

## **“Sincron”, a new *Brassica carinata* cultivar for biodiesel production**

**(Alessandro Bozzini, Fortunato Calcagno and Titi Soare)  
(Eurogen-Proseme, Enna)**

### **Summary**

The recent rapid increase of petrol price, due to the rising world demand for energy and the rapid depletion of fossil fuels, demands for a diversification of energy sources, with particular reference to liquid fuels: gasoline and diesel oil. Particularly diesel fuel is fundamental for human and trade transport.

Biodiesel, produced by a simple processing of oil from animal fat and/or oilcrops, could represent an interesting alternative, both pure or mixed with diesel oil, even if not certainly a complete substitution for diesel oil use.

In tropical areas oil palm, cotton oil, etc. could represent valid sources of vegetable oil, while in temperate areas, rape, soybean and sunflower now represent possible adapted biodiesel producers.

However, there is a need to identify other oil crop species, fall sowed, not needing irrigation and of good potential for oil productivity. Among the genus *Brassica*, *Brassica carinata*, an allopolyploid species, coming from natural crosses of *B. nigra* x *B. oleracea*, originated in Ethiopia, could be of interest for biodiesel production.

Being a semi-wild species, but domesticated for pod indehiscence, fall or spring seeded in our conditions, of good development, could be a candidate for biodiesel production. We introduced several lines/populations, selected with particular reference to winter survival (particularly in North and Central Italy), high biomass and seed production and good adaptation to marginal soils.

The collection and selection programme started in the '90s, with lines obtained from ENEA, Koipesol, India, Germany, Netherlands etc. After a first preliminary screening for agronomic performance, a few lines were identified and selected for higher seed and biomass production. The best performing line, selected from a population coming from north India, was tested in North, Central and South Italy, with interesting results.

The line, now called “Sincron”, for its synchronic ripening, should be seeded in fall, after a good soil preparation, in order to better resist to winter conditions, profit from winter rains and from longer growing cycle. In good conditions, Sincron reaches 1,50-1,70 m height, a seed production of 4,0 - 4,8 tons/ha, a seed oil content of 33%-35%, with high erucic acid content (47%) and good technological characteristics for biodiesel production.

A programme, involving some 35.000 Ha, has been proposed in Sicily for production of both biodiesel and electric power from the biomass, while the presence of glucosinolates in the cake, could be used for control of nematodes in greenhouses and protected cultivations, after the ban of methyl bromide.

### **Introduction**

In the recent period, petrol reached up to 78 US\$ a barrel, with an official forecast of the Golden Sachs Bank of the possibility of reaching soon a price of 100\$ a barrel. The increasing world demand for energy, with particular reference to the demand of several Asian developing Countries and the rapid decrease of fossil oils natural reserves, are considered the main causes of such a trend. Following the experts of British Petroleum, we have already consumed 42% of all known fossil oil resources. At world level, there is strong interest in the diversification of energy sources, in order to be able to better front eventual future oil crises.

To produce biodiesel, some tropical developing Countries ( Brazil, China, Indonesia, India, Vietnam etc.) have recently planted several million Ha with oil palm, the highest oil producing crop. Also developed and developing temperate Countries are planning to increase the production of adapted oilseed crops ( soybean, sunflower, rape etc.) in order to contribute to energy production diversification.

In Italy, in 2002, 16 Mt (million metric tons) of gasoline, 26 Mt of gasoil and 1,3 Mt of GPL have been used for rubber wheels transport; in 2004 have been used 15Mt of gasoline, 30 Mt of gasoil and 1,1 Mt of GPL. Biodiesel, either pure or mixed with gasoil, could contribute to reduce the oil import and the export of cash, together with the increase of other national sources of energy production( bioethanol, biogas, solar, wind, geothermic etc.). Moreover, the E.U., with law 30/2003, fixed for Italy the use of 800.000 tons/year of biodiesel in the year 2010.

In addition to the traditional oilcrops, there is a need to explore other sources of vegetable oil, to be used for biofuel production. Among the *Brassicaceae* and related species, besides rape (*Brassica napus*), there are several other known oil producing species (*B. oleracea*, *B. juncea*, *B. nigra*, *B. carinata*, *Sinapis alba*, etc.) to be analyzed and tested. Among these species, rape (*Brassica napus*) is the most known and studied. For biodiesel production, high yielding rape cultivars with high content of erucic acid were selected in Germany and other north European Countries in the past. However, we identified also *B. carinata* as a possible interesting crop for biodiesel production.

