PRELIMINARY RESULTS REGARDING THE BREEDING OF SOME SUNFLOWER HYBRIDS FOR BIODIESEL

REZULTATE PRELIMINARE PRIVIND CREAREA UNOR HIBRIZI DE FLOAREA SOARELUI PENTRU BIODISEL

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Abstract: *In this paper we present the preliminary results regarding the testing in Romania of some sunflower hybrids with middle or high oleic acid. We find that some of these hybrids have a yielding potential close to standard hybrids, but they have some morph-physiological deficiencies like: susceptibility to breaking, falling, and scorching heat and* Botrytis cinerea.

Rezumat: *În această lucrare sunt prezentate rezultate preliminarii privind testarea câtorva hibrizi de floarea soarelui cu conţinut mediu sau ridicat de acid oleic, în condiţiile din România. S-a constatat că unii dintre aceşti hibrizi au potenţial productiv apropiat de cel al hibrizilor normali, dar prezintă unele deficienţe morfo-fiziologice: sensibilitate la frângere, cădere, arşiţă şi* Botrytis cinerea.

Key words: *sunflower, biodiesel, oleic acid*
Cuvinte cheie: *floarea soarelui, biodisel, acid oleic*

INTRODUCTION

Sunflower is one of the main crops around the world, cultivated on a surface of approximately 21 million hectares (Škorić et al., 2007).

Interspecific hybridization is the most important method for increasing genetic variability for oil content. In standard sunflower hybrids, the proportion of fatty acids oil are as follow: linoleic acid (C-18:2) and oleic acid (C-18:1) make up about 90%; palmitic (C-16:0) and stearic (C-18:0) acids other 8-10% and the difference, another fatty acids (Friedt et al., 1994).

The first sunflower variety with high oleic acid content was created by Soldatov (1976), by an induced mutation in VNIIMK 8931. The new variety created, named Pervenets, is a source of genes for breeding of high oleic sunflower hybrids. In addition, the simultaneous presence of *Ol* genes for high oleic acid contents and *tph 1* and *tph 2* genes for low tocopherol results in 20- fold increase of oil oxidative stability and by this, a new perspective for use, like biodiesel (Škorić et al., 2006).

Biodiesel fuel (BDF) is a methyl ester of fatty acids from vegetable origin oils triglycerides (Soriano et al., 2005). In present, the researches are focused on:

- production of large amount of vegetable oil, at a low price;
- developing a reliable process for continuous production of biodiesel;
- conversion technologies for bio- refinery to make it profitable;
- developing some additives to improve the properties of fuel.

In February 16, 2005, by the Kyoto protocol, the world's industrialized countries decided to reduce their carbon emission. In the USA and European countries, much attention has been paid on biodiesel. So, the E. U. has decided to accelerate the application of biomass fuels, the target being 5.71% from the total by 2010; the USA plans to implement 30% BDF use for all vehicles by 2010 (Soriano et al., 2005).

In 1991, the first ten tons of biodiesel were produced in Germany, at Leer, from rapeseed oil. In the same period, the first biodiesel productions on an industrial scale started in

Austria and France. At present, the total capacity of the European biodiesel refineries consists in a few million tones, sunflower being the second vegetable source, after rape.

The vegetable oil with low levels of polyunsaturated fatty acids (like rape with 5-6% and sunflower with 6-10%) exhibits a high stability and an acceptable winter operability of -8^0C. By this, rape and sunflower are very attractive options, being very suitable for biodiesel (Table 1).

Table 1

Fatty acid profile of oils and fats

Fatty acid	Carbon no.	Rape	Sunflower	Soybean	Palm	Beef tallow
Iodine value		113-118	126-136	120-140	44-54	35-55
Fatty acid in %						
Palmitic	C 16:0	5	6	8	42	28
Stearic	C 18:0	1	4	4	5	19
Oleic	C 18:1	60	28	28	41	45
Linoleic	C 18:2	21	61	53	10	4
Linolenic	C 18:3	9	-	6	-	1

Source*: Mittelbach*

As it is a contributor to reducing greenhouse gas emissions, it is exempted from ecological taxation, being less pollutant than fossil fuels. By nature, there are less than 10 ppm sulphur and no polycyclic aromatic hydrocarbons in biodiesel, thus demonstrating its high environmental value.

In Europe, the pressure to create alternatives in non-food production will give oilseeds a chance such as biodiesel, which can absorb large volumes of oilseeds.

