, grains weight per ear, productive tillering and height of plants, — confirm the conclusions on the nonefficiency of intervarietal selection for quantitative traits and the possibilities to reproduce all recorded traits of the varieties, when only a few lines are at disposal. But it would be a great mistake to consider the constancy of winter wheat varieties to be absolute. These are also characterised by hereditary variability which may be due to two reasons: rearrangement of existing or occurrence of new genes.

The process of natural mutagenesis was observed in all the species and varieties, but the degree of its expression is different. Wheat has low mutability and high constancy. During four years only comparatively easily visible mutations were obtained in the lines of winter wheats. It appeared to be impossible to reveal small mutations touching the quantitative traits. In the variety Moskovskaya 2453 two lines were obtained for morphological and biological traits, which differed from the original variety; line 447 consisted of two plants of the subspecies *erythrosperum*, with globe-shaped grains; and line 537 consisted of two plants — *milthurum*. On re-sowing both lines gave a hybrid progeny.

Three lines were discovered in the variety PPG 186, which gave segregation when re-sown in the following year. One of them is the mutant, which differs from the original variety for several traits (leaf plates are broader and more intensively stained; depart from the stem, at an acute angle before the earing; ears have bright anthocyanin colour, ripening occurs 12 - 14 days later).

Particularly intensive segregation was observed in the variety Mironovskaya 808 : in seven lines one year, and in 37 lines — the following year. This indicates a significant heterozygosity for morphological traits, despite the study of quantitative economically important traits such a phenomenon was not observed.