

DOUBLE LOW WINTER RAPE FOR POLAND

By Jan Krzymanski
Plant Breeding and Acclimatization Institute
Oil Crop Department, Poznań, Poland

Polish research works on rape and its breeding deal mainly with winter rape because this form alone is of economic value in the agroclimatic conditions of Poland. Summer forms are used as an additional source of genetic variability.

The climatic conditions in Poland are less suitable for rape cultivation than in West Europe because of very changeable weather which is formed by the influence of continental climate from East Europe and marine climate from West Europe. For this reason true winter varieties with good winter hardiness and resistance to periodical droughts are necessary. Breeding of such varieties took a long time since desired characters of low erucic acid content in oil and low glucosinolate level in meal were available only in summer forms of rape. New varieties should be rigorously examined before release, which means that results obtained in small plot trials must be confirmed by tentative plantations on full production scale. Rape breeding in Poland is conducted as a team work by research workers and breeders.

Polish summer rape of the Bronowski variety is the only source of low glucosinolate character. This character is transferred to our best low-erucic strains of winter rape. Double low lines of winter rape obtained up to date have quite good winter hardiness and oil content in seeds but yield is still insufficient and needs further improvement.

Many degenerative plants appeared in segregating generations of crosses in which the Bronowski variety was used as pollen parent. These plants were described first by K.F. Thompson as male sterile forms and then investigated in detail by T. Shiga and co-workers. The majority of crosses made by us in the early years were done in this way. The strains obtained even these without degenerative signs were inferior as regards yield and vigour to strains selected from reciprocal crosses and were therefore discarded. So all our lines of double low winter rape possess N-type cytoplasm from the Bronowski variety. Slow growth in the initial stage is characteristic of them. The plants that are insufficiently developed before winter start poorly in spring time and give lower yield. This unfavourably growing rhythm has hitherto been strongly linked with low glucosinolate character. Back-crossings alone are insufficient to break this negative linkage. Intensive selection between crosses is necessary. This selection with regard to yield and vigour is only possible by evaluation of plants grown in field.

A good way to break unfavourable linkages may be to maintain hybrids in heterozygotic state during some generations to increase the probability of crossing-over. We found that zero-erucic strains selected in F₃ generation appeared much better than strains selected from F₂ population.

The best double low lines are used in back-crosses. These lines are also improved by interline crosses and selection. Back-crosses are

continued to introduce more desired characters from proved traditional varieties of winter rape, including also cytoplasm of S type.

Because selection plays so significant a part in our breeding programmes, it is very important to choose the most efficient methods that will ensure optimum breeding progress. The base for such a choice is knowledge of heritabilities of these characters in selected populations. Estimations of heritability are shown in Table. The first column refers to strain selection based on trials made in four repetitions and contains values obtained from variance analyses by calculation of expected components of mean squares. The other columns contain heritabilities for family selection (based on mean values of twenty plants) and for individual selection. These heritabilities are calculated according to formulae given by D.S. Falconer on the assumption that cross-pollination occurs in 25%. Obtained values agree quite well with the estimations of heritability calculated from correlation coefficients between generations.

The results presented in Table permit to choose the method and the program of breeding work on double low winter rape. Selection for every character should be conducted at the most suitable stage of breeding course and must be based on such valuation that heritability will be greater than 0,2. This condition is met by individual selection for following characters: linoleic and oleic acids content in seed oil and isothiocyanate content in meal. Chemical analyses of single plants are sufficient for effective selection in this case. Increase of oil content, decrease of linolenic acid and oxazolidinethione content, improving of 1000 seed weight and plant height need family selection based on mean value from a minimum of 20 plants. Amelioration of seed yield, winter-hardiness and ability early to self-regulate plant density in row are possible only by strain selection based on means obtained from field trials made in four repetitions.

Selection of single seeds may be very useful with regard to character having high heritability and controlled by embryo genotype like erucic acid content in seed oil. Results of recent researches on heredity of rape show that in many cases maternal environment plays a crucial part and in consequence seed properties are controlled by genotype of maternal plant. This situation occurs in zeroerucic strains of rape for glucosinolate and oil content in seeds and for oleic, linoleic and linolenic acids contents in seed oil.

An additional way to improve the yield of seeds in double low rape may be to make use of heterosis effect. Investigations made by our collective showed that heterosis occurred in intervarietal interstrain and interline hybrids of rape. This heterosis ranged between 15-100%, according to cross-combination and conditions of hybrid growth. It was more pronounced where growth conditions were inferior. Analyses of variance of diallel crosses were made by methods described by B.J. Hayman or B. Griffing. Heterosis and general combining ability were statistically significant in all cases. Specific combining ability was statistically significant only in some experiments.

Most double low winter rape lines differ from traditional winter rape varieties in growing rhythm and it is therefore necessary to recognize their requirements according to cultivation conditions. Appropriate trials are in progress.

Main factors investigated are sowing date, row spacing, sowing seed rate and nitrogen fertilization in autumn.

TABLE

HERITABILITY OF DIFFERENT CHARACTERS OF DOUBLE LOW WINTER RAPE
(ERUCIC ACID CONTENT 0,3%, TOTAL CONTENT OF ISOTHIOCYANATE AND
OXAZOLIDINETHIONE 2 mg/g f.f.d.m.)

Character	Strain selection based on trial (4 rep.)	Family selection (n=20)	Individual plant selection
Seed yield	0,63 (0,27-0,85)	0,10	0,01
Overwintering (% of plant)	0,50 (0,00-0,80)	0,06	-
Plant density in row:			
before winter	0,69 (0,41-0,86)	0,14	-
after winter	0,67 (0,42-0,93)	0,13	-
1000 seed weight	0,77 (0,12-0,92)	0,23	0,03
Plant height	0,76 (0,65-0,86)	0,23	0,03
Oil content	0,84 (0,55-0,97)	0,49	0,11
Oleic acid	0,87 (0,72-0,99)	0,79	0,44
Linoleic acid	0,87 (0,75-0,97)	0,79	0,44
Linolenic acid	0,85 (0,72-0,97)	0,56	0,14
Palmitic acid	0,64 (0,11-0,96)	0,11	0,01
Butenyl iso- thiocyanate	0,87 (0,69-0,98)	0,79	0,44
Pentenyl iso- thiocyanate	0,87 (0,41-0,97)	0,79	0,44
Vinyloxazo- lidinethione	0,84 (0,34-0,98)	0,49	0,11