In 2003, Baldini et al. found high oleic sunflower hybrids, ideal for biodiesel production. Up to the present, only one high oleic sunflower hybrid was registered in Hungary (Kutni et al, 2007), two in Italy (named Friuli and Carina), one in Spain (Lindor), one in the USA (PR 64 H 91), etc. In our country, the last two are registered in the Romanian Official Catalogue, but they are not cultivated yet.

The process of obtaining biodiesel is very easy, involving a reaction of a vegetable oil with ethanol (methanol), in the presence of a catalyst, to produce an ester (biodiesel) and glycerine (Baldini et al., 2003). This ester can substitute petroleum diesel fuel in most diesel engines. It is biodegradable, renewable, and non-toxic, with a reduced level of pollutants.

The oil fatty acids profile, regarding the degree of saturation, influence two important parameters of biodiesel: cold filter plugging point and iodine number. The sunflower genotypes with high oleic acid content and reduced linolenic acid are desirable for this (Baldini et al., 2003). Unfortunately, the high oleic hybrids are susceptible to some diseases, like *Plasmopara halstedii* or *Sclerotinia sclerotiorum* (Baldini et al., 2004), but, by specific breeding methods, it is possible to solve this problem.

MATERIAL AND METHOD

In the testing field of Agricultural Research and Development Station Oradea, during the year 2007, we tested five hybrids SEMPA with middle or high oleic acid contents. We studied the yielding potential and morpho-physiological characters of hybrids, in local climatic and soils specifically condition. Two of these sunflower hybrids (SO 1 and SO 2) were tested during the same year, in ISTIS network (State Institute for Variety Testing and Registration), in ten locations around all Romania.

The five sunflower hybrids SEMPA are the property of Guerresi Sementi s.r.l. from Verona, Italy.

The sunflower hybrid SO 1 is a middle oleic one (the oleic acid content is 60-75% by total fatty acids). It is a simple hybrid between A75 (a pure cythoplasmic male sterile line) and the fertility restoring pure line R 85, the latter having a high oleic content.

The maternal line A 75 consists in B 75 line, male fertile and its cytoplasm male sterile correspondent, A 75, a selection from *Helianthus petiolaris* Nut. This maternal line (A 75) is a pedigree selection of BC_1 F_5 from the cross HA 89 x 2/Peredovik.

The sunflower hybrid SO 2 is a high oleic one (the oleic acid contents is more than 80% by total fatty acids). It is a simple hybrid between A 26 (a pure cms line) and the fertility restoring line R 65, both of them with high oleic content.

The maternal line A 26 is a pedigree selection by a BC_1 F_5 plant from the cross HA 342 x 2/HA 89. The HA 342 line has a high oleic content one and the line HA 89 is a maintaining of fertility one.

During the experimentation, the specific technology of the competitive trials was used. On the basis of variance analysis, the experimental results was processed, in according with Latin square, the differences between yielding capacity of the variants being estimated by LSD 5%, 1% and 0.1%.

The resistance/susceptibility to diseases was estimated by notes (FAO system), the note 1 means very resistant and the note 9 very susceptible.

RESULTS AND DISCUSSION

The year 2007 was the doughtiest by the last 50 years, so the levels of sunflower yield being affected by water deficit. In addition, the high temperature (36- 40^0C) during the middle day, associated with wind, affected the leaves and calathidium by the scorching heat (tab. 2a). Two by these hybrids (SO 1 and SO 2) were more affected.

Table 2a

Same characters of sunflower hybrids SEMPA. Oradea, 2007

Sunflower hybrid	Resistance to:				
	Scorching heat (notes)	*Puccinia helianthi* (notes)	*Botrytis cinerea* (notes)	Breaking (%)	Falling (%)
SO 1	5	2	3	0.0	2.5
SO 2	7	2	3	8.2	6.2
SO 3	4	5	6	0.0	20.6
SO 4	3	4	3	8.6	56.8
SO 5	4	2	6	6.5	36.4
ALEX	4	3	2	0.0	5.3

The researches of Baldini et al. (2002) revealed that water stress causes a significant reduction of about 15% in the concentration of oleic acid in standard hybrids.

Except for SO 3, the rust (*Puccinia helianthi*) resistance of all hybrids tested was acceptable in the 2007 climatic conditions.

The head of SO 3 and SO 5 was strong affected by *Botrytis cinerea*. Another character derived from *Helianthus petiolaris* is breaking of stem, under heat. It seams that SO 1 and SO 3 hybrids are resistant to breaking head, like Alex (a standard check hybrid).

