INFLUENCE OF SEED QUALITY OF PARENTAL FORMS ON SUNFLOWER HYBRID SEED

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ABSTRACT

Quality of hybrid seed is influenced by the quality of parental forms and seed production technology. Quality of parental forms is determined by the biological purity and cultural value. To maintain biological purity, three methods of maintenance were applied and superiority of annual alternance of self-pollination with SIB pollination was revealed. Significant yield gains were obtained with this method both in parental and hybrid forms. Characterization of morphological traits of genetic material under study was performed. As the variation coefficients were small and medium, stability of the investigated material was demonstrated. Among the most important links in seed production technology could be mentioned: sowing time, to achieve a good flowering coincidence, parity of parental forms to assure the necessary pollen quantity; special works to remove foreign and diseased plants. Classification of genetic material, as depending on the melliferous index and pollination degree have been also made. The paper concludes with the economic profitableness of F_1 over F_2 seed, in order to outline the significance of using quality seed.

Key words: biological purity, hybrid seed, self-pollination, SIB pollination, sunflower.

INTRODUCTION

Sunflower is one of the outstanding oil plants cropped on world scale and the most important in Romania.

Since the development of the first sunflower hybrids in 1970 till now, the Romanian breeders have obtained a large number of hybrids with high yielding potential (over 3,500 kg/ha) and increased seed oil content (more than 50%) compared to local cultivars and varieties, however with higher requirements concerning the technology of seed production.

One of the essential factors in yield increasing in sunflower and other crops is the use of high quality seeds with high biological and cultural values, free from diseases and pests. The genetic material is an important element in achieving high levels of seed per hectare, however technological and agrometeorological factors are able to greatly influence seed quality and particularly the oil content, thousand grain weight, seed amount per inflorescence, attack degree by various diseases.

Achievements referring to sunflower genetic development of breeding methods and techniques, of methodology and technique of hybrid seed production allowed to obtain numerous hybrids, among which the following have been registered and spread to producers: Romsun 52, Romsun 53, Romsun 59, Sorem-80, Sorem 82, Felix, Super, Select, Festiv, Turbo, Domino, Favorit, Decor, Coril, Santiago, Alex, Rapid, Florom 328, Florom 350, Florom 249.

It is well known that heterosis effect is expressed as hybrid seed yield in F_1 generation. Yielding ability of a hybrid depends on the yield level of parental forms constituting a particular hybrid (Petakov, 1992).

Škoric showed in 1982 that in F_1 hybrids high values of correlation coefficients were found between the seed production per hectare and the oil contained by seeds of parental forms. The activity in the field of seed production has the role to organize, evaluate, multiply, process and distribute seeds.

The basic objective of seed production process is that during seed multiplication and handling, the value of the hybrid do not be altered so that it could be maintained at the level of initial value at the time of registration. Maintenance of biological purity, homogeneity and stability of morphological – physiological traits of parental forms is essential to attain the yielding potential of sunflower hybrids (Vrânceanu and Gumaniuc, 1988). In case of some errors in the process of seed production, hybrids do not achieve the normal yielding potential, while heterosis effect is reduced, therefore keeping the minimum isolation space is compulsory as well as observing the specific technologies, supplying pollinators, removal of father rows after pollination and use of combines with specific adjustment to avoid seed breaking, and seed processing and storing be correctly performed (Petrov, 1992).

In order to produce good quality seed of parental forms, it is highly important to use the most adequate maintenance method.

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MATERIALS AND METHODS

Investigations were performed during 1993-1997, by recording the influence of parental form quality on F_1 hybrid seed quality.

The parental forms and the hybrids resulted from their crossing, have been studied in parallel tests, by determining various morphological-physiological traits correlated with seed yield and its quality, such as:

- influence of maintenance method on seed yield of parental forms of hybrids and the resulted heterosis;
- influence of vegetation period on flowering coincidence;
- pollination degree and melliferous index;
- importance of F_1 seed utilization in achieving commercial yields and the economic efficiency obtained.

Data processing was made with ANOVA and correlations.

RESULTS AND DISCUSSIONS

The quality of hybrid seed is given by quality of parental forms and seed production technology (Figure 1).

The quality of parental forms is influenced by the biological purity and cropping value, a decisive role having the biological purity. In order to realize the maximum specific combinative capacity of each line, it is necessary that biological purity be maintained closely to 100%. When biological impurification appears, off-type plants should be removed before flowering.

