GERMPLASM WITH GOOD COMBINING ABILITY IN SUNFLOWER (*HELIANTHUS ANNUUS*)

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Abstract

To evaluate if the direct agronomic value of a hybrid could be taken into account in creating good combinations in a breeding program, in 1998 six F2 populations from four good and two bad hybrids were testcrossed with a narrow base tester. Since a progeny of a good hybrid disagreed with the stated hypothesis, in 2000 it was tested with 32 cytoplasmic male sterile (CMS) lines, twelve of which combined well with the hybrid progeny. Two of these CMS lines yielded many superior hybrids when crossed with 28 F5 plants selected from this last hybrid.

Introduction

There are many methods for developing a population with which to start a breeding program, but the two-parent method is the simplest and most widely used (Fehr, 1987; Hallauer and Miranda, 1986). When there is no reason to form a specific population, one good method is to use an F2 from a commercial hybrid. On the other hand, maintaining a germplasm bank and using the genetic variability needed in breeding is costly and impossible for small seed companies or research institutions. To by-pass this, it may be possible to work with populations from commercial selfed hybrids. F2 populations may have the advantage of being the culmination of selection efforts made by breeders and would therefore require less work than that needed when using ancestral or wild races. The hybrids available may be many and it would be necessary to have a criterion for selecting those that would maximise the selection process. In 1998 we started a program to evaluate if the direct agronomic value of a hybrid could be used as a measure for its suitability to give good combinations in a breeding program.

Materials and Methods

Six plants of six F2 populations coming from hybrids of divergent agronomic value, four good (Arbung P113, Nicosol, Sanbro, and Trisun 860) and two bad (Isanthos and Pablo) evaluated and selfed in the field in 1997, were testcrossed in 1998 with a CMS line with good combining ability. The test cross progenies were grown in 1999 in Osimo, east-central Italy, in a field split-plot trial with two replications under irrigated and rainfed conditions.

In the year 2000 germplasm from an F4 of Sanbro was testcrossed with 32 CMS lines. Pollen to pollinate the CMS was collected from the majority of the flowering F4s on the day of pollination. The testcross progeny was tested in a field split-plot trial in 2001, under

irrigated and rainfed conditions, with two replications. During 2002 two CMS lines (234 and 150-9-17), selected on the basis of the 2001 evaluation, were testcrossed with 28 F5 from Sanbro. The testcross progenies were evaluated in a completely randomised field trial, with three replications, during 2003, under irrigated conditions together with two controls (Sanbro and Forte). All agricultural practices employed were those usually used in the area.

Results and Discussion

According to the hypothesis that the yield value of a hybrid could be a mean for its suitability to be used as a germplasm source, the progenies coming from three good hybrids were more productive than the progeny of the poorest hybrid (Table 1) and, consequently, the general combining ability (GCA) was also positive for these three sources of germplasm. One progeny yield of a very good hybrid (Sanbro) showed a very poor testcross mean and low GCA values. This result indicated that the hypothesis was not valid for this source, or that the good value of the original hybrid was due to high heterosis that was lost in the cross with the tester employed, or the tester was simply not suitable for this kind of source. To verify this, a collection of F4 lines of Sanbro hybrid was testcrossed with 32 CMS lines in 2000, and the agronomical trial conducted in 2001 (Table 2) showed that the germplasm combined well with many CMS lines. The yields of 13 testcross progenies were as productive as the hybrid source confirming that with appropriate combiners this germplasm was also good for a breeding program.

Table 1. Agronomic value of hybrids per se and their F2 combination with a tester on a dry matter basis.

Germplasm source	Yield as F_1 (t/ha)	Testcrosses or controls (n°)	Yield of test crosses (t/ha)	Variance among testcrosses
Good source				
Arbung P113	3.09	6	3.03b	37.1
Nicosol	3.10	6	3.08b	58.8
Sanbro	3.15	6	2.64bc	35.3
Trisun 860	3.28	6	3.59a	155.6**
Bad source				
Isanthos	2.03	6	2.69bc	68.2
Pablo	2.22	6	2.42c	21.2
Controls			3.56a	

In all tables means with the same letter are not significantly differently at LSD of 5%
** significant at P<0.01

Further confirmation of the hypothesis was found in the results of the testcrosses made with 28 F5s from Sanbro crosses with the two best CMS lines in the 2003 trial (Table 3). With both CMS lines it was possible to obtain many hybrids that were more productive than the original source and the controls. One CMS showed superior combinations in yield, oil content and oil yield and consequently good specific combining ability (SCA) of the traits.

