INFLUENCE OF GENES FOR HIGH OLEIC ACID ON AGRONOMIC CHARACTERS OF SUNFLOWER

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SUMMARY

OL genes controlling the high oleic acid accumulation in the seed oil of sunflower have been found, allowing the development of high oleic cultivars. In order to evaluate the association of these genes with agronomic characters two cms and two restorer parental lines and their isogenics (low oleic) were crossed to obtain four high oleic and four low oleic hybrids. The pairs of isogenic hybrids were compared for agronomic performance at three environments. OL genes affected yield, specially at one environment where high oleic hybrids outyielded significantly their low oleic isogenics. The differences found were explained by a higher biomass since differences in harvest index were no significant. The addition of OL genes decreased significantly the degree of selfcompatibility of all hybrids although it varied with genotypes and environment. Oil content and length of cycle were influenced by OL genes only for some hybrids and/or environments.

INTRODUCTION

Although the seed oil of cultivated sunflower (Helianthus annuus L.) is considered of good quality for edible purposes, the development of high oleic type of oil is an important breeding objective in this crop.The advantages of this type of oil are higher degree of oxidative stability than normal low oleic oil (Fuller et al.,1967) and under the nutritional point of view, reduction of the cholesterol in blood plasma, which is a risk factor for coronary heart diseases (Grundy, 1986).

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Sunflower mutants with high and stable levels of oleic acid in the seed oil, were obtained by Soldatov (1976). Further genetic studies, for example, Miller et al. (1987) and Fernández-Martinez et al.(1989), worked out the mode of inheritance of this character. These studies concluded that, because of the low number of dominant genes involved, and the embryo (non maternal) control of the character,its incorporation to breeding lines to develop high oleic sunflower hybrids is a simple task. However, the feasibility of developing such a hybrids depend on the association of high oleic OL alleles with agronomic characters.

In safflower (Carthamus tinctorius L.) Knowles (1968) reported that the ol gene responsable for high levels of oleic acid in the oil was associated with gene(s) for early flowering, but there were no consistent diferences in oil content between OLOL (normal) and olol (high oleic) genotypes. The association of alleles controlling high levels of stearic acid content in soybean (Glicine max L.) has been studied (Lundeen et al, 1987). Stearic acid content was associated with yield, earliness, height and oil content, but none of the relationships were strong enough to preclude the development of high stearic cultivars. In rapeseed (Brassica napus L.) zero erucic lines showed lower yield and oil content than their isogenics high erucic in some genetic backgrounds (Morice, 1974). However the introduction of zero erucic alleles made possible the development of these type cultivars which have substituted the former with high erucic content.

The purpose of the present study was to evaluate the association of OL alleles, controlling high levels of oleic acid, with agronomic characters in sunflower.

MATERIAL AND METHODS

Four high oleic hybrids and their near isogenics low oleic were developed. The high oleic group of hybrids were obtained crossing two cms and two restorer parental lines, carrying OL alleles and the low oleic group, crossing the normal (low

oleic) isogenics, cms and restorer, lines. The high oleic isogenic lines had been developed by incorporating the OL genes, by backcrossing (at least five backcrosses), to the female lines HA 89 and HA 152 (a Rhone Poulenc line) and to the restorers RHA 274 and RHA 271. These isogenics, female and restorer lines, differed in oleic acid levels, 20-30% the normal and 85-90% the high oleic but were similar in other characteristics. The eight hybrids were grown in a split plot arrangement of a randomized complete block design having three replications at Cordoba, Spain, at three different environments during 1990-91. Whole plots consisted of the four crosses (two cms x two restorer) and high and low oleic isogenic hybrids for each cross were the subplots. Individual plots were 4 rows 10 m long. Plants were sown in 0.7 m rows and thinned to a population of 50000/Ha. Grain yield, above ground biomass, harvest index (HI), oil content and fatty acid composition were determined at harvest. Seed oil content was determined by nuclear magnetic resonance and fatty acid composition by gass chromatography. Date of flowering and degree of selfcompatibility (number of seed under selfpollination number of seed under open pollination) were also recorded.

RESULTS

Significant differences between environments were observed for all traits in the combined analysis of variance. Hybrids means were significantly different for all traits measured except for oleic content. The hybrid cms HA 152 x RHA 271 had the highest yield, above ground biomass, HI and oil content, while cms HA 89 x RHA 274 was the poorest for yield and oil content. A significant environment x hybrid interaction was detected also for most of the traits measured.

