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Use of biotechnology in breeding new varieties of winter oilseedrape in Germany

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There is no doubt about that today we see the commercial potential of biotechnology in breeding new varieties of winter oilseedrape much clearer than a few years ago. Plant breeders even know that the conventional breeding technique is very powerful and the high cost of traditional breeding techniques are wellknown. Biotechnology developments are increasing the budget of rapeseed breeders; up to now we do not risk the replacement of classical work by biotec methods, it is more or less additional. Nevertheless the good cooperation between plant breeders and plant breeding research (which is supported by the government) helps the German plant breeders to introduce biotechnology developments and/or to use raw material produced by research institutes via biotechnology.

German rapeseed breeders have access to following techniques in biotechnology:

- embryoculture
- DH-technique
- genetechnology

The embryoculture is primarily used in research institutes, the results can be used by plant breeders and there is interesting long term use of this material (table 1).

Table 1: Use of embryoculture in rapeseed breeding

1. synthetic rapeseed

1.1. creation of new characters

* dwarf types
* shattering resistance
* resistances to clubroot
* resistances to virus (BWYV)

1.2. increased genetic diversity

* use in hybrid breeding

2. interspecific crosses

- Raphanus sativus
  * nematode resistance

Resynthetic new rapeseed types have created new characters like dwarf types, types with shattering resistance and interesting resistances to clubroot and - as first results show - also to viruses (BWYV).

Also for the long term run we believe that synthetic rapeseed can be used for increasing the genetic diversity, especially for the use in hybrid breeding programmes.

Another use of the embryoculture in rapeseed breeding is the use of interspecific crosses, e.g. with Brassica juncea and Raphanus sativus. Especially the later one is used today in Germany for transferring the <u>nematode resistance</u> (Heterodera schachtii) from Raphanaus sativus into rapeseed.

Alltogether it seems rather difficult to calculate the commercial potential of the embryoculture, but in the long term these public supported research programmes will be paid by improved varieties. On the other hand plant breeders have to do a lot of backcrosses and selection work after getting the raw material from the scientists. The costs of these special programmes to introduce these exotic material into high yielding double low wintertypes are difficult to estimate. I myself believe that 5 to 15 % of the budget of the breeders will be used for these programmes.

There is no doubt about that the use of the double haploid technique is the most interesting one, and this technique has a very high commercial potential, especially by speeding up the breeding progress.

The timetable (<u>table 2</u>) shows that we have to differentiate between "standard" double haploid programme and a "fast" double haploid programme. Only a fast double haploid programme is really saving up to two years in comparison to the conventional breeding work. We have to recognize that the conventional technique is even rather quick.

<u>Table 2:</u> Timetable using DH-technique in comparision to conventional pure line breeding

year	conventional	DH (standard)	DH (fast)
1	P1 x P2	P1 x P2	P1 x P2
2	F1 + obs.	F1 lab/GH	F1/A0/A1
3	F2 + obs.	A0/A1	A2 + obs.
4	F3 + obs.	A2 + obs.	A3 + yld.
5	F4 + yld.	A3 + obs.	A4 + yld.
6	F5 + yld.	A4 + yld.	A5 + VCU
7	F6 + yld.	A5 + yld.	
8	F7 + VCU	A6 + VCU	

obs.: observation plots in the field
yld.: yield trials in the field

We have now first datas available for calculating the double haploid technique versus the conventional pedigree breeding technique (table 3). Please recognize that the cost of one haploid plant is without investments. This is based on the calculation, "that the breeder has already convinced the management the years before that a biotec-lab is a very important investment". These basic investments have to be paid by later royalty income. Depending where the seed of the double haploid line is produced we are estimating costs of DM 45,-- to DM 30,-- per double haploid line.

