Contribution to the evaluation of self-fertile lines of sunflower-genetic interpretation

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Abstract

Of the presented ways of pollination autogamy, geitonogamy and free pollination were used in the trials. Inheritance of self-fertility is governed by a higher number of genes. Materialisation of the trait depends to a considerable degree on the way of pollination. In interactions dominance and additivity prevail.

Keywords: line crosses, self-fertility, inheritance of trait

Introduction

In the scientific journal Helia, No. 20 of the year 1994 our paper " Findings on sunflower self-fertility in connection with line hybridisation" was published. It dealt with experiments on hybridisation of self-fertile lines from the point of view of their reaction in crosses, i.e. application in the hybrid breeding.

This contribution is continuation of the above mentioned paper. It evaluates self-fertility of the same lines from the point of view of inheritance of the trait. The original trial was completed by an analysis of crosses of lines with extreme expression of self-fertility, that were not yet available at the first stage of the experiment.

Methods and material

The most important methodical part is application of various ways of pollination. Ways of pollination are given in Fig. 1. Of the presented ways of pollination autogamy, geitonogamy and free pollination were used.

As material, lines differing in the achene set after application of autogamy and geitonogamy (further A and G) were used. Line characteristics from the point of view of self-fertility level are presented in Fig. 2. Of it a certain classification of lines can be derived.

1. Lines with a high level of self-fertility after A and G-line 5.
2. Lines with a medium level of self-fertility after A and a high level after G-lines 3 and 6.
3. Lines with a medium level of self-fertility after A and G-line 2.
4. Lines with a low level of self-fertility after A and a medium level after G-line 4.
5. Lines with a low level of self-fertility after A and G-line 1.

After free pollination three categories can be formed: achene set up to 60% (lines 1 and 2), 60-80% achene set (lines 3 and 4) achene set over 80% (lines 5 and 6).

Results

Fig. 3. Indicates that excess above the average of parental lines achieved by hybrids after free pollination in the combination 1x2, 1x3 reaches 25-30% in the combinations 1x6 and 3x4 it reaches 15-20% and in combinations 3x6 and 5x6 only 0-10%. This shows that a

significant enhancement of the achene set after optimal pollination (free pollination) manifests in the most distinctive way in hybrids of lines with a low or medium level of self-fertility.

Comparison of the average of parents with hybrids presented in Fig. 4. shows that after geitonogamy most hybrids (except combination 3x6) exceed in the achene set the average of parents. This situation can be connected either with the expression of hybrid vigour or with dominance effect of the more efficient parent. In comparison with the more efficient parent hybrid vigour manifests only in combinations 1x2 (25%) and 3x4 (10%). Comparison of the average of parents with F2 generation shows that even in these cases the set of achenes is influenced also by dominance of the more efficient parent besides the hybrid vigour. It is obvious that in inheritance of the achene set after geitonogamy the prevailing principle is incomplete dominance, in a lower number of cases intermediarity (combination 3x6). Hybrid vigour contributes to the expression of the trait particularly when parents show a lower level of self-fertility.

After autogamy the situation is slightly different as is evident in Fig. 5. In two combinations 3x4 and 3x6 achene set in the hybrid decreased in comparison with both parental lines, in combination 1x3 is the decrease noticeable in comparison with the more efficient parent. In these cases the level of achene set in F_2 is also higher than in F_1 which shows dominance of the parent that inclines to a low level of self-fertility. A situation close to the dominance of the self-fertile line or the effect of hybrid vigour is rather manifested in other combinations.

To make the above mentioned conclusions more precise an additional experiment was carried out in which only extreme categories of lines were crossed. Results of the cross of the line A (with 86% self-fertility after geitonogamy and 67% after autogamy) with the line B (showing achene set 16% after geitonogamy and 4% after autogamy) are presented in Fig. 6. The same self-fertile line was further crossed with other five almost self-sterile lines (achene set after autogamy 2-6%, after geitonogamy 11-22%). Results of these crosses are given in Fig. 7 and 8. Fig. 6 shows that the level of the hybrid in F1 generation corresponds to incomplete dominance of self-fertility after geitonogamy and incomplete dominance of self-sterility after autogamy. Fig. 7 shows that incomplete dominance of self-fertility after geitonogamy manifests in two out of five cases. Remaining three cases are closer to the expression of intermediarity. Fig. 8 presenting expression of the same trait after autogamy has a reverse trend. Two out of five crosses show more or less intermediarity, three other crosses show a trend to dominance of the self-sterile line.