The falling of plants was caused by a storm associated with rain, on the 26th of August. The poor development of roots caused the falling in a high percent in SO 4 (56.8%) and SO 5 (36.4%) hybrids. The effect consists in a reduced yield.

The vegetative period of Sempa Oradea hybrids is comparable with standard hybrid Alex (Table 2b).

Table 2b

Same characters of SEMPA sunflower hybrids. Oradea, 2007

Sunflower hybrid	Characters					
	Flowering date	Vegetative period (days)	High (cm)	Calathidium diameter (cm)	TKW (g)	Specific weight (kg/100 l)
SO 1	18.07	124	145	20.0	73.6	39.6
SO 2	11.07	120	134	17.7	79.5	40.8
SO 3	17.07	125	124	17.8	57.4	45.6
SO 4	13.07	122	123	19.7	62.4	44.8
SO 5	18.07	125	135	20.0	78.0	38.0
ALEX	17.07	125	115	20.2	79.5	40.8

All hybrids are higher than Alex. The calathidium diameters are comparable to standard check, Alex, except the hybrids SO2 and SO3, which are smaller by 20 – 30 cm.

The thousand kernel weight (TKW) of studied hybrids is equal with check one only in case of SO2. The specifically weight is bigger than check in case of SO3.

All of these characters, in addition to others, concurred in the yielding potential of the hybrids (table 3).

Table 3

Yields of some sunflower high oleic hybrids compared to standard one, Alex. Oradea, 2007

Class.	Hybrid	Yield (kg/ha)	Relative yield (%)	Difference (kg/ha)	Significance of differ.
1	SO 1	2405	146.6	+765	***
2	SO 2	2000	122.0	+360	**
3	SO 5	1875	114.3	+235	*
4	SO 3	1818	110.9	+178	*
5	SO 4	1717	104.7	+77	
6	ALEX (standard check)	1640	100.0	0	-

LSD 5% = 155.0 kg/ha:
LSD 1% = 243.0 kg/ha;
LSD 0.1% = 414.0 kg/ha.

In the specific soil and climatic conditions from Oradea, the yield of SO 1 hybrid gains was ensured at significant level. The yielding ability of SO 2 exceeded the check Alex by 360 kg/ha (122.0%), SO 3 and SO 5 hybrids proved to be superior to standard sunflower hybrid, Alex more than 110%.

The two best hybrids (SO 1 and SO 2) were tested all over the country, in an ISTIS network, in ten locations. The results are presented in table 4.

The SO 1 hybrid was better than SO 2 but both were under the standard hybrids, Performer and Favorit (comparative to network averages, 2839 kg/ha). However, in Inand testing centre (Bihor County) and Tecuci (Vrancea County), SO 1 exceeded the checks average. In addition, SO 2 exceed the checks averages in three locations: Inand, Portăreşti and Tecuci.

Table 4

The yield ability of high oleic hybrids SO 1 and SO 2 under ISTIS ecological network in 2007.

Locality	Yield of hybrid (kg/ha):				Relative yield (%) to checks average of:	
	SO 1	SO 2	Performer	Favorit	SO 1	SO 2
Arad	2774	2774	3839	3493	75,7	75,8
Cogealac	1726	1528	1665	2020	93,7	82,9
Dâlga	1865	1544	3150	2679	64,0	53,0
Inand	3035	3038	2962	2922	103,2	103,3
Negreşti-Vs	2449	2172	2700	3021	85,6	75,9
Peciu Nou	3144	2871	3757	3010	92,9	84,9
Portăreşti	3231	3336	3721	2910	97,5	100,6
Râmnicu Sărat	2735	2190	2958	3036	91,3	73,1
Tecuci	3459	3207	3297	3032	109,3	101,3
Troian	1108	1141	1406	1190	85,4	87,9
Network averages	2552	2380	2946	2731	89,9	83,9

Generally, the sunflower hybrid SO 1 realised around 90% of checks average and SO 2 only around of 80%. Therefore, their yielding potential was under standard hybrids, except for western Romania.

CONCLUSIONS

The experimental research showed the following:

- the new high oleic and middle oleic hybrids tested have yet some deficiencies: susceptibility to scorching heat, breaking stem and falling;
- The yielding ability of high oleic hybrid SO 1 and of middle oleic hybrid SO 2 is competitive to standard hybrids in western Romania, where the drought is not so strong as in the south and southeast Romania.

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