

## Hybrids of winter rapeseed - varieties for the future ?

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The first fully restored winter rapeseed hybrids world-wide were added to the German variety list December 19th 1995, JOKER was listed after a three year testing period starting in 1992, whereas PRONTO, tested only since 1993, was already listed according to a two year variety testing cycle now used in Germany. Nearly at the same time two other hybrids were listed in Germany, SYNERGY (INRA / SERASEM / NPZ) and ACCENT (DSV / CARGILL) on January 8th 1996 after two years of testing. The hybrids SYNERGY and ACCENT are both composite hybrids or varietal associations based on the French INRA-ogura hybrid system, developed by protoplast fusion.

The hybrids JOKER and PRONTO are both based on the MSL hybrid system (Male Sterility LEMBKE) which was found as a spontaneous mutation in the rapeseed nursery of NPZ / LEMBKE in Hohenlieth in 1983. Eversince, the MSL hybrid system has been developed throughout several steps by *Dr. Paulmann* at the Institute of Plant Breeding in Göttingen, Germany. The MSL system has also been used in spring rapeseed and the first hybrid named ORAKEL was recently listed in Denmark. Several other MSL hybrids are officially tested in different countries. In Sweden the third fully restored winter rapeseed hybrid variety based on MSL system named KASIMIR came on the variety list December 19th 1995.

The MSL hybrid system like the INRA-ogura system is based on a cytoplasmic male sterility. For a breeding program the three following components are needed (see figure 1) :

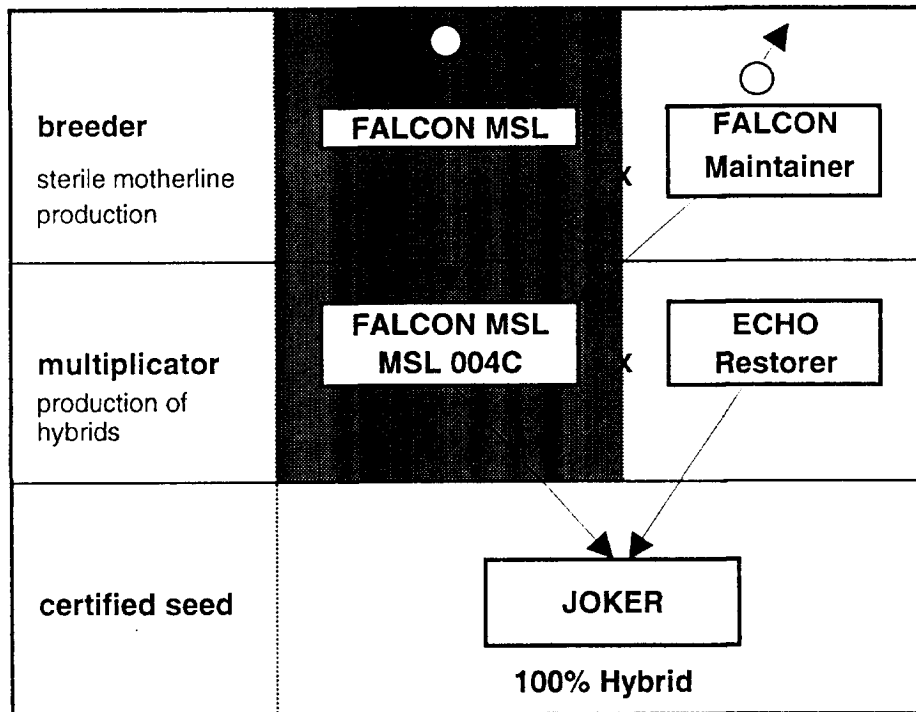
1. a male sterile female line (to produce the hybrid seed),
2. a fertile maintainer line (to multiply and maintain the male sterile line),
3. a fertile restorer line (as pollinator to produce hybrid seed).

Compared to the ogura-system as it is used up to now, the father line of the MSL system has restorer genes, which allow to overcome male sterility in the commercial certified seed. There is no need of a conventional variety as source of pollen as used in varietal associations, as MSL hybrids are nearly fully self pollinating. Nevertheless, composite ogura hybrids seem to have a positive yield effect beyond heterosis due to energy saved for not producing pollen. This "effect of sterility" cannot be used in restored MSL hybrids (see figure 2).

It is difficult to develop father lines with restorer genes for the orgura-system, whereas for the MSL system it is difficult to develop maintainer lines. Those can only be found in very extensive back crossing programs.