Conclusion

Inheritance of self-fertility is conditioned by a higher number of genes. In their interactions two basic principles prevail, dominance and additivity. The degree of trait expression largely depends upon the way of pollination eventually form of self-pollination. After geitonogamy interactions among genes determining inheritance of self-fertility are expressed in various degrees of incomplete dominance of self-fertility, absence of dominance-intermediarity is the extreme case. On the contrary after autogamy the final effect manifests by a trend to incomplete dominance of self-sterility (eventually low degree of self-fertility) or again by a trend to a state close to intermediarity.

From the point of view of plant breeding the above mentioned way of inheritance can be

materialised in the maintenance of lines, as well as for influencing the number of fertilised achenes in the hybrid under less favourable conditions for the pollination (lack of pollinators, unfavourable weather at flowering, either too hot and dry or too cold and wet).

Hybrid developed by crossing two self-fertile lines can achieve a high degree of achene set even under unfavourable conditions for the pollination. Both lines can be also maintained easily by the most labour-saving way, autogamy.

Hybrid developed with participation of a line with medium level of self-fertility (offering a higher achene set only after geitonogamy) will achieve under unfavourable conditions for the pollination slightly decreased achene set and the parental line must be maintained by a more laborious geitonogamy. Application of a line with a high trend to self-sterility in the development of hybrids should be only an exceptional case. Only in the case when such a line is an exclusive donor of the necessary genes its use can be justified. Hybrid developed with participation of an almost self-sterile line is exposed to the risk of a very low achene set under unfavourable conditions for pollination and is able to give high yields only under optimal conditions for pollination. The line itself is worse maintainable, successful self-fertilisation can be usually achieved only when a laborious way of pollination-adelphogamy (see Fig. 1) is used.

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Fig. 1

Ways of sunflower pollination.

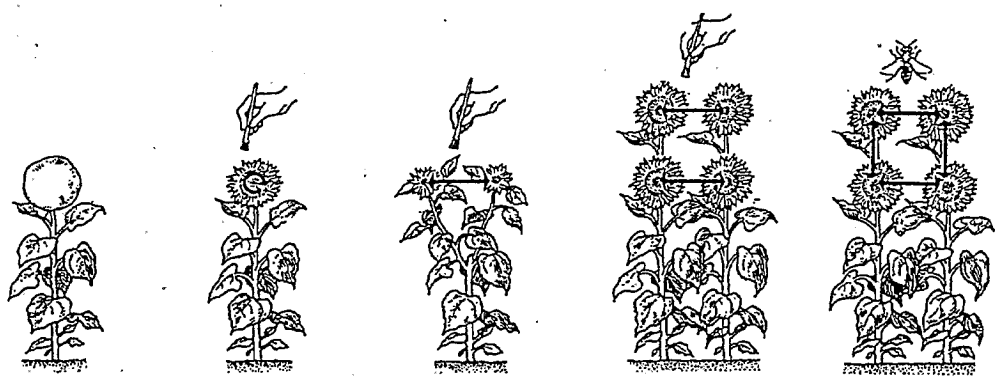


Fig. 2

Comparison of lines as for fertilized achenes after autogamy, geitonogamy and free pollination.

