

**THE INFLUENCE OF INBREEDING AND SIB CROSSING ON THE
CHARACTERS OF PRODUCTIVITY IN SUNFLOWER**
(*HELIANTHUS ANNUUS* L.)

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At present, sunflower breeders have on a large scale developed hybrids on the basis of cytoplasmic male sterility which exhibit high hybrid vigour. In connection with this not only the efficiency of hybrid seed production but also problems of economical production of the initial material, i.e. of inbred lines, are of great interest. Therefore it becomes important to investigate the effect of long-lasting inbreeding on various agronomically important characters of sunflower, as well as to compare the consequences of inbreeding and sib-crossing in the course of inbred line development.

A general comparison of sib-crossing with inbreeding may prove the advantage of sib-crossing, namely concerning the amount of seed yield as well as the general vitality of lines. On the contrary, inbreeding contributes to a quicker development of the homozygous lines that would be useful in producing sunflower hybrids. Moreover, inbreeding can be considered technically and practically a less expensive method than sib - crossing.

This paper deals with the evaluation of inbreeding effect in relation to sib-crossing in various characters of sunflower plants.

We investigated the influence of long-lasting inbreeding, in the form of selfpollination within the head, on the decreasing values of some important characters. At the same time we judged the influence of sib-crossing on the possible increase of the intensity of some characters in sunflower lines with various degrees of long-lasting inbreeding. In the case of I_2 generation, we investigated a continuous sequence of inbred generations that succeeded the sib-crossing by which the course of the inbreeding had been interrupted.

The population of the new strain Ruzyňská No 9 was employed as experimental material from which lines of six inbreeding generation were developed. Investigation on the following eleven characters was

included into experiments : four characters concerning the type of plant growth, two connected with the earliness, and five characterizing the yield performance of the sunflower crop.

SOME SHORT RESULTS

The first character, namely, the height of plant, was measured in four terms. Within the period of 30—60 days after sowing the height of plants in the inbred generations decreased gradually from I_0 to I_5 , in the latter one the minimum inbreeding being attained. With the increasing number of days after sowing, the difference between I_0 and the subsequent inbred generations increased too. A comparison at the time of full ripeness proved the continuous reduction in plants height, as influenced by inbreeding, up to the generation I_6 (90% as compared to I_0). The minimum inbreeding was more apparent in early terms of measuring than at full maturity. Thus the influence of inbreeding on the plant height was mostly pronounced up to the flowering time while later, the differences between the inbred generations were not to remarkable. Sib-crossing favoured the height of plants, namely in I_4 generation, when hybrid vigour, measured 60 days after sowing attained 110,6%. In other inbred generations the effect of sib-crossing was not significant.

The average diameter of the head decreased from I_0 to I_4 , the minimum attained being 84,4% of the average diameter of I_0 generation. The seed yield decrease got its minimum value in I_4 dropping even up to 11,6% of the I_0 value ; in subsequent generations it was restored again up to 28%. As compared to the parental inbred generations I_2 and I_6 , sib-crossing does not result in any increase of the seed yield ; on the contrary, its very strong influence was apparent in I_4 generation which manifested the minimum inbreeding. In this case, hybrid vigour resulted from sib-crossing amounted even to 438.5%. A similar tendency may also be observed in thousand kernel weight, the value of which dropped considerably in I_2 and I_4 . In contrast to the other yield characters, the oil content in dry-matter of kernel was slightly reduced by inbreeding, and sib-crossing in the generation of the minimum inbreeding did not cause any increase in it.

Comparing different individual characters according to the number of inbred generations before the minimum inbreeding was attained it is evident that all the yield characters reached their minimum values in I_4 while characters such as the number of days up to the flowering time and the height of the plant measured 30—60 days after sowing, in I_5 generation ; the height of the plant at the harvest time achieved its minimum even in I_6 generation. The degree of reduction in the generation with minimum inbreeding, as compared to the initial I_0 generation, was extremely different for various characters. The most distinct decrease was noticed in the weight of seeds per head ; as compared to the I_0 generation, this character attained only 11.6%. The thousand kernel weight proved also a considerable reduction caused by inbreeding.

A relatively less pronounced influence was found in such characters as the number of days up to flowering time and the height of the plant at full maturity. Comparing the hybrid vigour after sib-crossing in I_2 and after crossing also in I_2 two lines originating from the same initial population, it is obvious that sib-crossing did not cause any perceivable hybrid vigour while, as a result of crossing between lines, some characters, except for the number of days up to flowering time, exhibited considerably pronounced hybrid vigour.