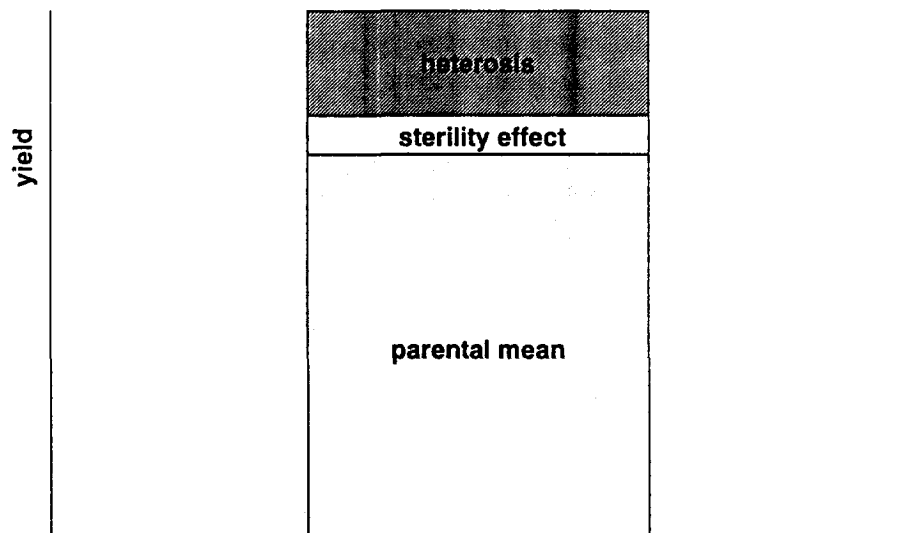
(1) Breeding director of NPZ/Lembre, Germany

**Scheme of multiplication structure winter oilseed rape JOKER**



source: Norddeutsche Pflanzenzucht, Hohenlieth

**Yield structure of a variety association of winter oilseed rape**



## Good hybrids need the right choice of parents

As hybrid varieties are the result of a crossing of two (or more) parental lines, following conditions have to be considered :

1. a genetically fixed perfect double low quality on the level of the parents
2. a high genetical distance between the lines as basis of a high general combining ability
3. a good expression of agronomical characters in the lines to combine important characters of yield stability (disease resistance, standing ability, winter hardiness) in the hybrid
4. a high specific combining ability for a maximum heterosis effect

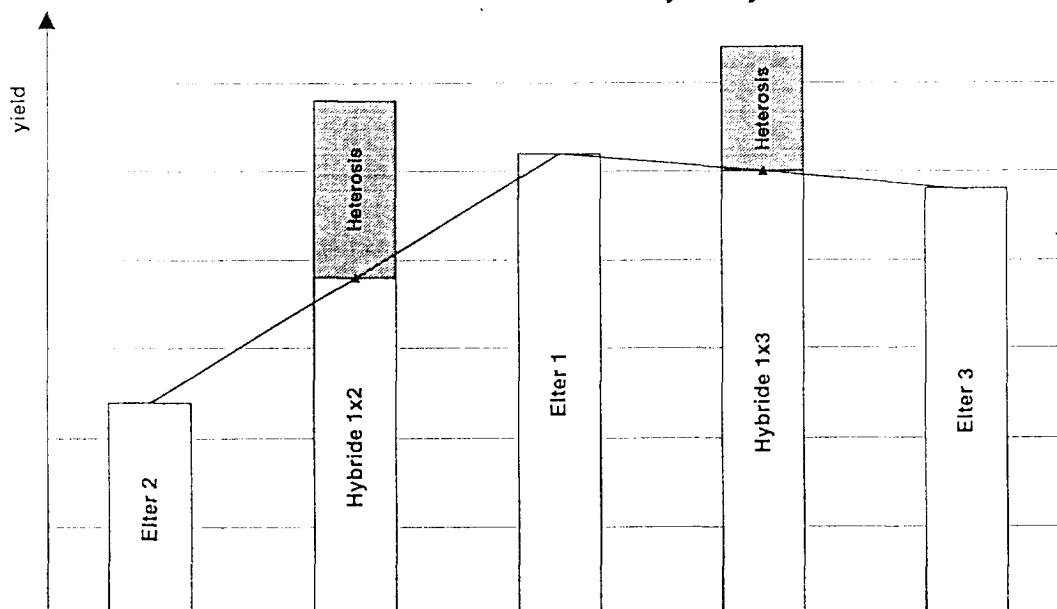
The choice of suitable parental lines is very time consuming and needs a large gene pool, a double low breeding material, an exact follow up of the descent of the breeding material and a good "breeders know-how".

Technics to identify the genetic distance are more and more used today. Technics of restrictions fragment length polymorphism or polymerase chain reaction are effective tools to find ideal parental combinations. But nevertheless, heterosis cannot be predicted precisely, and a huge amount of test crossings are necessary especially when we think about complete diallel mating designs. The high amount of test hybrids easily comes close to the maximum feasible test capacity of a breeder. Beside some exceptions, the probability to find a new outstanding hybrid is estimated to be at least 1 to 1.000 !

## Conventional line varieties used as components of hybrids

The existing conventional line varieties with market success are useful for hybrid breeding as they show a good combination of agronomic characters as a basis for heterotic yield increase. Therefore, the first generation of MSL hybrid varieties uses the heterosis between parents which themselves have already a good performance. These hybrids show a lower percentage of heterosis compared to hybrids having parents with lower performance. But in absolute terms the hybrid yield level is higher, and this is the main goal of hybrid breeding (see figure 3).