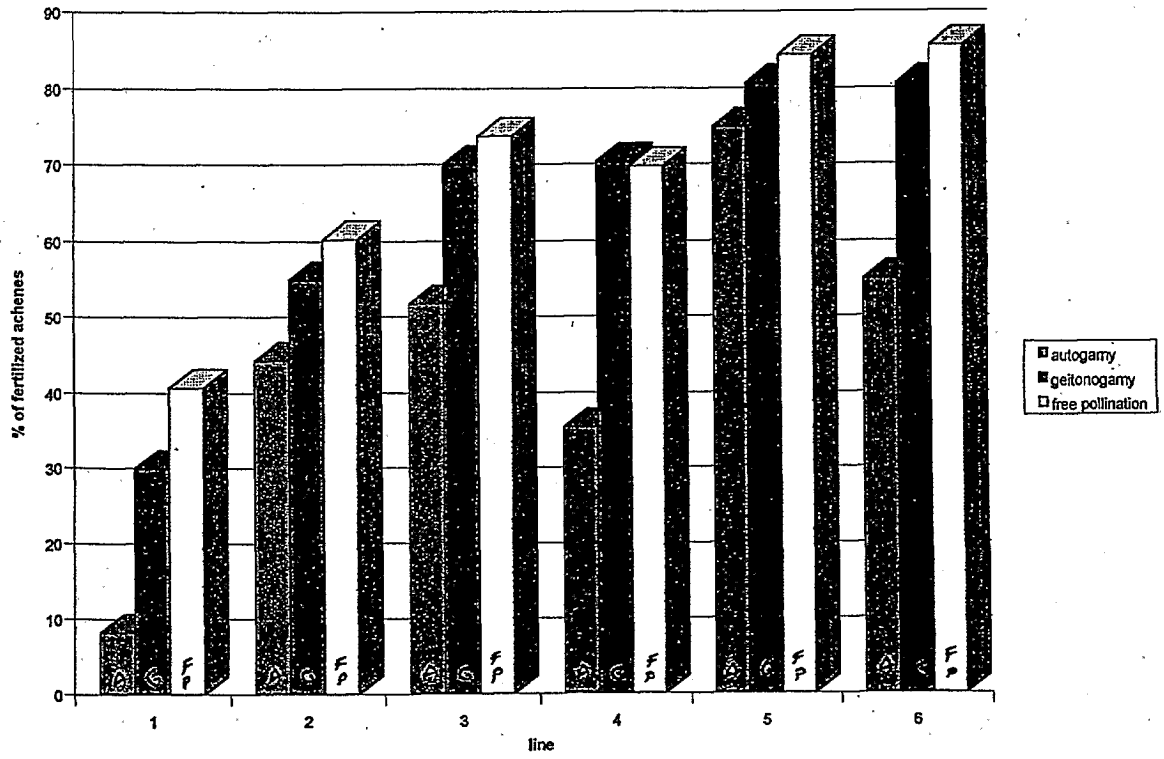


Fig. 3

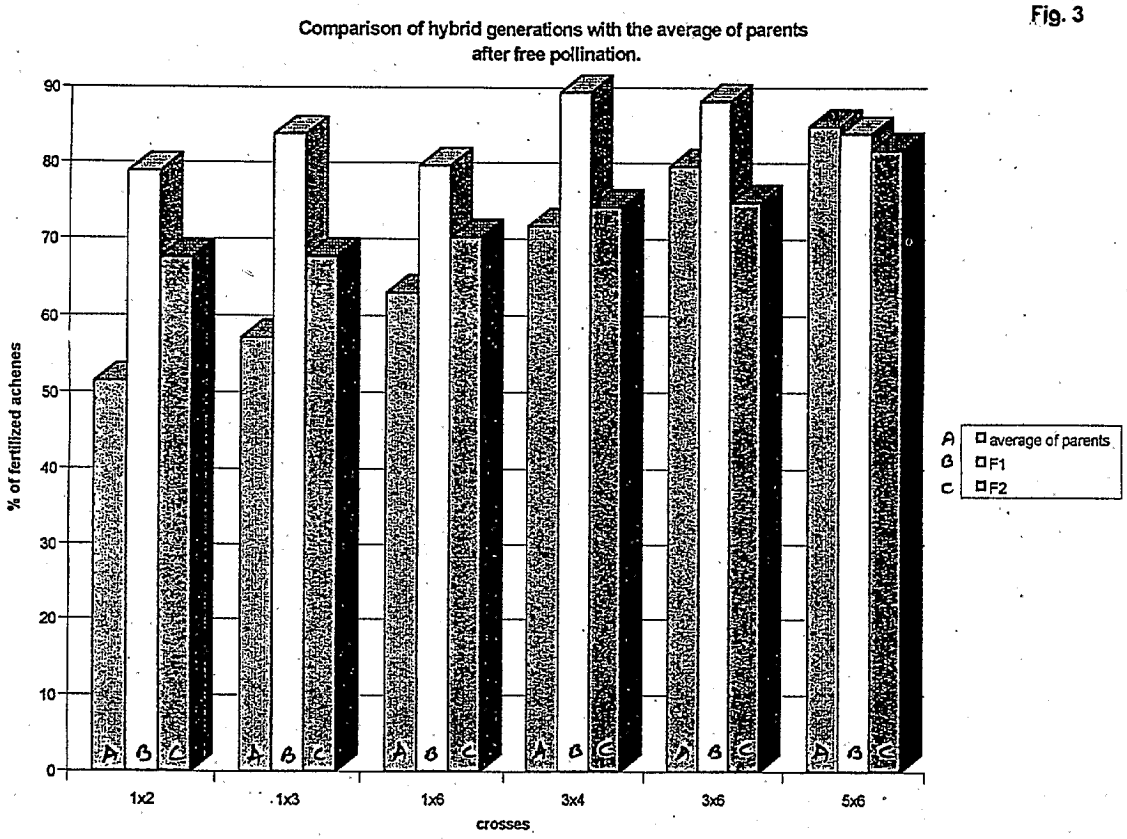

Comparison of hybrid generations with the average of parents
after free pollination.
% of fertilized achenes
90
80
70
60
50
40
30
20
10
0
A
B
C
1x2
1x3
1x6
3x4
3x6
5x6
crosses