Seed with germination above 85% and good penetration power will provide a rapid and uniform emergence.

Among the technological sequences in the process of seed production, very important are:

- spatial isolation;
- time of sowing;

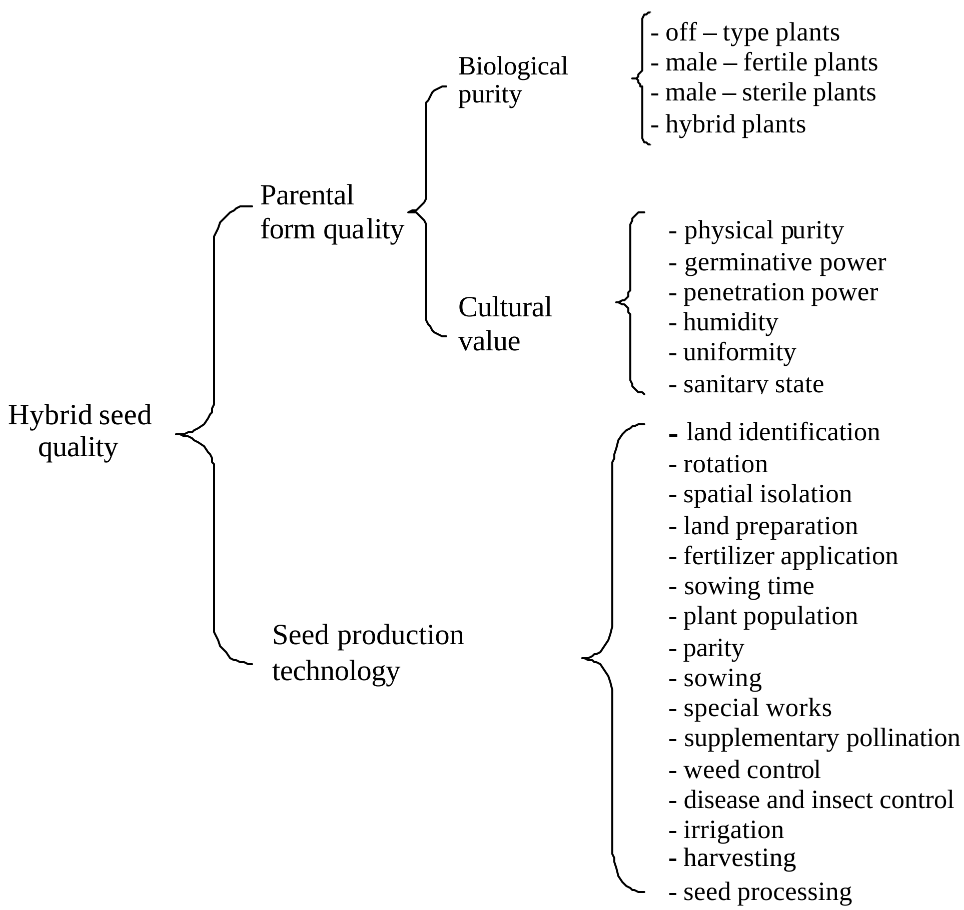

Figure 1. Hybrid seed quality

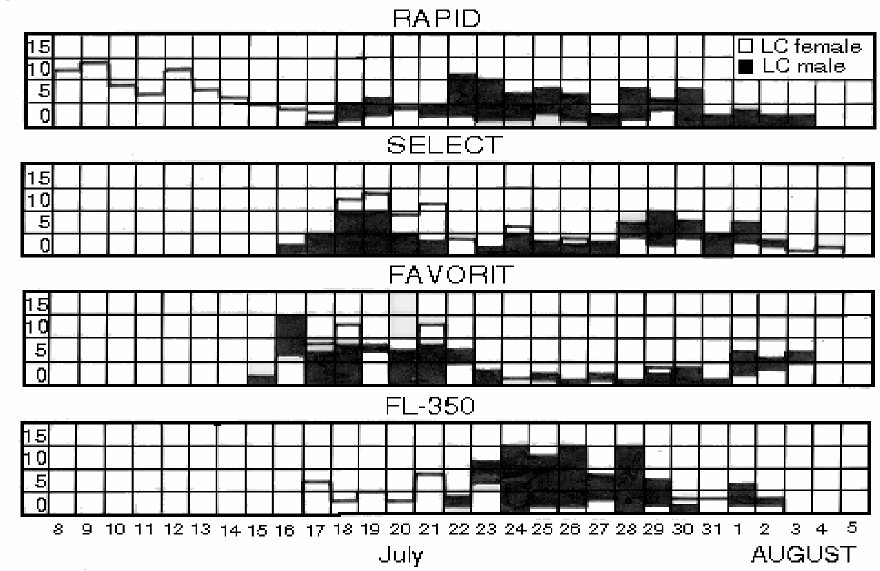

Figure 2. Flowering dynamics of sunflower parental forms

- ratio of female to male rows;
- specific works.

