

(Bernard and Weiss, 1973).

The characteristic for trichome stiffness was not evaluated in the laboratory; however, data obtained from the field evaluation suggest that this character is also simply inherited (Table 2). These data suggest a one gene factor; however, this is difficult to confirm since the field method is, at best, a cursory estimate.

The character for trichome coarseness was also not evaluated in the laboratory. Data obtained from the field evaluation suggest that this character is controlled at least by two genes (Table 2).

The observed F₂ segregation ratio of 15:1, HA 89 plant type: *H. argophyllus* plant type, of the combined phenotypic characteristics of trichome length, density, stiffness, coarseness as well as other agronomic characteristics mentioned previously may be an extension of the results obtained for trichome density (Table 2). The observed results indicate a digenic control of the *H. argophyllus* parental characteristics which seem to be recessive to the HA 89 parental trichome characteristics of short, sparse, erect, and coarse as well as nonanthocyanic stems and leaves, relatively rapid growth habit, and a light green coloration of the leaves. These results may also suggest linkage of some of these genes that control the various characteristics observed in this study; however, no analysis was made to determine the presence of linkage.

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GENETIC IMPLICATIONS IN TRANSFERRING FERTILITY RESTORER GENES TO A NEW GENETIC BACKGROUND IN SUNFLOWER (*HELIANTHUS ANNUUS* L.).

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ABSTRACT

The second generation progeny consisting of seven surviving plants of the cross between the male sterile hybrid, 2 cm 183 x E.C.68415 and the restorer line, BCZ.111 presented two types of segregation for the pollen fertile and sterile plants. Four of them gave a 3:1 ratio for the fertile and sterile fractions while the remaining three progenies fitted into a 9:7 ratio, thus suggesting two genotypes in the F₁ plants from the point of fertility restoration. The implications underlying this type of inheritance have been discussed and the genetic symbols of $rf_1rf_1rf_2rf_2$, $Rf_1Rf_1rf_2rf_2$ or $rf_1rf_1Rf_2Rf_2$ and $Rf_1Rf_1Rf_2Rf_2$ have been suggested for the parents 2 cm 183, E.C.68415 and BCZ.111 respectively.

INTRODUCTION

Sunflower has been introduced as an oilseed crop into India recently for filling the vegetable oil gap. The Russian cultivars, bearing the accession numbers, E.C.68413, E.C.68414, E.C.68415 and E.C.69874, given out for general cultivation did not make much headway because of poor yield coupled with high percentage of empty seed. During the past few years reports on the possibility of exploiting heterosis by utilising the cytoplasmic male sterility have opened new lines of work in this crop (Gundaev, 1967; Vranceanu *et al.*, 1973). The cytoplasmic male sterile line, 2 cm 183, its maintainer and the fertility restorer line, BCZ.111 were kindly made available by the French Sunflower Breeder, DR. P. Leclercq, in 1973. The restorer line was weak, stunted and was found to be unsuitable for the commercial hybrid seed production. The inheritance of fertility restoration has been investigated

(Reddy and Thammi Raju, 1977) and the restorer genes have been transferred over a new genetic background of the male sterile hybrid, 2 cm 183 x E.C.68415 (Reddy *et al.*, 1976). The genetic implications underlying the transfer of restorer genes over the said genetic background are discussed in this paper.

MATERIALS AND METHODS

The male sterile hybrid of the cross between the cytoplasmic male sterile line, 2 cm 183 and the popular cultivated variety of Russian origin, E.C.68415 was chosen for transferring the restorer genes from BCZ.111. The progeny of the three-way cross, (2 cm 183 x E.C.68415) x BCZ.111, consisted of seven surviving plants and all of them were pollen fertile, as expected. The flower heads of these plants were selfed and seeds were collected separately from each of the selfed heads. The F₂ generation of these seven plants was grown in two sets for want of space; the first set during October-December, 1975 and the second during February-April, 1976. The progenies were assigned the numbers P₁ to P₇. The fertile and the sterile plants were identified in the segregating progenies based on the presence or absence of pollen in the anther sacs and also its stainability in the 1% I₂-KI solution. The pollen fertile plants were expected to possess the restorer genes as all of them contained sterile cytoplasm of the male sterile parent, 2 cm 183.

RESULTS

Each progeny, as expected, consisted of both pollen fertile and sterile individuals indicating the heterozygous nature of the three-way cross hybrids with regard to fertility restoration (Table 1). Although the segregation ratios have been constituted based on smaller populations, four out of seven progenies (P₁, P₂, P₄ and P₇) fitted into a 3:1 ratio, while the remaining three progenies (P₃, P₅ and P₆) gave a closer fit to

a 9:7 ratio for the fertile and the sterile fractions of the population.