A average of parents
B F1
C F2

Fig. 4

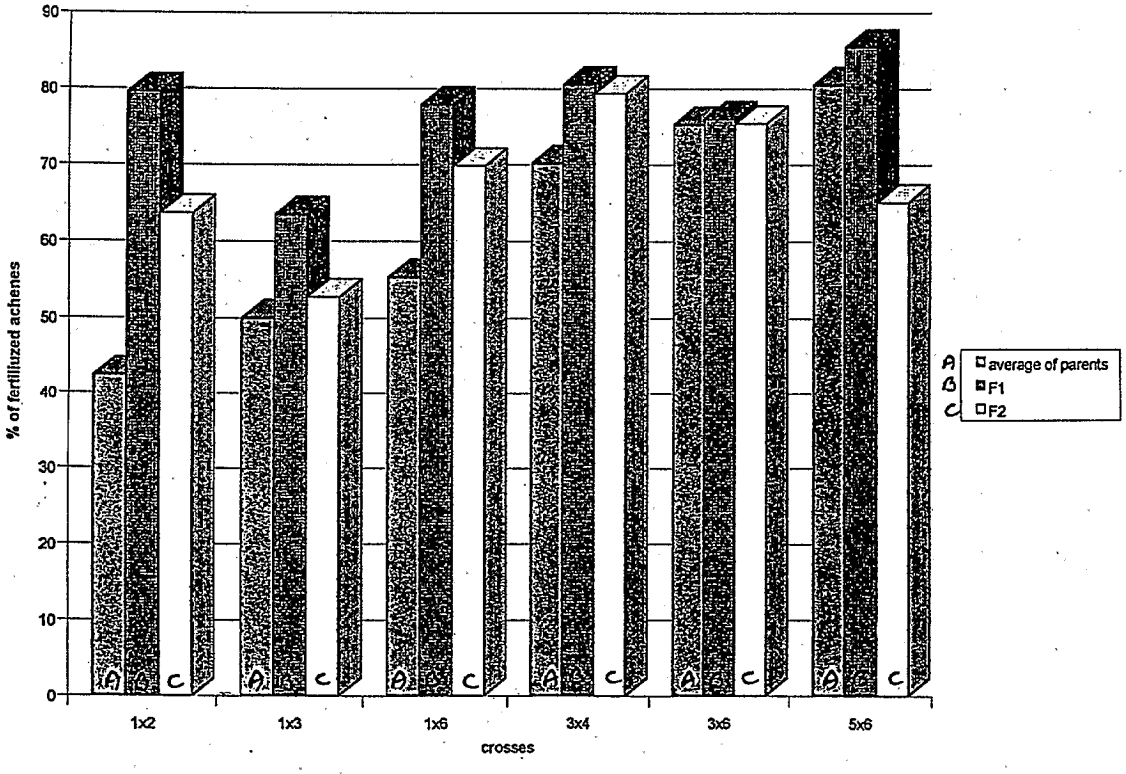

Comparison of hybrid generations with the average of parents
after geitonogamy.
% of fertilized achenes
90
80
70
60
50
40
30
20
10
0
A
C
1x2
1x3
1x6
3x4
3x6
5x6
crosses
A average of parents
B F1
C F2