The parental forms should be space isolated at a minimum distance of 2,500 m from sunflower crops, for avoiding their impurification with foreign pollen carried by bees. The hybridization plots should be planted at a minimum distance of 1,200 m from other sunflower plants. When the minimum spatial isolation couldn't be achieved, a time isolation can be performed by delaying the sowing with minimum 45 days as against the sowing of sunflower neighbouring crops. Because the parental forms of some hybrids can differ in their vegetation period, they could be sown at different dates, so that a good flowering coincidence be achieved (Figure 2).

The parity of parental forms is 2:1 (female:male), for providing the necessary pollen quantity and getting a complete fertilization.

Among the special works, very important are: biological purification and discarding of diseased plants (Stanciu and Stanciu, 1997).

The evaluation of the investigated genetic material is presented in table 1. The experimental data show that for plant height, oil percentage and 1,000 – seed weight, the variation coefficients are small, and for head diameter

Table 1. Evaluation of sunflower genetic material

Genotypes		Plants height (cm)			Head diameter (cm)			Yield (g/head)			Oil (%)			1,000 grain weight		
		amplitude	average	CV %	amplitude	average	CV %	amplitude	average	CV %	amplitude	average	CV %	amplitude	average	CV %
FL-350	Female	115-145	128	8.1	21-28	24	10.3	34-42	38.2	9.2	41.8-44.6	43.1	3.3	72.0-86.9	77.4	9.4
	Male	85-110	100	8.2	21-26	22	11.2	31-40	36.2	11.2	46.0-56.2	50.3	8.1	58.3-69.1	64.1	7.1
	Hybrid	162-183	170	4.7	18-27	25	12.1	74-90	81.0	10.2	52.1-54.2	52.6	5.7	65.5-75.4	70.2	8.1
Turbo	Female	130-137	133	5.0	22-28	26	11.2	45-57	51.0	11.0	43.0-50.4	46.8	4.8	55.4-67.1	61.8	7.0
	Male	93-110	98	6.6	18-25	21	10.8	31-40	36.2	11.1	45.5-56.0	50.3	8.6	65.0-72.0	67.8	4.2
	Hybrid	162-172	167	4.9	23-31	28	12.1	82-101	95.0	10.9	51.4-54.5	53.1	6.1	70.1-75.2	72.4	5.3
Select	Female	138-157	147	5.4	19-26	22	13.2	35-52	45.0	13.4	42.4-52.8	46.0	6.0	41.3-53.1	46.0	9.1
	Male	93-110	98	6.6	19-23	22	10.8	32-40	36.5	10.1	45.5-56.0	50.3	8.6	65.0-72.0	67.8	4.2
	Hybrid	163-182	171	4.4	29-33	31	10.9	90-105	96.0	11.2	53.6-55.7	54.2	4.1	70.1-74.2	72.4	5.1
Favorit	Female	130-137	133	5.0	22-28	26	11.2	45-57	51.0	11.0	43.0-50.4	46.8	4.8	55.4-67.1	61.8	7.0
	Male	122-135	126	4.5	10-16	15	10.4	23-29	26.4	11.0	44.0-52.0	47.0	6.2	45.0-54.5	49.6	6.9
	Hybrid	154-177	167	4.8	21-30	26	10.8	92-109	98.0	11.4	51.8-53.9	52.4	5.4	65.2-70.4	67.5	6.4
Rapid	Female	110-120	115	4.5	19-24	21	10.1	44-56	53.1	11.3	41.0-47.2	43.0	7.2	67.5-91.0	70.0	8.5
	Male	97-110	105	6.6	12-17	15	11.3	20-27	23.0	12.1	40.0-46.9	42.0	6.5	22.1-33.2	26.0	8.7
	Hybrid	142-165	156	5.2	22-28	24	10.9	69-81	73.0	12.3	49.2-51.4	50.1	5.2	60.3-70.1	67.1	7.9
Felix	Female	138-157	147	5.4	19-26	22	13.2	35-52	45.0	13.4	42.4-52.8	46.0	6.0	41.3-53.1	46.0	9.1
	Male	137-152	141	5.7	24-33	27	11.7	58-69	67.0	11.5	42.7-46.9	44.9	4.6	75.1-83.4	79.5	9.2
	Hybrid	157-177	162	4.9	24-33	28	10.9	70-81	76.0	12.1	51.1-53.2	52.1	5.1	80.3-90.4	85.1	8.9
Female Festiv	Female	75-95	90	7.2	17-23	20	10.3	34-45	38.0	11.1	46.5-54.7	51.0	6.1	45.8-55.1	50.0	9.0
	Male	113-126	123	4.2	23-29	24	16.1	38-48	42.7	10.5	39.4-48.4	44.1	6.3	68.5-74.2	70.9	7.3
	Hybrid	152-160	154	5.1	26-29	27	12.4	58-67	63.0	11.4	50.1-53.2	52.1	5.9	60.2-70.5	65.1	8.2

