

BREEDING FOR IMPROVED RESISTANCE TO FUNGI
IN RAPE AND TURNIP RAPE

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Severe damages of rape caused by fungi have occurred during the last years in Sweden in areas with intensive cultivation. In 1966 the yield of winter rape in the most southern parts of Sweden was low due to attack by a fungus causing a premature ripening. At that time *Sclerotinia sclerotiorum* was considered to be the cause. Later, however, it has been shown that the real cause was *Verticillium dahliae*, a formerly in rape unknown parasite (KROEKER, 1972). This fungus, which also causes a premature ripening and consequently low yield and bad seed quality, has brought about considerable decreases in yield per hectare in the southern part of Sweden in the last years. The loss in yield caused by the fungus has not exactly been established but reductions of 10 dz/ha in severely infected fields are expected. Since 1970 each year 100-150 varieties of winter rape have been tested for their resistance to *V. dahliae* in heavily infested fields. The percentage of attacked plants in each variety has been determined just before ripening. The variety Svalöf's Norde is superior in resistance to other Swedish market varieties (Table 1). In attacked fields Sv. Norde ripens more normally and keeps its green colour longer. However, Svalöf's Sinus, with low content of erucic acid in the oil, is today the only variety permitted for cultivation in Sweden. The breeding goal, therefore, is to combine good oil quality and resistance to *V. dahliae* in the same variety. Even among lines with low content of erucic acid, there is a very good variation with respect to the resistance to *V. dahliae* (Table 2), and further progresses can probably be attained by plant breeding.

Table 1: Comparison in resistance to *Verticillium dahliae* in Swedish varieties of winter rape. Mean of 5 trials in 1970-72

Variety	Attacked plants, %		
	Sv Norde	Variety	Diff. fr. Norde
Sv Matador	33	50	+ 17
Sv Victor	44	55	+ 11
Sv Panter	37	52	+ 15
Sv Sinus	41	59	+ 18
Hg Hector	33	50	+ 17
WW Argus	33	52	+ 19

A laboratory method, which is a modification of the method used for testing resistance to *V. albo-atrum* in luzerne, has been tried in winter rape. Young seedlings, with cut off root tips, are placed in a spore suspension for 20 minutes and then planted in heavily infested soil. After 3 weeks the

Table 2: Variation in resistance to *Verticillium dahliae* and *Phoma lingam* in winter rape

Variety	Verticillium			Phoma	
	Attacked plants, %			Degree of attack, 0-5	
	Sv. Sinus	Variety	Diff. fr. Sin.	Sv. Sinus	Variety
Sv 70/8225	36	16	- 20	3	1
Sv 70/8228	36	22	- 14	3	5
Sv 70/8286	21	42	+ 21	3	4
Sv 70/8368	20	6	- 14	4	0
Sv 70/8384	20	12	- 8	4	1
Sv 70/8695	15	44	+ 29	5	5
Sv 70/8704	13	33	+ 20	4	2
Sv 72/899	16	2	- 14	4	2

0 = not attacked

5 = very hard attacked

treatment is repeated. After another 2-3 weeks symptoms appear on the leaves and attacked plants are discarded. The results of the laboratory and the field tests are in good agreement.

Rather severe attacks of a third fungus, *Phoma lingam*, causing premature ripening have occurred in Sweden in the last years. With this parasite too, significant differences in resistance have been found between lines of winter rape with low content of erucic acid by trials in fields (Table 2). Some lines showed good resistance to both *Verticillium* and *Phoma*. Further progresses in regard to the resistance to *Phoma lingam* can probably be attained by selection.

Plasmodiophora brassicae, clubroot, causes locally severe damages on rape and turnip rape in Sweden. As gene sources for the resistance work in oil rape and oil turnip rape have been used lines of fodder rape (Clubroot Resistant Rape from N. Zealand, Dc 101 from Wales), swede (Wilhelmsburger, Gry), cabbage (Breeding material from Norway) and fodder turnip (Mainepe, Vobra, Debra). The selection for resistant plants and lines is made in artificially infested soil in the greenhouse. The cultivation values of resistant varieties have continuously been improved and are now at the same level in the best lines as in the market varieties. The first variety of winter turnip with good resistance to clubroot is now tested in local trials in Sweden. In rape breeding emphasis is placed on combining resistance to clubroot and improved oil and meal quality.

The breeding is complicated by the occurrence of various races of *P. brassicae*. Many different test systems have been used to differentiate and determine the number of races. As differentials to determine the races we use in Scandinavia two varieties of cabbage, Badger Shipper, and Jersey Queen and two varieties of swede, Laurentian and Wilhelmsburger. These

Table 3: Differential reactions to infection by races of *Plasmodiophora brassicae* (Williams 1966)

Differentials	Reaction to race															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Jersey Queen, cabbage	+	+	+	+	-	+	+	-	-	+	-	+	-	-	-	-
Badger Shipper, cabbage	-	+	-	+	-	-	+	-	-	+	-	+	-	+	+	-
Laurentian, swede	+	+	+	+	-	-	-	+	+	-	+	-	+	-	-	-
Wilhelmsburger, swede	+	-	-	+	-	-	-	-	+	+	+	+	-	+	-	+

indicates susceptibility - indicates resistance

Table 4: Races of *Plasmodiophora brassicae* in Sweden

Locality	Degree of attack on differentials				Possible races for locality	
	Jersey Queen	Badger Shipper	Laurentian	Wilhelmsburger		
A. B. H. L.	+++	++	+++	+++	1 - 16	
C. D. E. K. N. P. Q. R.	+++	-	+++	+++	1.3.5.6.8.9.12.16	
F	++	++	-	-	5.15	
G	+	(+)	-	-	5.6. (7). (15)	
J	-	-	+++	-	3.5.6.8	
M	-	++	+++	+	5.8.9.11.13-16	
O	(+)	-	++	+++	(1). (3). 5. (6). 8. 9. (12). 16	

very hard attack - = no attack

varieties make it possible to differentiate 16 races (WILLIAMS, 1966). The occurrence of races in 17 localities in Sweden is shown in table 4. Several localities contain many races, other few, and in one case the infection was caused by race 15 merely. A thorough knowledge about races is necessary to make further progresses possible in the breeding for resistance to clubroot. At Svalöf the callus method (INGRAM, 1969) is now tried to isolate pure races of clubroot. The results so far are promising. For more accurate determination of races the set of differentials should be improved as well.

References

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