Oleic class means differed significantly for all traits except for HI (Table 1). Environment x oleic class interaction, were significant only for level of selfcompatibility and days to flovering. Mean yield of the high oleic-acid class was higher for all the hybrids except for cms HA 89 x RHA 274 which was similar for both, high and low-oleic acid classes. This

higher productivity corresponded to higher production of biomass while HI was similar for the two oleic classes.

Table 1- Mean performance of high and low oleic near isogenic hybrids combined over three Cordoba (Spain) environments.

Hybrid	Oleic class	Yield MQ/Ha	HI %	Biomass MT/Ha	Oil %	Days to Flower*		Self compa-tibi-lity %	Oleic acid %	
						Winter env.	Spring env.		self seed	OP seed
Cms HA 89 X RHA 271	High	19.6	30	6.6	44.8	113	75	23	91.1	76.3
	Low	17.7	27	6.6	44.5	118	77	70	34.0	38.6
Cms HA152 X RHA 271	High	23.5	30	8.1	46.8	114	75	29	90.0	75.1
	Low	22.3	30	7.8	45.6	117	77	77	34.4	42.6
Cms HA 89 X RHA 274	High	17.0	25	6.7	39.7	115	75	57	90.2	78.8
	Low	17.1	25	6.7	38.7	115	74	71	32.9	39.8
Cms HA152 X RHA 274	High	18.4	24	7.6	42.3	115	75	54	90.1	78.1
	Low	17.0	25	6.8	39.5	114	76	84	33.5	42.7
All Hybrids**	High	19.6a	27a	7.3a	43.4a	114a	75a	41a	90.3a	77.5a
	Low	18.5b	27a	6.9b	42.1b	117b	76b	77b	37.7b	40.9b

* Only data of two environments, not combined.
** Overall means followed by the same letter are not significantly different at the 0.05 level of probability.

The overall mean of the high oleic hybrids was significantly earlier than that of the low oleic. However, an examination of the days to flowering for each cross, showed that while hybrids with the restorer RHA 271 the high oleic hybrids were significantly earlier in all the environments, the hybrids with restorer RHA 274 showed similar length of cycle for both oleic-acid classes.

For other important characters, as oil content and selfcompatibility, were observed also significant differences between the means of high and low-oleic-acid classes, for all the hybrids tested (Table 1). The high oleic hybrids had

consistently higher oil content and lower level of selfcompatibility. The selfcompatibility level was specially low for the high oleic hybrids with the restorer RHA 271, with values of 23 and 29% as compared with their isogenics low oleic(70 and 77%). The oleic acid content of the high-oleic-acid hybrids were similar for the four hybrid tested (Table 1) ranging from 90.0 to 91.1% for selfed seed and 75.1 to 78.8% for open pollinated (op) seed. The values for the four low-oleic hybrids were also similar for ranging from 32.9 to 34.0% for selfed seed and 38.6 to 42.7 for op seed

DISCUSSION

The OL alleles for high oleic content were clarly associated with better agronomic performance and higher oil content. The possitive effect exerted on seed yield was more important under dry conditions. Apparently OL alleles could be associated with genes at other loci for adaptation to dry and/or high temperature conditions. The greater productivity of the high oleic hybrids was due to a higher production of biomass since diferences in HI were not significant. The association of OL alleles with characters, other than yield and oil content, was also evident for earliness and selfcompatibility. The differences in earliness, were not large enough to explain the better adaptation of high oleic hybrids to dry conditions although could have some influence. The association of OL alleles with lower levels of selfcompatibility can be considered as negative for the development of high oleic hybrids, since this character is an important objective in sunflower breeding. However, the level of selfcompatibility varied with the genetic background what suggests that the use of favorable background could allow to the development of high oleic selfcompatible hibrids. The oleic acid content of selfed seed of the high oleic hybrids, had the same level of this acid that the parental lines as expected. The shift, 13 points dowward, of the oleic acid of the high oleic hybrids could be explained by the high frecuency in the genotypes of the pollen of the sunflower surrounding the

experiment, of the modifier Ml alleles described by Miller et al. (1987).Pollen carrying these dominant alleles would have fertilized the high oleic hybrids and reduced their level of oleic. In conclusion, our results indicate that high oleic-acid hybrids with aceptable agronomic characteristics can be developed. For very high levels of oleic isolation may be needed.

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