and seed yield per head, the variation coefficients are middle, which demonstates the stability of the genetic material.

The following observations could be underlined after studying the F test values from analysis of variance for three maintenance methods of inbred lines and hybrids, concerning the influence on seed yield and heterosis, compared with the medium parent (Table 2):

Table 2. F-values obtained from variance analysis of three methods for maintaining sunflower inbred lines and their hybrids

	Seed yield		
	Parental forms	Hybrids	Heterosis compared to the mean parent
Maintenance method (M)	20.90**	165.11**	2.84^{NS}
Genotypes (G)	423.91***	1163.34**	64.69***
M x G	1.20^{NS}	1.20^{NS}	1.57^{NS}

- Genotypes have the greatest weight in seed yield variation both for parental forms and hybrids and for heterosis compared to the medium parent;

- The maintenance method has a significant influence on seed yield of parental forms and hybrids, while the interaction between maintenance method and hybrids was insignificant in all cases, which suggests that genotype reaction to the maintenance method is uniform;

- The heterosis effect is not influenced by the maintenance method and the method - genotype interaction, each combination keeping its specific combining ability, if the biological purity is 100%.

With the view of choosing the most adequate method for maintaining the parental forms, the seed yield of parental forms and hybrids and the heterosis level were analysed using three methods: a) standard method (check) – two years of selfing, one year SIB multiplication; b) continuous selfing; c) annual alternance of selfing with SIB multiplication.

Data presented in table 3 point out that the method which consisted in annual alternance of selfing with SIB multiplication provided significant yield increases both concerning seed yield of parental forms and hybrid seed production.

Table 3. The influence of maintenance method on seed yield (t/ha) of parental forms and heterosis compared to the mean parent

Methods	Seed yield		
	Parental forms	Hybrids	Heterosis compared to the mean parent
Standard (check)	2.055	3.747	182.937
Continuous selfing	2.030	3.670***	180.856
Annual alternance of selfing with SIB multiplication	2.140**	3.817**	178.495
LSD 5%	0.049	0.023	5.17
1%	0.082	0.038	8.58
0.1%	0.154	0.071	16.04

The continuous use of selfing leads to significant reduction of hybrid seed production.

Heterosis value is kept no matter what maintenance method is used.

The Romanian sunflower hybrids have been developed on the cytoplasmic male sterility basis, with pollen fertility restorer parental forms. The parental forms of certain hybrids have a similar vegetation period, but there are many hybrids with different flowering dates. Therefore, for getting a good flowering coincidence of parental forms and a good pollination, the disparity in planting should be performed.

Figure 2 shows that when the parental forms are planted concomitantly, their flowering is very different, depending on hybrids. So, whether in the case of Rapid and Fl-350 hybrids the female form flowers with 8-9 days before the male form, the Select hybrid presents two flowering peaks, the disparity in planting being necessary, and the parental forms of Favorit hybrid, which have a good flowering coincidence, can be planted concomitantly (the male parent is a branching genotype, which allows a good pollination for a longer period).

As a result of many observations on experiments with different planting times, in different years and localities, the sum of useful temperatures required by each parental form for different phenophase development was calculated as Σ ut°>7°C, their sowing being carried out according to the meteorological conditions of each year, keeping the delay expressed as sum of useful temperatures required for passing the specific phenophases sowing-emergence and emergence-flowering of each parental form.