Fig. 5

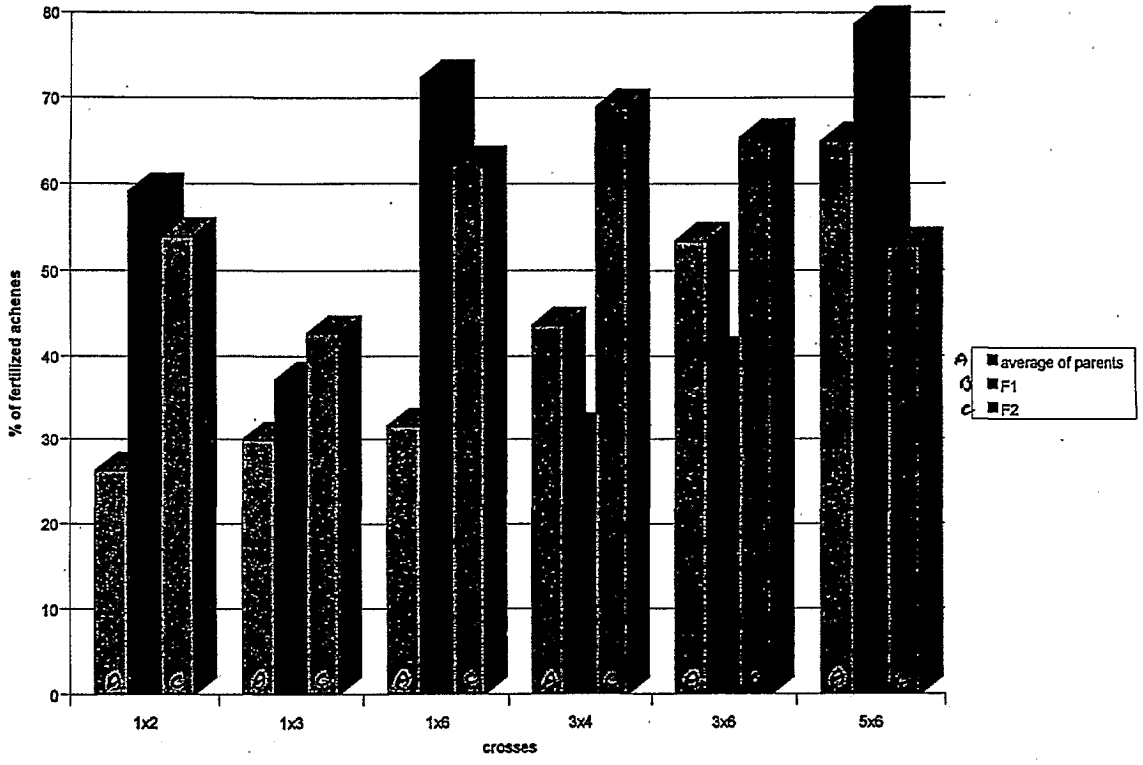

Comparison of hybrid generations with the average of parents after autogamy.
% of fertilized achenes
0
10
20
30
40
50
60
70
80
1x2
1x3
1x6
3x4
3x6
5x6
crosses
average of parents
F1
F2

