INHERITANCE OF WHITE POLLEN IN SUNFLOWER (*Helianthus annuus* (L.))

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ABSTRACT

An experiment was undertaken for two seasons during 1990-1991 in the university, to study the inheritance of white pollen trait in sunflower. Result showed that white pollen is qualitatively inherited and controlled by a pair of single recessive genes which we designate as pp. Therefore, a pure line can be developed from the white pollen plants to enrich the gene pool of sunflower germplasms. White pollen sunflower is also a good germplasm for genetic study. It may have special significance in sunflower breeding programs.

Keywords: Sunflower (*Helianthus annuus* (L.)), white pollen, inheritance.

INTRODUCTION

Sunflower(*Helianthus annuus* (L.)) is an important oilseeds crop, which normally has yellow or yellowish pollen. White pollen color has not ever been reported in sunflower from other sources. Since we found white pollen mutants in the male-sterile restorer line C8711 in 1989 (Qiao Chungui et al., 1990), an preliminary experiment has been conducted to study the inheritance of white pollen trait in suflower (Qiao

Chungui et al., 1992). Result from the experiment showed that white pollen is heritable, qualitatively inherited and is controlled by a pair of single genes or a few major genes. The main purpose of this experiment was to further examine the inheritance of white pollen through hybridization, and to determine the genes and the ways in which these genes act in sunflower.

MATERIALS AND METHODS

The experiment was conducted at the Experimental Station of Jilin Agricultural University for two seasons from 1990 to 1991. In 1990 growing season, seeds from the 4 white pollen mutants C8711-1, C8711-2, C8711-3 and C8711-4, togather with those of yellow pollen C8711 line, were planted on 5 May in the field. Manual hybridization was made for crosses of Yellow pollen C8711 x White pollen C8711-4, White pollen C8711-4 x Yellow pollen C8711, and White pollen C8711-4 x White pollen C8711-4 in the fields. Hybrid seeds were harvested on individual crosses after maturity. The hybrid seeds of all the crosses were sown in the greenhouse of the university on 15 November 1990 during the 1990-1991 winter season to increase generations of the crosses. Before flowering, all the individual plants were bagged to prevent open-pollination. After flowering, numbers of both white and yellow pollen plants were recorded in each of the crosses. In 1991 growing season, an experiment of genetic study was conducted at the Experimental Station of the university. The F2 seeds were sown

on 8 May. Plants were spaced 25 cm apart by hand-thinning after emergence. After flowering, numbers of both white and yellow pollen plants were recorded in each of the populations. Certain agronomic traits were also examined such as grain yield and oil content. Plants were harvested on individual crosses. Data of the F2 segregation ratio were chi-square-tested against 3:1 for yellow:white pollen plants.

RESULTS AND DISCUSSION

1. Performances of F1 Generation for the Crosses

The 1990-1991 winter season greenhouse experiment was very promising. As shown in Table 1, all the F1 plants from cross White pollen C8711-4 x White pollen C8711-4 have white pollen grains, no yellow pollen of F1 plants could be found in the cross. But in the other two crosses White pollen C8711-4 x Yellow pollen C8711 and Yellow pollen C8711 x White pollen C8711-4, all the F1 plants had yellow pollen grains, and none of the F1 plants had white pollen. Apart from the two pollen colors, no other pollen color could be found. Continuous or intermediate variation has not been found in pollen color in the F1 generation, either, compared to those of their parents. White pollen can either be fully expreesed or fully concealed in the F1 generation. These are all typical of quallitatively-inherited character and of full dorminance over recesiveness. Hence, it can be concluded that white pollen is recessive to yellow pollen, and white pollen trait can be expressed when the genotype is homozygous.

Table 1. Pollen color of F1 generation for different crosses

Crosses	Pollen color
White pollen C8711-4 x White pollen C8711-4	White
White pollen C8711-4 x Yellow pollen C8711	Yellow
Yellow pollen C8711 x White pollen C8711-4	Yellow

2. F2 Pollen Color and the Chi-square Test

The pollen colours of F2 generation for different crosses are listed in Table 2. Segregation of pollen colour showed that pollen colour is probably controlled by a pair of single genes, for the ratio of yellow to white pollen is nearly equal to 3:1 for each of the two crosses. Hence, a chi-square test was made against 3:1 ratio, that is, one pair of genes' model for the trait. The chi-square test for each of the crosses is not significant at 5% probability level. The ratio of yellow to white pollen plants remained basically the same (around 3:1) whether white pollen plants were used as male or female. This indicates that there is no reciprocal effect for the expression of pollen colour. When data of all the crosses were pooled, the same trend can be found. Therefore, pollen colour of sunflower is controlled by one pair of single genes. Normal sunflower plants have yllow pollen with genotype PP, while white pollen plants have genotype pp. When white and yellow pollen plants are crossed, they form genotype Pp which also

exhibits yellow pollen, for recessive gene p is concealed by dorminant gene P. From the above analysis, a conclusion can be made that white pollen is controlled by a pair of single recessive genes pp, and only when the recessive genes are homozygous can they be expressed. Genes PP controlling yellow pollen are fully dorminant to genes pp and can be expressed at whatever circumstances.

Table 2. Segregation of pollen color in F2 generation of different crosses *

Crosses	Total No of plants	No of plants YP	WP	Ratio of yellow to white	Chi-square test (P=5%)
YP C8711 x WP C8711-4	256	192.0	64.0	3.197:1	$X^2=0.1875<X^2_{0.05}$
WP C8711-4 x YP C8711	186	139.5	46.5	2.875:1	$X^2=0.1972<X^2_{0.05}$
Pooled	442	331.5	110.5	3.210:1	$X^2=0.3650<X^2_{0.05}$

* WP---white pollen; YP--- yellow pollen; $\chi^2_{0.05}=3.84$

The result of this experiment further confirms the speculation of our previous research that white pollen is controlled by a pair of single recessive genes pp. The discovery of white pollen sunflower helps to enrich the gene pool of sunflower germlasms. It is a very good tool for sunflower genetic study. If this trait is linked with any particular traits such as

high-yielding potential, resistance to enviromental stresses, better quality or some other morphological traits, it can be used as an indicator for selection in practical breeding programs or as a marker character for crossing, backcrossing and testcrossing, where true hybrids need to be identified. White pollen trait can also be used as a marker trait in the long term population improvement programs such as recurrent selection. With the help of young embryo culture technique in which six generations can be finished in one year, these practices should be possible. Further research is needed to study the molecular mechanisms of the expression of white pollen. The genetical, biochemical and physiological basis for the expression of white pollen will be investigated. Linkage relationships of pollen colour with other qualitative and quantitative traits, especially agronomic traits, remain to be examined.

REFFERENCE

1. Qiao Chungui et al.: A preliminary report on the discovery of white pollen mutants in sunflower. Journal of Jilin Agricultural University. 1990, 12(3):93.

2. Qiao Chungui et al.: A preliminary study on the white pollen mutant in sunflower. 1992, (To be published).