CHLOROPHYLL-DEFICIENT MUTANTS IN SUNFLOWER
II. Non-Mendelian inheritance

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Summary

The investigation of the mode of inheritance included five monocephalic inbred lines (AMAC-14; YMAC-27; XMAC-27; NETMAC-13 and SPTMAC-A) with laminar sectors varying in color from white to dark yellow. A genetic analysis involved the monitoring of the phenotype of the progenies of the selfed genotypes with changes of the leaf, the crosses with genotypes phenotypically similar in the color of laminar sectors,and the direct and reciprocal crosses between the mutants and the green-leaved genotype. The results obtain confirmed the persistance of differences between direct and reciprocal crosses as well as the hypothesis on the influence of cytoplasmic particles on the expression of the changes studied. The occurence of the novel mutant phenotypes was established only for the branched progenies of the selfed hybrids.

Introduction

Occurrence of sectors differing in color and color intensity on the leaves of individual plants is common. In sunflower, maculatus type spots (albo- and xantho-) and variegata type spots (chlorino- and brunescens-) have been described. The edge of the chlorotic sector is sharp with the former type and diffuse with the latter. The above alterations in leaf pigmentation may be induced (Razoriteleva et al., 1970) or spontaneous (Mihaljcevic, 1992). The sectoring is not in itself indicative of extrachromosomal inheritance (Jinks, 1964). Sectors may arise by gene or plasmagene mutation. The best examples are mutants of the maculata type (status maculatus) which develop in consequence to the action of nuclear and cytoplasmic hereditary determinants.

This paper presents the results of a study in which we checked the contribution of hereditary determinants, the persistence of differences between direct and reciprocal crosses, and the occurrence of novel phenotypes in the F_1 or later generations that are not present in female or male inbreds.

Material and Method

More than one thousand experimental hybrids and their parental components served as a source of maculata and variageta type mutants. The analysis of the mode of inheritance included the following genotypes: AMAC-14 (white sectors), YMAC-27 (yellow-green sectors), XMAC-27 (dark yellow sectors), NETMAC-13 (a white net-like structure independent of leaf venation), and SPTMAC-A (white interveinal areas with green spots. The inbred line V-8931-3-4 with normal green leaves served as the check. The genetic analysis involved the monitoring of the phenotype of the progenies of the selfed genotypes with changes of the leaf, the crosses with genotypes phenotypically similar in the color of laminar sectors, and the direct and reciprocal crosses between the mutants and the green-leaved genotype. Persistence of differences between the direct and the reciprocal crosses was checked in two years.

Results and Discussion

Hybrids and inbred lines that exhibited chlorotic areas on the lamina prior to the stage of budding were crossed to form a collection of 15 mutants with leaf sectors ranging in color from white to nearly orange. The selfed plants did not produce phenotypically uniform progenies: some resembled the parents, some had normal green leaves, and some were albinos. The recurrence of the three classes, generation after generation, indicated the extranuclear nature of the chlorotic changes. The collection of mutants was therefore maintained by repeated removals of gree-leaved plants and spontaneous extinction of albino plants.

In both years, non-Mendelian segregation was indicated by the ratios calculated for the F_1 generation of the direct crosses with chlorophyll-deficient female plants. In the succeeding cycle of selfing, the progenies of the green-leaved plants were exclusively green-leaved while the albinos were lethal and produced no progeny. The selfed plants with variegated leaves again produced the three phenotypes. The progenies of the reciprocal crosses with V-8931-3-4 as the female had normal green leaves.

Reciprocal differences occur only when the two sexes make unequal contributions to the offspring. To be persistent, such a difference must involve an unequal contribution of hereditary determinants (Jinks, 1964). In all five mutants tested, plastid variegation indicated a strict maternal determination of the progenies.

The crossing of mutually similar phenotypes originating from the same mutant plant produced in the F_1 generation the ratio among the phenotypic classes which were similar to those obtained after selfing and direct crossing. Regardless of the male phenotype, the variegated female determined the type of mutation.

Tab. 1 - The number of plants in different phenotypic classes in the two-year experiment

Cross	1990				1991			
	Total no.of plants	Green leaves	Sectored leaves	Albino plants	Total no.of plants	Green leaves	Sectored leaves	Albino plants
AMAC-14 x V-8931-3-4	98	53	37	8	125	63	46	16
V-8931-3-4 x AMAC-14	119	119	0	0	106	106	0	0
AMAC-14 x AMAC-14	132	67	49	16	83	36	34	13
AMAC-14 (selfed)	103	56	38	9	116	58	49	9
YMAC-27 x V-8931-3-4	116	63	42	11	120	49	58	13
V-8931-3-4 x YMAC-27	127	127	0	0	103	103	0	0
YMAC-27 x YMAC-27	131	71	51	9	114	64	39	11
YMAC-27 (selfed)	116	63	40	13	99	52	39	8
XMAC-21 x V-8931-3-4	126	63	55	8	136	72	48	16
V-8931-3-4 x XMAC-21	105	105	0	0	115	115	0	0
XMAC-21 x XMAC-21	98	44	40	14	128	64	47	17
XMAC-21 (selfed)	133	69	47	17	135	73	46	16
NETMAC-13 x V-8931-3-4	124	60	48	16	126	52	58	16
V-8931-3-4 x NETMAC-13	114	114	0	0	115	115	0	0
NETMAC-13 x NETMAC-13	106	46	51	9	131	65	55	11
NETMAC-13 (selfed)	101	49	39	13	102	55	40	7
SPTMAC-A x V-8931-3-4	135	64	52	19	116	41	56	19
V-8931-3-4 x SPTMAC-A	142	142	0	0	100	100	0	0
SPTMAC-A x SPTMAC-A	113	61	41	11	92	51	33	8
SPTMAC-A (selfed)	92	48	35	9	118	62	41	15

Table 1 shows the number of plants per phenotypic class for both years.

The investigation of the mode of inheritance included five monocephalic inbred lines with laminar sectors varying in color from white to dark yellow. The progenies of the direct crossing and selfing between the variegated plants differed in the number of chlorotic leaves and the size of chlorotic areas from plant to plant and from generation to generation; however, the type of change was not altered and each mutation type replicated itself. This should be accepted only conditionally because of the monocephalic characteristic of the restorers (all leaves on a single stem).

The selfing of the crosses between the cms lines and the branched restorers produced in a few cases the branched progenies which were novel phenotypes in relation to the original mutant plants. The selfing of the hybrids with xantho maculata leaves yielded branched plants with xantho maculata leaves (light yellow) on the main stem and different leaf colors on the lateral branches. If such genotypes are maintained, it would allow an experiment to be organized in which the same plant could simultaneously be used as the female and male parent.

The results obtain confirmed the persistence of differences between direct and reciprocal crosses as well as the hypothesis on the influence of cytoplasmic particles on the expression of the changes studied. The occurrence of novel mutant phenotypes (excepting the lethal albino plants) was established only for the branched progenies of the selfed hybrids.

References

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