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CONTRIBUTION TO DEFINING THE INHERITANCE OF EARLINESS IN SUNFLOWER AND THE METHOD OF ITS EXPLOITATION IN BREEDING

By

Kovacik A., Skaloud V.

In some regions of sunflower cultivation a short vegetation period has been the limiting factor of its successful gorwing. In northern regions relatively early forms prove thus promising being capable to produce high yield of achenes even under conditions of a short vegetation period. Early sunflower types are successful not only in colder regions but also in regions in which plants are negatively influenced by drought at the end of its increased claims on water. Breeding early sunflower necessitates to recognize decisive developmental phases of the plant as well as to respect the commonly known dependence of the seed and oil yields upon duration of the vegetation period.

The vegetation period with sunflower can be essentially divided into two fundamental components, first of them being the period until florescence and the second one after blossom-fall. Somewhat simplified denoted, the phases after blossom-fall are decisive for a high total weight of achenes as well as for the high content of oil in seed. In contrast to it, the period until florescence exerts a decisive influence by means of the means of the number of set flowers as well as their ability to develop the final quantity of seeds. The intention to shorten the period after blossom-fall seems rather problematic, while the period until florescence can be shortened in considerable extent: the heads may be of only medium size provided they produce a sufficient quantity of well developed seeds. Therefore, shortening of the vegetation period is to beintended on the period between sowing and inflorescence. This opinion, being supported by data on hereditary variability has thus to be respected in breeding. Within the program of line-hybrid breeding it was shown that, concerning duration of the period until florescence, uniform and stable lines can be developed more easily than lines with uniform period after blossom-fall. Also different duration of both essential vegetation phases with plants cultivated in less suitable climate conditions confirm a greater stability of the phase until inflorescence, as compared with that after blossom-fall. Apparently, the period between sowing and florescence represents a less variable component of the vegetation period; it is thus stronglier inherited than the period after blossom-fall is.

Regarding the relation of essential developmental phases to yield components, and also its more simple hereditary determination, the phase between germination and florescence seems to be decisive for shortening the total vegetation period.

Summary Resultats and Discussion

The period until florescence can be virtually differentiated into three developmental phases as follows: the period of emerging, the dperiod between emerging and head setting, and the period between head setting and florescence.

In our experiments the first two phases were fused into one phase, because the time of emerging, though being a hereditary character, is considerably variable under field conditions due to variations in soil cultivation and drilling.

In principle, both studied phases prove divergent distributions of phenotypes in F_2 and F_3 generations after crossing lines divergent in duration of given developmental phase. The phase between sowing and head setting, with variation spread of 37-59 days in F_2 generation, shows the phenotypical distribution corresponding to additive inheritance with greater number of genes involved. On the contrary, the phase between head setting and florescence, showing the variation spread of 18-35 days, proves, in generation F_2, a phenotypical distribution which is characteristic for dominance, a small number of genes being involved. The final distribution of phenotypes for the total period between sowing and florescence has been derived from the combination of both partial distributions which correspond to additive dominance.

It can be stated that duration of the phase between emerging and florescence, which proves a greater genetic stability than duration of the period after blossom-fall does, is a complexly inherited character being conditioned by combined effect of several gene systems. From two components of this complex character the period between head setting and florescence has been much simplier inherited. Phenotypes which tend to prolongate the phase after head setting are dominant over those with a short period between head setting and florescence. In breeding on earliness the highest effect may be expected if lines are selected with a relatively short period between the "star" and florescence. Subsequent developmental phases are inherited somewhat more complexly so that selection for shortening them encounters some difficulties.

Besides studies on inheritance of individual well defined developmental phases our interest was concentrated to elaborating biometrical methods to be exploited in selecting hybrid progenies manifesting the highest ratio of recombinations in which close correlations between total period until florescence and its two composing phases are mostly disturbed. Progenies selected by this method then become suitable initial material for breeding early forms which could not be otherwise exactly distinguished in a great set of F_2 generations. For to identify recombined progenies methods were employed of partial correlations and of sector coefficients between individual components and the complex character. Relations between individual phases of earliness and the total period between sowing and florescence should commonly exhibit a partial correlation = 1.0. This fact fully corresponds to the supposition of a complete dependence between all three characters in question. The genetic interpretation of experimental data by the proposed method has been derived of the fact that in both parental and F_1 generations, in which no segregation of recombined genotypes can be expected the functional dependence is being maintained between the complex character and its components. In generations F_2, in which both standard and recombined genotypes segregate, offsprings with disturbed functional dependences can occur. In our experiments, among 33 hybrid progenies of generation F_2, eight progenies were selected which had manifested partial correlations divergent from 1.0. In this restricted set of eight progenies successful selection can be performed for shortening of any of both vegetation phases. In offsprings, in which partial coefficients are equal to 1,0, no response to selection on shortened vegetation period can be expected. Reversely, among selected recombined offsprings a number of individuals will occur with different combinations of duration of the period between sowing and head setting, and of the period between head setting and florescence, the total vegetation period being unequal. In mentioned progenies selection may be successful.