Fig. 6

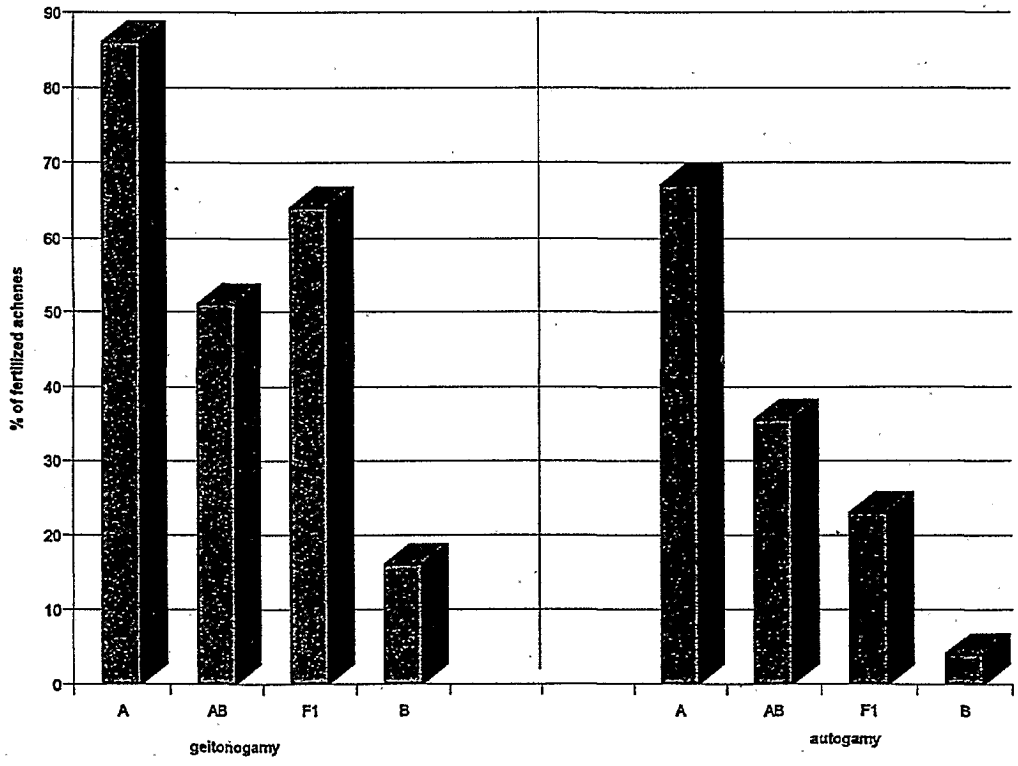

Result of crosses of two lines with extreme levels of self - fertility after geitonogamy and autogamy.
% of fertilized achenes
0
10
20
30
40
50
60
70
80
90
A
AB
F1
B
geitonogamy
A
AB
F1
B
autogamy