*B. carinata* is still a semi wild, not fully known species, with seeds with high erucic acid and glucosinolates content and therefore not commonly used for production of edible oil. It is original from Ethiopia, derived as

allopolyploid from natural crosses of *B. nigra* x *B. oleracea*. Practically the only domestication trait is a relatively delayed seed dehiscence, particularly if compared with rape.

Moreover we found lines with good tolerance to low temperatures and therefore with the possibility of fall seeding, particularly in central and south Italy. It shows also more tolerance to important parasites: *Meligetes aeneus*, *Ceutorrhincus assimilis* and to aphids.

In the '90s several lines and populations were introduced in Italy, particularly through national and European projects financial support. However, at the time, main interest was for edible oil and the *carinata* had not adapted traits (high content of erucic acid and glucosinolates).

The collection and selection programme started in the '90s. Many populations and lines obtained from ENEA (Italy), Koipesol (Spain), India, Germany, Netherlands etc. were grown in order to identify those more potentially productive and adapted to our conditions. Lines with lower biomass, lower height, high cold susceptibility, higher dehiscence, lower seed production, were discarded after a first testing.

In the year 2000 a first agronomic trial was performed with 7 best performing selected lines, followed by trials conducted in South, Central and North Italy, also in comparison of some of the most diffused cvs of rape.

The best seed production line, derived from a population coming from North India, has been chosen and called "Sincron", because of a good synchronization of ripening, another important character for mechanical harvesting.

### Material and Methods

The original material (35 entries) was grown in single rows of 10 meters, 50 cm between rows, at the rate of 10kg of seed/ha. Seven best performing lines/populations were grown in 3 replication plots of 12 m<sup>2</sup>, after seeding in December 1999 in Enna (Sicily). From the results obtained a line was selected and grown in the following years in large plots in South Italy (Sicily), in Central Italy (Viterbo) and North Italy (Filo di Ferrara, Ancona) with fall and spring seeding. The best performing line was named Sincron, in relation to the ripening synchrony.

### Experimental results

The first agronomic trial results were obtained in Gelsi locality (Enna province, Sicily, 1999-2000). Table 1.

**Table 1. Agronomic trial with the 7 lines selected**

| Lines<br>N° | Maturity<br>day/month | Seed Production (tons/ha) |            |            | Mean        |
|-------------|-----------------------|---------------------------|------------|------------|-------------|
|             |                       | 1° Replic.                | 2° Replic. | 3° Replic. |             |
| 1           | 20 VI                 | 4,2                       | 4,0        | 4,5        | 4,23 ***    |
| 2           | 15 VI                 | 3,8                       | 4,0        | 3,8        | 3,87 ***    |
| 3           | 18 VI                 | 2,8                       | 3,1        | 2,6        | 2,83 ---    |
| 4           | 10 VI                 | 2,6                       | 2,8        | 2,5        | 2,63 ---    |
| 5           | 7 VI                  | 2,9                       | 2,9        | 2,1        | 2,63 ---    |
| 6           | 7 VI                  | 1,9                       | 2,2        | 2,1        | 2,07 ***    |
| 7           | 12 VI                 | 2,0                       | 1,9        | 2,0        | 1,97 ***    |
| <b>Mean</b> | <b>13 VI</b>          |                           |            |            | <b>2,89</b> |

(\*\*\*) Significant difference 0,1%

Two lines resulted with higher production at 0,1% significance. Analyses for oil seed content gave 35% for line 1 and 33% for line 2. The fatty acid analysis (performed by INRAN) of the 2 best performing lines gave the following composition:

**Table 2. Fatty acids composition of the 2 best lines**

| Fatty Acids   | Line 1 | Line 2 |
|---------------|--------|--------|
| Palmitic acid | 6,7    | 8,5    |
| Linoleic acid | 18,2   | 25,4   |
| Oleic acid    | 11,0   | 12,1   |
| Stearic acid  | 5,4    | 3,6    |
| Gadolic acid  | 7,5    | 6,0    |
| Erucic acid   | 47,0   | 34,7   |

Line N° 1(Sincron) was grown in Viterbo(central Italy) in 2003-2004 in 2000 m<sup>2</sup>, seeded the 15 December at the rate of 10kg/ha and, combine harvested, gave a production corresponding to 4,4 tons/ha.

