THE FIRST RESULTS REGARDING THE BREEDING OF SOME SUNFLOWER HYBRIDS FOR BIODIESEL

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Abstract

The paper presents the preliminary results regarding the first testing in western Romania of some sunflower hybrids with middle or high oleic acid contents. We find that some of these hybrids have a yielding potential close to standard hybrids, but, in the Oradea climatic conditions, they have some morphological and physiological deficiencies like: susceptibility to breaking, falling, scorching heat and Botrytis cinerea.

Key words: sunflower, biodiesel, middle and high oleic.

INTRODUCTION

By Kyoto protocol (16.02.2005), the world's industrialized countries decided to reduce carbon emission. After this, in USA and European Union, much attention has been paid on biodiesel. Therefore, the E. U. has decided to accelerate the application of biomass fuels, the target being 5.71% from total by 2010. In addition, USA plans to implement 30% biodiesel fuels (BDF) use for all vehicles by 2010 (Soriano et al., 2005).

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

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

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

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

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 industrial scale started in Austria and France. In present, the total

capacities of European biodiesel refinery consists in some millions 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 nr.	Rape	Sunflower	Soybean	Palm	Beef tallow
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
Iodine value		113-118	126-136	120-140	44-54	35-55

Source*: Mittelbach*

The oil fatty acids profile, regarding 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).

Sunflower is one of the for principals crops around the world, with a surface of approximately 21 millions ha (Škorić et al., 2007).

In standard sunflower hybrids, the proportion of fatty acids oil are as fallow: 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 another 8-10% and the difference, another fatty acids (Friedt et al., 1994).

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 glycerin (Baldini et al., 2003). This ester can substitute petroleum diesel fuel in most diesel engines. It is biodegradable, renewable, and nontoxic, with a reduced level of pollutants.

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, Pervenets, is a source of genes for breeding of high oleic sunflower hybrids.

The simultaneously presence of *Ol* genes for high oleic acid contents and *tph 1* and *tph 2* ones for low tocopherol results in 20- fold increase of oil oxidative stability and by this, a new utilization perspective, like biodiesel (Škorić et al., 2006).

Interspecifically hybridization is the most important method for increasing genetically variability for oil content. By this method, in 2003, Baldini et al.

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

Unfortunately, the high oleic hybrids are susceptible to some diseases, like *Plasmopara halstedii* or *Sclerotinia sclerotiorum* (Baldini et al., 2004), but, by breeding specifically methods, is possible to solve it.

MATERIAL AND METHODS

During the year 2007, in the testing field of Agricultural Research and Development Station Oradea, we tested five sunflower hybrids created at University of Udine (Italy), hybrids with middle or high oleic acid contents. We studied the yielding potential, morphological and physiological characters of hybrids, in local climatic and soil specifically conditions. Two of these sunflower hybrids (SEMPA 1 and SEMPA 2) were tested during the same year, in ISTIS network (State Institute for Variety Testing and Registration), in ten locations around all Romania.

The sunflower hybrid SEMPA 1 is 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 breeding line) and the fertility restoring pure line R 85, a selection from *Helianthus petiolaris* Nut., with high oleic content.

The maternal line A 75 consist in B 75 line, male fertile and its cytoplasm male sterile corespondent, A 75. This maternal line is a pedigree selection of BC_1 F_5 from the cross HA 89 x 2/Peredovik.

The sunflower hybrid SEMPA 2 is a high oleic one (the oleic acid contents are more than 80% by total fatty oleic 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 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 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.

In western Romania, 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. 2). Two by these hybrids (SEMPA 1 and SEMPA 2) were more affected.

Table 2

Same characters of SEMPA sunflower hybrids.
Oradea, 2007.

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

In the 2007 climatic extreme conditions, except the hybrid SEMPA 3, the rust (*Puccinia helianthi*) resistance of all sunflower hybrids tested was acceptable

The heads of SEMPA 3 and SEMPA 5 were strong affected by *Botrytis cinerea*, these two hybrids being very susceptible to this disease. *Botrytis cinerea* was favored by the rains of September.

Another undesirable character, derived from *Helianthus petiolaris,* is breaking of stem, under heat. It seams that SEMPA 1 and SEMPA 3 hybrids are resistant to breaking head, comparable with Alex (a Romanian standard hybrid utilized like check in this experiment).

The falling of plants were caused by a storm associated with rain, in 26 august. The pour development of roots caused the falling of plants in a high percent in SEMPA 4 (56.8%) and SEMPA 5 (36.4%) hybrids. The effect consists in a decreased yield.

All of these characters, in addition to another, (like the drought resistance) concurred in yielding potential of hybrids (table 3).

In the soil and climatically conditions from Oradea, the yield of SEMPA 1 hybrid gains was ensured at significant level. The yielding ability of SEMPA 2 exceeded the check Alex with 360 kg/ha (122.0%) and

SEMPA 3 and SEMPA 5 hybrids proved to be superior to standard sunflower hybrid, Alex more than 110%.

Table 3

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

Class.	Hybrid	Yield (kg/ha)	Relative yield (%)	Difference (kg/ha)	Significance of differ.
1	SEMPA 1	2405	146.6	+765	***
2	SEMPA 2	2000	122.0	+360	**
3	SEMPA 5	1875	114.3	+235	*
4	SEMPA 3	1818	110.9	+178	*
5	SEMPA 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.

The two best hybrids (SEMPA 1 and SEMPA 2) were tested allover the country, in an ISTIS networks, in ten locations (table 4).

Table 4

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

Locality	Yield of hybrid (kg/ha)				Relative yield (%) to checks average of:	
	SEMPA 1	SEMPA 2	Performer	Favorit	SEMPA 1	SEMPA 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 aver.	2552	2380	2946	2731	89,9	83,9

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

In general, the sunflower hybrid SEMPA 1 realised around 90% of checks average and SEMPA 2 only around of 80%. So, there yielding pottentials is under standard hybrids.

CONCLUSIONS

Experimental researches 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 SEMPA 1 and of middle oleic hybrid SEMPA 2 is competitive to standard hybrids in western Romania, where the drought is not so strong like in south and south-east Romania.

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