Majority of the male fertile plants in the segregative populations were vigorous, had larger flower heads with abundant fertile pollen. It is hoped that some of these vigorous male fertile plants will turn out to be useful lines of fertility restoration. Further work is in progress for the isolation of a suitable restorer line.

Table 1. Segregation pattern in the second generation progeny of three way cross, (2 cm 183 A x E.C.68415) x BCZ.111 in sunflower.

Segregation					Phenotypic Ratio	X ²	P-value
Progeny		Fertile	Male sterile	Total			
P ₁	Observed	50.00	20.00	78	3:1	0.0171	0.80 — 0.90
	Expected	58.50	19.50	78			
P ₂	Observed	77.00	28.00	105	3:1	0.1556	0.50 — 0.70
	Expected	78.75	26.25	105			
P ₃	Observed	43.00	28.00	71	9:7	0.5359	0.30 — 0.50
	Expected	39.94	31.06	71			
P ₄	Observed	89.00	29.00	118	3:1	0.0113	0.90 — 0.95
	Expected	88.50	29.50	118			
P ₅	Observed	87.00	63.00	150	9:7	0.1874	0.50 — 0.70
	Expected	84.37	65.63	150			
P ₆	Observed	138.00	109.00	247	9:7	0.0146	0.90 — 0.95
	Expected	138.94	108.06	247			
P ₇	Observed	95.00	34.00	129	3:1	0.1267	0.70 — 0.80
	Expected	96.75	32.25	129			

DISCUSSION

For the transfer of restorer genes on to a new genetic background, the male sterile hybrid of the cross, 2 cm 183 x E.C.68415 was chosen as the female parent because of the following reasons:

1. It was not possible to transfer the restorer genes directly to any of the male fertile cultivar since emasculation in sunflower was found to be difficult. The disc florets were very small and even very careful handling resulted in their dropping. The anthers were syngenesious and formed a cylinder around the style. Removal of anthers required slitting open their cylindrical disposition which was difficult without damaging the style. Also, the two-celled anthers dehisced intressely by longitudinal slits and even slight manipulation of the mature florets resulted in the shedding of pollen.

2. In sunflower, the high degree of self incompatibility can be taken advantage of and emasculation avoided for producing hybrids as suggested by Schuster (1964). If hybrids with the restorer line are produced by using this method, selection of plants possessing the restorer genes is laborious since all the plants in the segregating progenies would be pollen fertile.

The authors (Reddy and Thammi Raju, 1977) based on the inheritance of fertility restoration assigned the male sterile parent, 2 cm 183, the double recessive genotypes of $rf_1rf_1rf_2rf_2$ and the restorer parent, BCZ.111, the double dominant genotype, $Rf_1Rf_1Rf_2Rf_2$.

There were seven surviving plants in the three-way cross, (2 cm 183 x E.C.68415) x BCZ.111. The second generation progenies of these seven plants when grown independently gave two types of segregation for fertile and sterile plants. Four out of seven progenies (P₁, P₂, P₄ and P₇) gave a 3:1 ratio, while the remaining three progenies (P₃, P₅ and P₆) resulted in a closer fit to 9:7 ratio. This type of segregation clearly suggests that:

1. The genotype of the F₁ plants were of two types from the point of fertility restoration, and

2. E.C.68415 possessed one of the two factors responsible for fertility restoration in a homozygous condition ($Rf_1Rf_1rf_2rf_2$ or $rf_1rf_1Rf_2Rf_2$).

The hybrid, 2 cm 183 x E.C.68415 would have had the genotype, $Rf_1rf_1rf_2rf_2$ or $rf_1rf_1Rf_2rf_2$. The heterozygous nature of the hybrid for one of the gene pairs would result in the production of two types of gametes (Rf_1rf_2 and rf_1rf_2). Because of this reason there will be two classes of plants in the three-way cross progeny, one having the genotype $Rf_1Rf_1Rf_2rf_2$ and the other $Rf_1rf_1Rf_2rf_2$. In the subsequent generation, these two classes result in two types of segregating

populations, the first fitting into a monogenic ratio of 3:1 and the second giving a 9:7 ratio. Both the types of segregating populations were actually obtained in the three-way cross, (2 cm 183 x E.C.68415) x BCZ.111. Appropriate symbols have been assigned for the genotypes of the parents, F₁ and F₂ segregants, following the pattern suggested by Duvick (1959) and Kinman (1970).

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