As an insect cross-pollinated species, sunflower requires for fertilization supplementary artificial pollination (1 -2 bee hives per hectare).

Table 4. Genotype classification as depending on melliferous index

Genotypes	Melliferous index (mg sugar/pl.)	Difference from check	Signif.
LC-1066 check	0.07	-	-
LC-1019	0.23	0.160	***
LC-1103	0.23	0.160	***
LC-1104	0.16	0.090	**
LC-1064	0.12	0.050	*
LC-014A	0.11	0.041	-
LC-01C	0.11	0.041	-
LC-1093	0.10	0.032	-
FL-350 check	0.53	-	-
Select	0.63	0.100	***
Rapid	0.60	0.070	**
Turbo	0.59	0.060	*
Favorit	0.57	0.040	-
LSD 5% 1% 0.1%		0.049 0.070 0.100	

Two indicators were calculated which point out the melliferous value and the pollination degree of the investigated genetic material. Data presented in table 4 indicate that the parental forms of Rapid and Select hybrids have the highest melliferous index and the majority of hybrids are superior to the hybrid check FL-350.

A positive correlation was found between the melliferous index and seed yield of the parental forms and hybrids, the correlation coefficient being very significant (r=0.89***) (Figure 3). As regards the pollination degree, the parental forms of Select and Rapid hybrids have given significant values compared to the check. As a matter of fact, all hybrids are superior to the check hybrid Turbo, from this viewpoint (Table 5).

Table 5. Genotype classification according to pollination degree

Genotypes	Pollination degree	Difference from check	Signif.
LC-1066 check	0.20	-	-
LC-1093	0.30	0.10	-
LC-014A	0.34	0.14	-
LC-1064	0.34	0.14	-
LC-01C	0.37	0.17	-
LC-1004	0.49	0.29	**
LC-1019	0.72	0.52	***
LC-1103	0.88	0.68	***
Turbo check	2.71	-	-
Select	3.85	1.14	***
Rapid	3.57	0.86	***
Favorit	3.28	0.57	***
FL-350	3.09	0.38	**
	Lines	Hybrids	
LSD 5%	0.18	0.20	
1%	0.25	0.30	
0.1%	0.34	0.45	

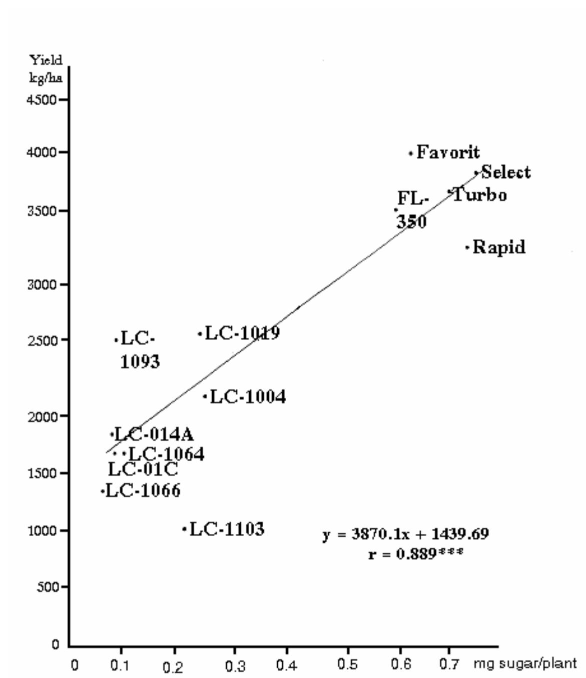

Figure 3. Relationship between melliferous index and genotype seed yield

A positive correlation, with a very significant correlation coeficient (r=0.876***), is also evident between the type of pollination and the seed yield of parental forms and hybrids (Figure 4).

Table 6. Economic efficiency of using F_1 seed compared to F_2 seed

Hybrids	F_1			F_2			Difference from F_1		Value of commercial seed (200 $/t)		
	% oil	seed yield kg/ha	oil yield kg/ha	% oil	seed yield kg/ha	oil yield kg/ha	seed yield kg/ha	oil yield kg/ha	F_1 mill. lei	F_2 mil. lei	Difference mil. lei
FL-350	52.6	3645	1917	51.5	2912	1501	733***	416	6.20	4.90	1.30
Turbo	53.1	3875	2050	52.0	3030	1576	845***	482	6.60	5.10	1.50
Select	54.2	3920	2125	52.9	2979	1575	941***	550	6.70	5.10	1.60
Favorit	52.4	4010	2101	50.6	3025	1532	985***	569	6.80	5.10	1.70
Rapid	51.1	3285	1646	48.2	2592	1250	693***	396	5.60	4.40	1.20
Felix	52.1	3420	1782	50.8	2900	1474	520*	308	5.80	4.90	0.90
Festiv	52.1	2850	1485	51.3	2432	1247	418*	238	4.80	4.10	0.70
Mean	-	3572	-	-	2838	-	734	-	6.07	4.80	1.27
LSD 5%						364.4					
1%						551.8					
0.1%						886.5					