Fig. 7

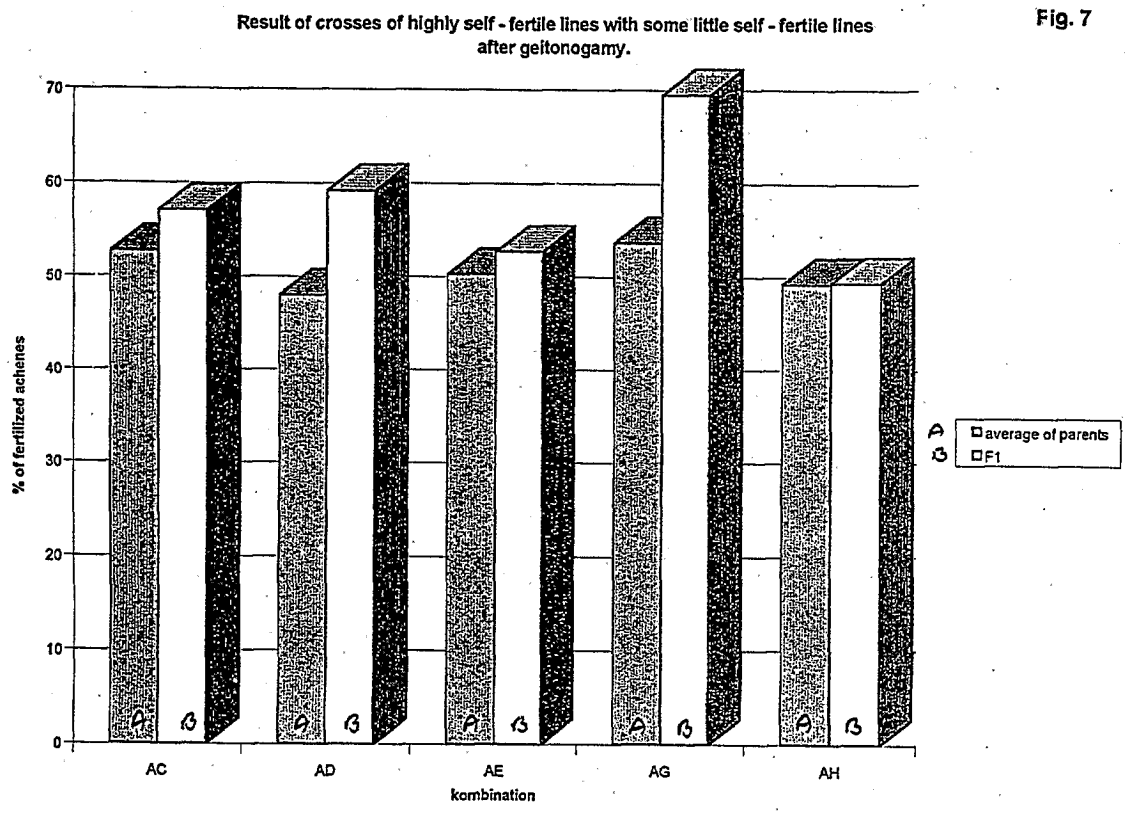
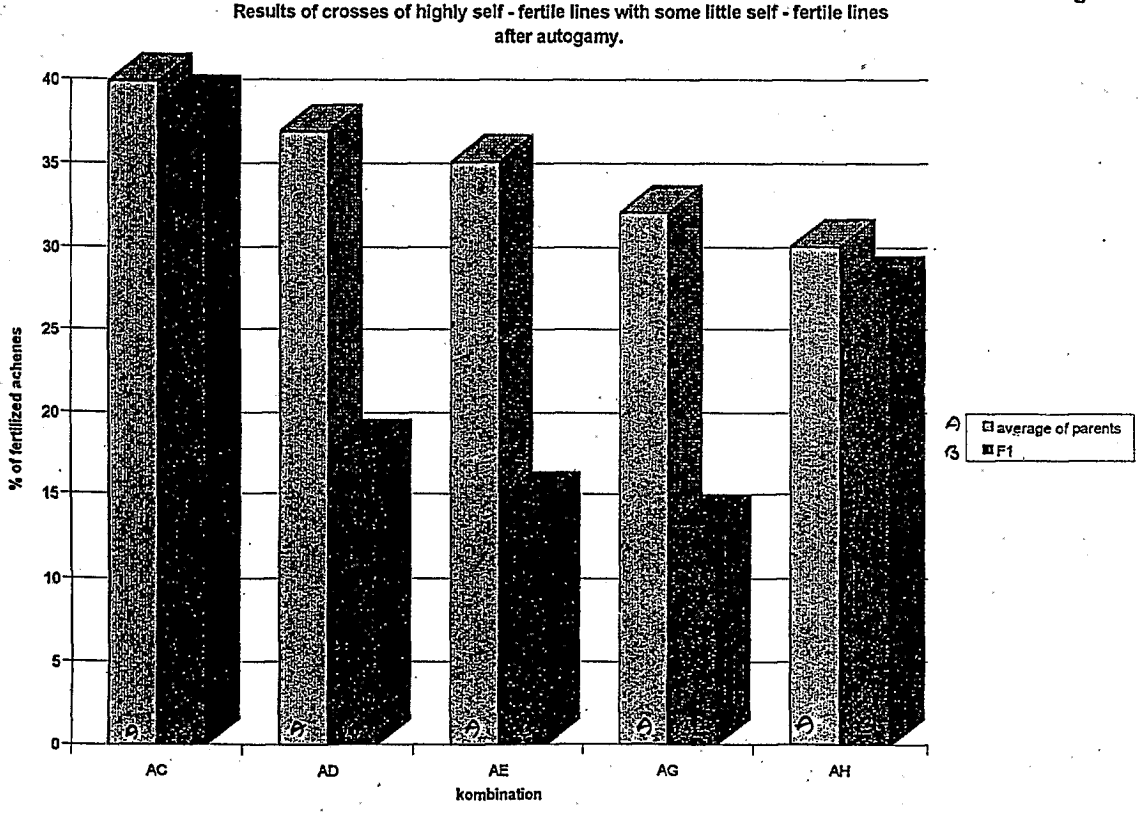

Result of crosses of highly self - fertile lines with some little self - fertile lines after geitonogamy.
% of fertilized achenes
70
60
50
40
30
20
10
0
AC
AD
AE
AG
AH
kombination
A
B
average of parents
F1

Fig. 8


Results of crosses of highly self - fertile lines with some little self - fertile lines after autogamy.
% of fertilized achenes
40
35
30
25
20
15
10
5
0
AC
AD
AE
AG
AH
kombination
A
B
average of parents
F1