Table 2. Selected testcrosses between some CMS and mixed lines from Sanbro 2001 trial on a dry matter basis.

Genotypes	Yield (t/ha)		Oil (%)		Oil yield (t/ha)	
Testcrosses						
243 x Sanbro	4.34	a	51.10	el	20.20	a
150/9-17 x Sanbro	4.10	ab	51.80	cj	19.40	ab
219/3 x Sanbro	4.01	ac	53.10	ae	19.30	ab
23/9-65 x Sanbro	3.96	ad	50.40	fm	18.20	ae
237/2-2 x Sanbro	3.96	ad	50.40	fm	18.20	ae
22 UPR x Sanbro	3.83	ae	52.30	ch	18.10	af
229/3 x Sanbro	3.82	ae	50.10	hm	17.50	ag
181/5-34 x Sanbro	3.77	af	48.50	m	16.70	ah
181/5-12 x Sanbro	3.77	af	49.60	jm	17.00	ah
232/1-3 x Sanbro	3.75	af	51.40	dk	17.60	ag
284 x Sanbro	3.72	af	54.80	a	18.60	ad
29 UPR x Sanbro	3.60	af	50.30	gm	16.50	ah
219/1-3 x Sanbro	3.60	af	53.80	ac	17.70	ag
Controls						
Sanbro	4.13	ab	50.20	gm	18.90	ac
Select	3.15	ef	53.40	ad	15.30	ch
Mean field	3.55		51.30		16.60	

Table 3. Best testcrosses between the selected two CMS and F_5 from Sanbro on a dry matter basis.

Test-crosses	Yield (t/ha)		SCA (t/ha)		Oil (%)		Oil yield (t/ha)	
150/9-17 x S 17-4-1	4.39	a	0.96	a	45.5	bm	1.81	a
150/9-17 x S 7-4-1	4.30	ab	0.47	b	43.3	io	1.70	ab
150/9-17 x S 12-3-2	4.16	ac	0.33	b	44.4	cn	1.68	ac
150/9-17 x S 13-3-2	4.09	ad	0.35	b	44.9	bn	1.67	ad
150/9-17 x S 12-2-1	3.71	ae	0.19	b	44.3	cn	1.49	ah
150/9-17 x S 9-4-2	3.70	ae	0.10	b	47.1	ae	1.58	ae
150/9-17 x S 10-5-1	3.60	bf	0.29	b	45.6	bm	1.52	ag
243 x S 13-4-3	3.64	bg	0.45	b	45.6	bm	1.51	ag
150/9-17 x S 13-5-1	3.64	bg	0.06	b	46.2	hi	1.53	af
243 x S 10-3-1	3.60	bg	0.39	b	45.9	bk	1.50	ag
150/9-17 x S 7-2-2	3.60	bg	0.20	b	45.8	bk	1.51	ag
150/9-17 x S 12-1-1	3.59	bg	0.09	b	44.0	fn	1.43	bj
243 x S 10-1-1	3.58	bh	0.45	b	45.5	bm	1.48	bh
150/9-17 x S 7-3-3	3.55	bj	0.29	b	44.8	bn	1.44	bi
243 x S 11-5-3	3.53	bj	0.39	b	43.7	ho	1.41	bj
Forte	3.36	dl			49.3	a	1.51	ag
Sanbro	2.78	iq			41.0	o	1.04	lo
Mean of the trial	3.20				45.1		1.31	

Conclusions

The agronomic value of a hybrid is enough to gauge its suitability for use in developing a population for a successful breeding program. A cms line with good GCA combined well with 3 out of 4 F2 populations. The fourth that did not combine well with the first CMS showed good combinations with many other CMS lines and gave some superior hybrids. The poorest hybrid could also be useful with a proper combiner, but it is assumed to have lower probability.

References

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