In 2004 Line 1 was seeded, at 20 Kg/ha, the 03 /April/2004 in 0,63 ha, in hilly area, close to Senigallia (Ancona, central Italy), without irrigation. The vegetation cycle lasted only 100 days. The crop was combine harvested and gave a production corresponding to 1,0 ton/ha of seed yield.

It should be noted that, normally, the production life cycle of *B. carinata* should be of some 250 days.

In 2003 -2004, line 1 was grown also in Filo of Alfonsine (Ferrara) in an agronomic trial, seeded in fall (15 October 2003) and in spring ( 3 March 2004) at the rate of 10 kg/ha. The results of the analyses performed is presented in table 3.

**Table 3. Seeding date effect on some important production parameters of *Brassica carinata* cv. "Sincron"**

| No. | Analyzed parameters          | Seeding time |               |
|-----|------------------------------|--------------|---------------|
|     |                              | Fall (2003)  | Spring (2004) |
| 1.  | Moisture (%)                 | 6,3          | 6,7           |
| 2.  | Ashes (%)                    | 5,1          | 4,8           |
| 3.  | Proteins (%)                 | 29,4         | 33,8          |
| 4.  | Non protein substances (%)   | 15,3         | 16,2          |
| 5.  | Fibres (%)                   | 8,1          | 8,6           |
| 6.  | Lipids (%)                   | 35,8         | 29,9          |
| 7.  | Seed Production (tons/ha)    | 3,7          | 2,2           |
| 8.  | Oil Production (kg/ha)       | 1.315        | 658           |
| 9.  | Biomass production (tons/ha) | 24,6         | 17,3          |
| 10. | Life cycle (days)            | 241          | 128           |

Late seeding not only affected seed production, but also seed oil content.

In 2005-2006 Sincron was tested in 2 agronomic trials, with 5 replications of 10m<sup>2</sup> in Enna province (Sicily) in Gelsi and Geracello localities, in comparison with 3 cvs of rape (*B. napus*): "Comet", "Dubla" and "Sponsor".

In Gelsi the material was seeded in mid December, while in Geracello at the end of January.

The mean production of Sincron in Gelsi was 2,5 tons/ha, of Comet 1,2 , of Dubla 1,5, of Sponsor 1,8 t/ha; while in Geracello Sincron produced 4,3 tons/ha, Comet 2,0 t/ha, Dubla 2,3 t/ha, Sponsor 2,8 t/ha.

In both trials the Sincron production was significantly higher at 0,01% level.

## Conclusions

From the results obtained in the last 7 years of trials and cultivations, the cv Sincron constantly gave productions higher than other tested *B. carinata* and *B. napus* lines, populations or cvs. If seeded in proper time, (possibly October: in north Italy and November: in central and south Italy) the seed yield has been around or over 4 tons/ha. With an oil content of seeds of at least 33-35%, the oil production should be over 1 ton/ha.

In normal conditions the cv Sincron has a vigorous growth, even in marginal soils, the vegetation height reaches 1,60 - 1,70 m; the stem and leaves are deep green, with anthocyanin in cold periods; leaves are waxy, Sincron has white flowers, yellow pods and brown seeds. Pods are more resistant to shattering than rape cvs, providing more time and easier and more complete mechanical harvesting.

The selection of Sincron will continue, to explore the variability for seed oil content and eventually isolate higher oil content plants. The selection is easy, since the species is largely self pollinated.

A programme for selection for low glucosinolates of another *B. carinata* line, after irradiation of seeds, has been performed by ENEA (**Brunori**, personal communication) without clear results, probably because of the allopolyploid nature of this species.

A programme, involving some 35.000 Ha, has been proposed in Sicily for production of both biodiesel and electric power from the biomass of Sincron. It should be noted that the high content of glucosinolates in the cake, could be used for control of nematodes in greenhouses and protected cultivations in general, after the ban of methyl bromide (**Lazzari**, personal communication).