Scheme of heterosis and hybrid yield



Looking at the expression of agronomic characters of the composite and restored hybrids, recently officially listed in Germany, following similarities and differences can be identified (see figure 4):

### Extract of German variety list (January of 1996)

SORTE	Blüh-Beginn	Reife-Zeit	Pflanzen-Länge	Lager-Neigung	Phoma-Anfälligkeit	Alternaria-Anfälligkeit	Korn-Ertrag	Öl-Ertrag
*ACCENT <sup>70+</sup>	3	4	5	5	4	4	8	8
*SYNERGY <sup>80+</sup>	3	4	5	3	5	5	9	9
*JOKER <sup>100</sup>	3	4	5	4	4	5	9	9
*PRONTO <sup>100</sup>	3	4	5	4	4	5	9	9

**1** sehr früh · kurz gering · niedrig    **3** früh · kurz gering · niedrig    **5** mittel    **7** spät · lang stark · hoch    **9** sehr spät · lang stark · hoch    Gerade Zahlen = Zwischenstufen

\*100 = 100 % Hybriden (Restaurierte Hybride, Selbstbefruchter) · \*80+ = 80 % Hybride + 20 % Pollenspender (Verbundhybride, Fremdbefruchter) \*70+ = 70 % Hybride + 30 % Pollenspender (Verbundhybride, Fremdbefruchter)

1. Hybrids in general show an outstanding yield potential. They reach a new level of very high seed and oil yields.
2. Hybrids show a quick vegetative development in autumn and spring, they are early in flowering and mid-early in maturity.
3. Hybrids have longer stems but, nevertheless, differences in standing ability are found.
4. Hybrids show in general a medium expression of disease resistance but they have an additional vitality and compensatory potential.

Hybrids show also similarities on the level of yield components. Compared to conventional line varieties, the higher yield of hybrids is mainly due to higher pod numbers per plant, resulting of an increased branching. The MSL hybrids show a nearly completely regular pod set and a homogeneous pod length and seed number per pod. The thousand grain weight can also be high.

### Results of official testing at the Bundessortenamt

Figure 5 gives a summary of 1994 and 1995 yields in official trials, where hybrids have clearly shown their higher yield potential compared to conventional line varieties. On an average the yield of the hybrids was clearly increased compared to the conventional standard varieties but the yield advance depends however on locations and years.

### Oilseed rape Official yield results 1994 and 1995 (mean)

	check varieties		hybrids			
	LIRAJET	FALCON	ACCENT <sup>70+</sup>	SYNERGY <sup>80+</sup>	JOKER <sup>100</sup>	PRONTO <sup>100</sup>
seed yield relativ 100 = 43 dt/ha n = 20	100	100	107	115	115	116
oil yield relativ 100 = 17 dt/ha n = 20	100	100	109	117	118	118

\* n = 21

## **Experience on farmers fields**

In 1994 and 1995 extensive farmer trials have been carried out in Germany with the hybrid variety SYNERGY. They have shown that conventional varieties can easily be replaced by hybrids on the farms by using the same cultivation scheme. But a small group of farmers will have to adapt their cultivation system to this new type of rapeseed varieties. Following mistakes were made : too early seeding, too high seed rates, nitrogen fertilisation in autumn, appearance of pollen beetle, too high application of nitrogen in spring, insufficient mineral fertilisation with sulphur or other elements (average yields of 1995 were about 4 t per ha), missing fungicide treatment during flowering which gave high sclerotinia infections, missing treatments against fungal diseases during maturity and underestimated insect attack. You could easily add more mistakes in cultivation technics and some farmers are not convinced to grow hybrids on their farm.

Based on the experience of those farmer trials, a lot of practical advises for cultivation technology could be summarised. Furthermore, the crop area of SYNERGY for harvest 1996 increased to more than 30.000 ha in Germany which will be another important step for more practical experience.

For the MSL hybrids JOKER and PRONTO, less practical experience is available today (both hybrids showed i.e. a high tolerance for late seeding), therefore composite hybrids will first be promoted in the market.

## **Outlook**

The first generation of winter rapeseed hybrid varieties have a very high yield potential.

As short term goal we need to increase some of the agronomical characters as standing ability and disease resistance up to the level of the best known conventional line varieties (as EXPRESS) and to increase heterosis in yield to about 20 to 25 % compared to conventional varieties. It seems more probable today to develop good composite ogura hybrids instead of restored MSL hybrids. The high number of ogura hybrids in official trials in different countries seems to prove this and clearly shows the potential of this system.

Nevertheless, the development of MSL hybrids will be continued. First trial results show that both systems are not only to be considered as being competitive, but could also be combined in a modified type of composite hybrids, i.e. with 50 % male sterile ogura hybrids and 50 % MSL hybrids. Beyond that, even more hybrid systems will compete for breeding progress in future. But there is no doubt that hybrids will give new perspectives for rapeseed cultivation in general.

It seems very probable that the market success of a hybrid will depend on its specific agronomic characters and not on the hybrid system used. And it has to be remembered that good hybrids will be based on good line varieties. That means conventional line breeding will, however, have to be continued and will leave a place for this type of varieties in the market. Rapeseed breeding today stands at its turning point. Hybrids show enormous perspectives but they will probably not completely push good conventional line varieties out of the market.