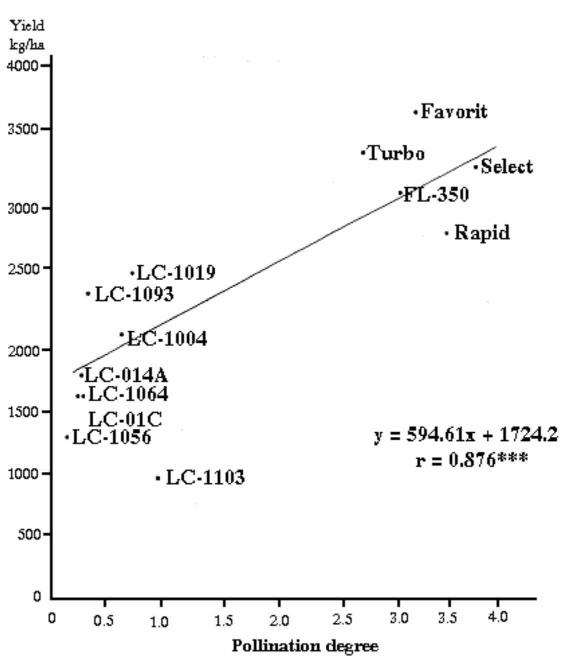

Figure 4. Relationship between pollination degree and genotype seed yield

Table 6 presents the economic calculation regarding the utilization of F_2 seed for sowing.

It is evident that, in this case, the seed yield decreases with values ranging from 418 to 986 kg/ha and the oil yield with 238-569 kg/ha, depending on hybrid and seed hybridity degree, which leads to considerable value losses per hectare.

CONCLUSIONS

The observance of seed production adequate scheme and technological sequences, carrying out the specific works for maintaining the biological and cultural value, checking the seed plot from sowing to harvest, seed conditioning and storage under special conditions will lead to getting a quality F_1 hybrid seed.

The method of annual alternance of selfing with SIB pollination proved to be superior as regards seed yield of parental forms and hybrids.

A positive relationship statistically proved is evident between melliferous index, seed yield and pollination degree.

The differences in flowering phase between parental forms require the disparity sowing of most hybrids in order to allow a good flowering coincidence.

In any case, the F_2 seed should not be use for sowing because, besides the lack of crop uniformity, the yield losses are very high.

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- Hybrid seed quality
  - Parental form quality
    - Biological purity
      - off – type plants
      - male – fertile plants
      - male – sterile plants
      - hybrid plants
    - Cultural value
      - physical purity
      - germinative power
      - penetration power
      - humidity
      - uniformity
      - sanitary state
  - Seed production technology
    - land identification
    - rotation
    - spatial isolation
    - land preparation
    - fertilizer application
    - sowing time
    - plant population
    - parity
    - sowing
    - special works
    - supplementary pollination
    - weed control
    - disease and insect control
    - irrigation
    - harvesting
    - seed processing

Figure 1 Hybrid seed quality

Table 1. Evaluation of sunflower genetic material

Genotypes		Plants height (cm)			Head diameter (cm)			Yield (q/head)			Oil (%)(			1.000 grain weight		
		amplitude	aver-age	CV %	amplitude	aver-age	CV %	amplitude	average	CV %	amplitude	average	CV %	amplitude	aver-age	CV %
FL-350	Female	115-145	128	8.1	21-28	24	10.3	34-42	38.2	9.2	41.8-44.6	43.1	3.3	72.0-86.9	77.4	9.4
	Male	85-110	100	8.2	21-26	22	11.2	31-40	36.2	11.2	46.0-56.2	50.3	8.1	58.3-69.1	64.1	7.1
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	Hybrid	162-172	167	4.9	23-31	28	12.1	82-101	95.0	10.9	51.4-54.5	53.1	6.1	70.1-75.2	72.4	5.3