Table 3: Comparison of costs of DH-technique versus conventional pedigree breeding in rapeseed

	greenhouse	field
1. costs per 1 haploid plant (AO)	DM 20,--	DM 20,--
colchizin-treatment, seed production (A_1)	DM 25,--	DM 10,--
total per DH-line	DM 45,--	DM 30,--
2. cost of breeding programme based on DH-technique		
10 crosses with 200-300 DH-lines/cross n = 2.500 DH-lines per year		
cost per year:	DM 112.500,--	DM 75.000,--
3. cost of (comparable) conventional inbreeding which is SSD and no selection		
6 (field-) generations x DM 3,--/generation		
total cost (n = 2.500)	DM 45.000,--	
4. result:		
Running cost of DH-technique is twice or three times more expensive !!		

Estimating a minimum size of a breeding programme based on this technique by 10 crosses with 200 to 300 lines per cross, it results to cost per year between DM 112.500,-- and DM 75.000,--.

The comparable conventional inbreeding technique, which is SSD (single seed descend) and no selection, results in costs - if you do it for 6 generations - of total DM 45.000,--.

Alltogether the total result is that the running costs of the double haploid technique is twice or three times more expensive than the conventional technique; on the other hand you are one or two years faster.

But the direct production of varieties by the double haploid technique will be changed completely when we have to produce inbred lines for producing F1-hybrids. In this case the strategy of early testing in S2-generation and producing double haploid inbreds from S2-lines will be the future. In this case the double haploid technique will be probably not faster, but we can select easier suitable inbreds with high combining ability.

Biotechnology developments is also influencing the development of F1-hybrid varieties. The table 4 shows the development in Germany, there are different systems of pollination control in use.

Table 4: Breeding F1-hybrids of winter rapeseed in Germany

1. systems of pollination control
   * CMS (ogura, pol, MSL)
   * SI (rez., dom.)

2. strategy
   * backcrosses into CMS-systems
   * inbreeding (DH-technique)
   * test crosses (Topcross, Diallel)
   * plant types (straw stiffness)
   * pedigree information
   * RFLP information of genetic distance

3. status
   * first NPZ-hybrid applied for PVP and VCU in 1992/93
   * seed production will be tested in large fields 1993/94

The strategy of producing best F1`s: (1) produce sterile lines by backcrossing, (2) inbreeding especially of the restorerlines can be done by the double haploid technique. (3) There is no doubt about that the genetic distance is very important, this can be taken from the written pedigree information which breeding companies with long history have in their books, but also by using RFLP information. Up to now the RFLP information is quite good correlated to the information which we have from our pedigree information.

The use of genetechnology in winter rapeseed is another exciting field for plant breeders (table 5).

Table 5: Rapeseed breeding and genetechnology in Germany

- transformation is routine in serval labs
- genes available for following characters
  * herbicide tolerance (routine)
  * resistance against fungus diseases (research)
  * modification of fatty acids (research)

To do transformations is routine in several labs in Germany. There are also interesting genes available for different characters like herbicide tolerance, resistance against fungus diseases and more and more for the modification of the fatty acid profile. This material can be cultivated in greenhouses, but it is very difficult to do field experiments in larger scale. There has been no field trial with transgenic rapeseed until now in Germany. We hope that a first experiment will start next year (1994).

German plant breeders can produce adapted transgenic rapeseed ony with conventional breeding techniques. Therefore we need field experiments in larger scale, we need more or less "normal nurseries" with transgenic material, not only one year and one location, it must be a continous selection programmes over years and locations!

Alltogether there is the conclusion that the use of biotechnology is widely accepted for breeding improved varieties of winter oilseedrape in Germany. To give a final answer about the economics of this new technique we have to wait a few more years, but it is absolutely clear that breeding companies have to invest in these techniques.

There is a good comparision with the conventional breeding work: Every breeder is doing hundreds of crosses per year, but only a few crosses are successful, maybe only one cross within three years. This is similar, if you have to estimate the value of different biotechnology developments. Nevertheless it is on a higher price level and the risk potential is higher.