In contrast to the I_2 generation, in which no hybrid vigour caused by sib-crossing was observed, most characters manifested in I_4 higher values after sib-crossing than the parental plants. It is evident that, in inbred generations which approach to the minimum inbreeding, sib-crossing results in a markedly pronounced hybrid vigour.

For considering the advantage of sib-crossing over the inbreeding, it is important to compare the F_1 generation after sib-crossing with the progeny obtained by inbreeding within the same generation, when sib-crossing was made. Comparing the F_1 generation subsequent to sib-crossing carried out in I_2 or in I_3 , the favourable effect of sib-crossing on the weight of achenes per head is evident. In this case, sib-crossing provided an increase up to 177.7% of the inbred control. The favourable influence of sib-crossing in other characters fluctuated between 101—112% of the inbred control. In the generation I_4 which is closer to the minimum inbreeding, the advantage of sib-crossing is even more pronounced, attaining 245.9% at the character „weight of achenes per head“. Besides the fact that sib-crossing is able to substitute the inbreeding and thus to improve the general state of plants as well as to increase the production of seeds for multiplication, the appropriate frequency of sib-crossing into the progressive sequence of selfing generations is also of great importance. From evaluating the minimum inbreeding of some selfing generations subsequent to sib-crossing made in I_2 , it is apparent that, as compared to F_1 generation, the decrease in yield characters is not significant. Concerning the weight of achenes per head, the minimum inbreeding reaches 96.6% of the F_1 generation; in opposition to it, however, as a result of inbreeding subsequent to sib-crossing, plant height was reduced considerably. From the experimental data it may be deduced that the inclusion of sib-crossing into the sequence of selfing generations proved useful for increasing seed yield, its frequency, however, must not be too high.

Instead of employing continuous sib-crossing or including sib-crossing every other selfing generation, it seems preferable to employ a continuous sequence of selfing generations interrupted by sib-crossing from time to time. The most appropriate scheme is represented by including sib-crossing into some early selfing generations, i.e. in I_2 or I_3 , and later on again after three or four selfing generations. In agreement with most of the authors dealing with inbreeding in sunflower we got the minimum inbreeding for the majority of characters

in I_4 — I_5 generations, the decrease in seed yield being much more pronounced than in other characters.

It may be concluded that for the majority of characters the minimum inbreeding was reached in I_4 or I_5 generations. The most considerable decrease was observed in weight of achenes per head as well as thousand kernel weight. The highest hybrid vigour, obtained as a result of sib-crossing, was ascertained in the generation in which the minimum inbreeding was attained. In I_2 no significant hybrid vigour was observed after sib-crossing while crossing between lines in the same generation resulted in considerable hybrid vigour, F_1 generation after sib-crossing significantly exceeded the parallel selfing generation in seed yield. These facts give evidence on the favourable influence of sib-crossing in producing inbred lines. Selfing generations subsequent to sib-crossing did not markedly differ in their yielding capacity from F_1 generations. Thus the intervals of including sib-generation into the sequence of selfing generations can be prolonged.

REFERENCES

- Boguslawski E., Schuster W., 1955, *Mehrjarige Untersuchungen über Inzucht und Heterosis — Erscheinungen bei der Sonnenblume*, Z. f. Pflanzenzüchtung, 35.
- Kováčik A., Škaloud V., 1972, *The Proportion of the Variability Component Caused by the Environment and the Correlations of Economically Important Properties and Characters of the Sunflower*, Scientia Agriculturae Bohemoslavaca, Tomus 4 (XXI) 1972 — Nr. 4.
- Kováčik A., Škaloud V., 1972, *Combining Ability and Prediction of Heterosis in Sunflower*, Scientia Agriculturae Bohemoslavaca, Tomus 4 (XXI) — Nr. 4.
- Schuster W., 1970, *Die Auswirkungen der fortgesetzten Inzucht von I_0 bis I_{18} auf verschiedene Merkmale der Sonnenblume*.
- Škorić D., 1969, *Ulicaj samoopyloduje na najvažnija svojstva suncokreta*, Zbornik Radova 7, Novi Sad.
- Stojanova J., 1972, *Les possibilités de sélection dans les lignées primaires et les effets dépressifs de l'autofécondation chez le tournesol*, Fifth international sunflower conference, Clermont-Ferrand.
- Unrau J., White W. Y., 1944, *The yield and other characters of inbred lines and single cross of sunflowers*, Scient. Agriculture, 24, 11.