Select	Female	138-157	147	5.4	19-26	22	13.2	35-52	45.0	13.4	42.4-52.8	46.0	6.0	41.3-53.1	46.0	9.1
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Rapid	Female	110-120	115	4.5	19-24	21	10.1	44-56	53.1	11.3	41.0-47.2	43.0	7.2	67.5-91.0	70.0	8.5
	Male	97-110	105	6.6	12-17	15	11.3	20-27	23.0	12.1	40.0-46.9	42.0	6.5	22.1-33.2	26.0	8.7
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	Hybrid	157-177	162	4.9	24-33	28	10.9	70-81	76.0	12.1	51.1-53.2	52.1	5.1	80.3-90.4	85.1	8.9
Female	Female	75-95	90	7.2	17-23	20	10.3	34-45	38.0	11.1	46.5-54.7	51.0	6.1	45.8-55.1	50.0	9.0
Festiv	Male	113-126	123	4.2	23-29	24	16.1	38-48	42.7	10.5	39.4-48.4	44.1	6.3	68.5-74.2	70.9	7.3
	Hybrid	152-160	154	5.1	26-29	27	12.4	58-67	63.0	11.4	50.1-53.2	52.1	5.9	60.2-70.5	65.1	8.2

Table 6. Economic efficiency of using F1 seed compared to F2 seed

Hybrids	F1			F2			Difference from F1		Value of commercial seed (200 $/t)		
	% oil	seed yield kg/ha	oil yield kg/ha	% oil	seed yield kg/ha	oil yield kg/ha	seed yield kg/ha	oil yield kg/ha	F1 mil. lei	F2 mil. lei	Difference mil. lei
FL-350	52.6	3645	1917	51.5	2912	1501	733***	416	6.20	4.90	1.30

Turbo	53.1	3875	2050	52.0	3030	1576	845***	482	6.60	5.10	1.50
Select	54.2	3920	2125	52.9	2979	1575	941***	550	6.70	5.10	1.60
Favorit	52.4	4010	2101	50.6	3025	1532	985***	569	6.80	5.10	1.70
Rapid	51.1	3285	1646	48.2	2592	1250	693***	396	5.60	4.40	1.20
Felix	52.1	3420	1782	50.8	2900	1474	520*	308	5.80	4.90	0.90
Festiv	52.1	2850	1485	51.3	2432	1247	418*	238	4.80	4.10	0.70
Mean	-	3572	-	-	2838	-	734	-	6.07	4.80	1.27
LSD 5%							364.4				
1%							551.8				
0.1%							886.5				

Table 2. E-values obtained from variance analysis of three methods for maintaining sunflower inbred lines and their hybrids

	Seed yield		
	Parental forms	Hybrids	Heterosis compared to the mean parent
Maintenance method (M)	20.90**	165.11**	2.84^{NS}
Genotypes (G)	423.91***	1163.34**	64.69***
M x G	1.20^{NS}	1.20^{NS}	1.57^{NS}

Table 3. The influence of maintenance method on seed yield (t/ha) of parental forms and heterosis compared to the mean parent

Methods	Seed yield		
	Parental forms	Hybrids	Heterosis compared to the mean parent
Standard (check)	2.055	3.747	182.937
Continuous selfing	2.030	3.670***	180.856
Annual alternance of selfing with SIB multiplication	2.140**	3.817**	178.495
LSD 5% 1% 0.1%	0.049 0.082 0.154	0.023 0.038 0.071	5.17 8.58 16.04

Table 4. Genotype classification as depending on melliferous index

Genotypes	Melliferous index (mg sugar pl)	Difference from check	Significance
LC-1066 check	0.07	-	-
LC-1019	0.23	0.160	***
LC-1103	0.23	0.160	***
LC-1104	0.16	0.090	**
LC-1064	0.12	0.050	*
LC-014A	0.11	0.041	-
LC-01C	0.11	0.041	-
LC-1093	0.10	0.032	-
FL-350 check	0.53	-	-
Select	0.63	0.100	***
Rapid	0.60	0.070	**
Turbo	0.59	0.060	*
Favorit	0.57	0.040	-
LSD 5% 1% 0.1%		0.049 0.070 0.100	