The analysis of partial correlations makes possible to choose offsprings for selection while the analysis of sector coefficients shows, what aim of selection each selected offspring can be utilized to. As far as shortening of the period between head setting and florescence is being emphasized, offsprings are to be exploited which are characterized by a relation P_{13} P_{23}. Parental lines and F_1 hybrids exhibit a stronglier dependence of the period between sowing and florescence on the period between sowing and head setting. In generation F_2 seven offsprings occurred with a changed relation of sector coefficients; it means with a stronglier dependence of the total period on the period between the "star" and florescence. For selecting on increased role of the second period in forming the complex character, only one offspring, namely 198/7, proved important, because its exceptional character was documented so as by the analysis of partial correlations so by the analysis of sector coefficients.

In our experiments with the vegetation period in sunflower a parallel application as well as mutual confrontation of the method of partial correlations and that of sector coefficients made possible to choose, among more than thirty offsprings, one offspring to be exploited for selecting on shortened developmental period between head setting and florescence and, in this way, for increasing the earliness of the plant without any definite depression in the yield of oil. Analogic methods were also applied for the evaluation of a set of plants influenced by different doses of gamma irradiation or by NMM chemomutagene. From evaluation it follows that acute gamma irradiation by 3000 r as well as NMM solution at 1.0 mM do not result in any disturbance of the functional dependence between earliness, as complex character, and its components in generation M_3. As compared with hybridization of selfed lines mutagenesis seems thus less efficient for breeding early sunflower.

Results of our experiments concerning genetic and breeding aspects of earliness in sunflower can be summarized in the following way. The developmental phase between head setting and florescence is of decisive importance. This phase is relatively most simply inherited. Suitable initial material for developing early sunflower can be produced more easily by hybridization of lines than by mutagenesis. Recombined hybrid progenies can be identified by the method of parallel evaluation of generations F_1 and F_2 by means of partial correlations and sector coefficients between earliness, as a complex character, and its components, one of which being represented by the phase between head setting and florescence. Results of an actual experiment made apparent that the ratio of suitable hybrid combinations for developing early sunflower was not too high fluctuating about 5%.

TABLE 1. Values of partial correlation coefficients between earliness and its two components.

Number of variant	$r_{13.2}$	$r_{23.1}$
P		
59	1,0000	1,0000
60	0,9952	0,9970
61	1,0000	1,0000
62	0,9964	0,9997
F_1		
59 x 60	1,0000	1,0000
59 x 61	1,0000	0,9999
59 x 62	0,9975	0,9996
60 x 59	0,9910	0,9972
60 x 62	1,0000	1,0000
61 x 59	1,0000	1,0000
61 x 60	1,0000	1,0000
61 x 62	0,9944	1,0000
62 x 59	1,0000	1,0000
62 x 60	1,0000	1,0000
62 x 61	0,9927	0,9988
F_2		
192/9	1,0000	1,0000
3	1,0000	1,0000
5	1,0000	1,0000
191/3	0,9340	0,9792
1	0,9998	1,0000
10	0,9986	0,9973
190/10	0,9998	1,0000
6	1,0000	1,0000
5	0,9998	1,0000
193/7	0,9989	0,9997
5	1,0000	1,0000
8	1,0000	1,0000
194/10	0,9994	0,9989
8	1,0000	1,0000
4	0,9599	0,9667
197/8	1,0000	1,0000
2	0,9965	0,9992
4	0,5923	0,7546
195/6	1,0000	1,0000
1	0,9998	0,9998
4	0,9996	0,9997
196/5	0,8659	0,9739
4	0,8660	0,8700
3	0,5244	0,8364
199/2	1,0000	1,0000
8	1,0000	1,0000
1	1,0000	1,0000
198/7	0,7939	0,7815
2	1,0000	1,0000
9	0,9995	0,9989
200/7	0,8840	0,9515
1	0,9996	1,0000
3	0,9991	0,9993