Table 5. Genotype classification according to pollination degree

Genotypes	Pollination degree	Difference from check	Significance
LC-1066 check	0.20	-	-
LC-1093	0.30	0.10	-
LC-014A	0.34	0.14	-
LC-1064	0.34	0.14	-
LC-01C	0.37	0.17	-
LC-1004	0.49	0.29	**
LC-1019	0.72	0.52	***
LC-1103	0.88	0.68	***
Turbo check	2.71	-	-
Select	3.85	1.14	***
Rapid	3.57	0.86	***
Favorit	3.28	0.57	***
FL-350	3.09	0.38	**
	Lines	Hybrids	
LSD 5%	0.18	0.20	
1%	0.25	0.30	
0.1%	0.34	0.45	

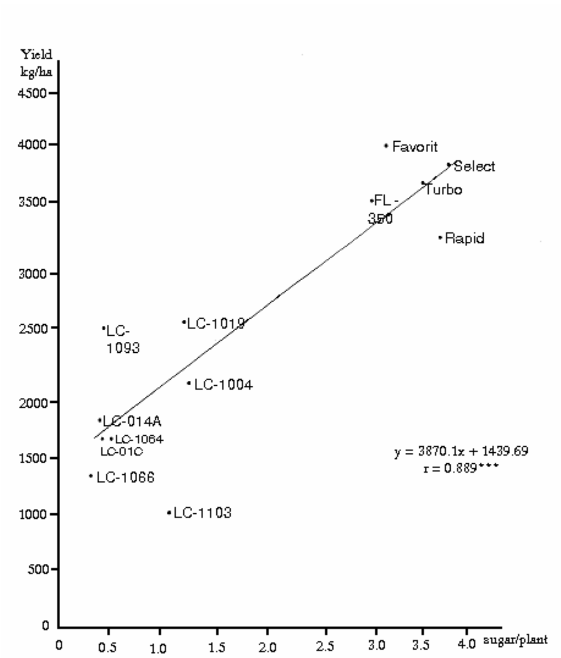

Figure 3. Relationship between melliferous index and genotype seed yield

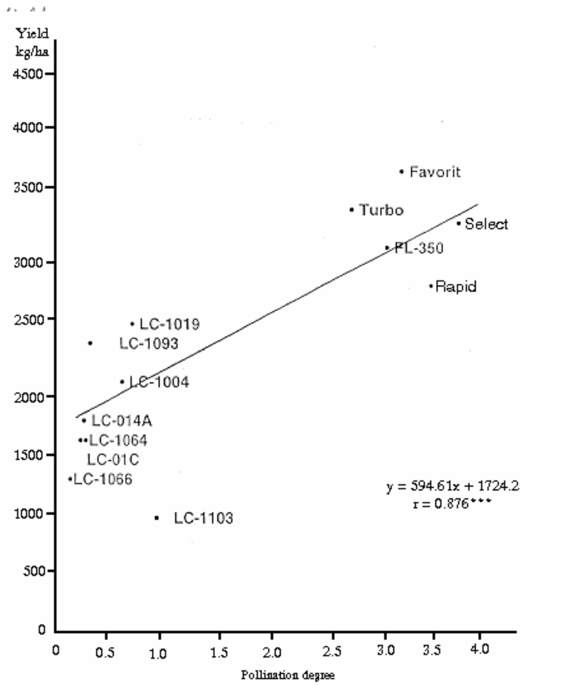

Figure 3. Relationship between degree and gen otype seed yield

Table 6. Economic efficiency of using F1 seed compared to F2 seed

Hybrids	F1			F2			Difference from F1		Value of commercial seed (200 $/t)		
	% oil	seed yield kg/ha	oil yield kg/ha	% oil	seed yield kg/ha	oil yield kg/ha	seed yield kg/ha	oil yield kg/ha	F1 mil. lei	F2 mil. lei	Differ-ence mil. lei
FL-350	52.6	3645	1917	51.5	2912	1501	733***	416	6.20	4.90	1.30
Turbo	53.1	3875	2050	52.0	3030	1576	845***	482	6.60	5.10	1.50
Select	54.2	3920	2125	52.9	2979	1575	941***	550	6.70	5.10	1.60
Favorit	52.4	4010	2101	50.6	3025	1532	985***	569	6.80	5.10	1.70
Rapid	51.1	3285	1646	48.2	2592	1250	693***	396	5.60	4.40	1.20
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Mean	-	3572	-	-	2838	-	734	-	6.07	4.80	1.27
LSD 5%							364.4				
1%							551.8				
0.1%							886.5				