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COMMERCIAL POTENTIAL OF INTERSPECIFIC CROSSES AMONG SEVERAL BRASSICA SPECIES

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I would like to outline some of the factors that encouraged the use of interspecific crosses as part of the breeding program.

Rapeseed is grown over an extensive area of Western Canada which varies considerably in climatic and soil conditions. Present varieties of rapeseed belong to the two species, Brassica napus and B. campestris, which differ in maturity by as much as three weeks. The relative performance of these two species varies with the season and area of production. Variety tests have indicated that there are large areas which could grow varieties with an intermediate maturity rather than be limited to the present varieties. Also, since much of the recent expansion in production moved into the drier areas, it has raised the possibility of considering other species which are better suited to these conditions.

Prior to about 1960 mustards belonging to the B. hirta and B. juncea species were grown only in the drier areas as an alternative to wheat. However, production had to be limited to about 250,000 acres due to the limited market for mustard seed. The price paid to the producer for mustard seed of the B. juncea species has always been and still is well below that of rapeseed, often selling at a price about half of that of rapeseed. Mustard (B. juncea) has shown a number of favorable agronomic features over rapeseed. It is more widely adapted, especially to the drier areas, competes with weeds more readily and is considerably more resistant to shattering than rapeseed. It also has an advantage in seed yield as illustrated in Table I.

You will notice that during the three years of the test superior yields were obtained from B. juncea with a maturity requirement which is intermediate between that of the two rapeseed species. These tests covered an extensive area of Western Canada.

Another very significant feature is the difference in protein content of the oil-free meals between mustard and rapeseed. The difference between Oriental mustard and Echo rapeseed meal in protein content is of special interest since the B. campestris species makes up 80% of our total production. Previous speakers have illustrated one of our present problems with the inverse relationship between oil and protein content

TABLE I

YIELD IN POUNDS PER ACRE AND DAYS TO MATURE OF COMMERCIAL MUSTARD AND RAPESEED VARIETIES

Crop and Variety	Yield lb/ac			Days Seeding to Maturity		
	1962	1963	1964	1962	1963	1964
No. of Stations	8	17	5	7	13	4
B. napus						
Nugget Rapeseed	1,286	1,471	1,027	104	101	99
Tanka Rapeseed	1,309	1,579	1,034	104	103	99
B. campestris						
Arlo Rapeseed	1,081	1,150	1,225	85	84	81
Echo Rapeseed	1,230	1,338	1,194	86	86	81
B. juncea						
Brown Mustard	1,373	1,626	1,364	96	92	94
Oriental Mustard	1,474	1,674	1,346	94	92	94
B. hirta						
Yellow Mustard	1,157	1,337	1,048	89	88	90

in our rapeseed crop. Here is a situation where Oriental mustard is practically identical to Echo rapeseed in oil content but is considerably higher in protein content. This would be a very desirable feature to incorporate into an oilseed crop.

Countries that use oilseed meals for fertilizer might consider using Oriental mustard for this purpose. It would provide a higher protein meal at a lower price. The fatty acid composition of the oil is very similar to that of Echo rapeseed. One difference is that mustard oil has a linolenic acid content of about 14% compared to 10% in Echo rapeseed oil. Oriental and Brown mustard are used as sources of edible oil in Pakistan.

Another interesting feature in Table II is the difference between Brown and Oriental mustard in both oil and protein content. Oriental mustard is higher in both oil and protein content. The difference in oil content is in the order of 2 to 3%. Close examination of the seed coats of the two mustards indicated that the yellow seed coat of Oriental mustard is

TABLE II

PROTEIN CONTENT OF COMMERCIAL MUSTARD AND RAPESEED VARIETIES

1965 Location	% PROTEIN IN OIL-FREE MEAL				
	Tanka	Brown	Oriental	Yellow	Echo
Winnipeg	44.7	44.8	46.6	46.2	41.7
Indian Head	45.1	48.0	49.9	49.5	42.1
Fargo, N.D.	45.1	46.3	48.1	47.8	42.0
Minot, N.D.	44.4	46.8	48.7	48.3	41.4
Outlook	44.0	45.5	47.3	47.0	41.1
Scott	46.7	46.9	48.7	48.4	43.5
Av.	45.0	46.4	48.2	47.8	42.0

considerably thinner than the seed coat of Brown mustard. In a more detailed study of comparisons of yellow and brown seeds in Echo rapeseed it was indicated that yellow seed coats were associated with several desirable features. Yellow seeds proved to be 1.9% higher in oil content, the meal was 3.2% higher in protein and fibre content was reduced from 12 to 7.5%. Seed size was found to have a relatively minor effect on these factors. Yellow seed in the *B. napus* species would no doubt have a similar effect and interspecific crosses may be a means of establishing this feature in that species.

I have described certain aspects of *B. juncea* in greater detail because most are not as familiar with it as they are with various aspects of *B. napus* and *B. campestris*. Interspecific crosses were confined to the above three species since they all have the A genome in common and cross relatively easily. Oriental mustard (*B. juncea*) contains sinigrin which gives the meal its better taste but does not contain any of the glucosinolates present in rapeseed. The variety Bronowski which is practically free of glucosinolates was used for the *B. napus* species. In initial crosses brown-seeded Echo was used but was replaced with yellow-seeded types in subsequent crosses.

A high oil content strain of *B. juncea* was used with Echo rapeseed in the initial cross. For some reason F_1 seed was relatively difficult to obtain and F_1 plants were highly sterile. Doubling the chromosome number of F_1 material resulted in increased fertility but the improvement in fertility of subsequent generations was slow. However, doubling the chromosome number made a lot more seed available for chemical analysis. Transgressive segregation for practically every fatty acid was obtained. However, a disadvantage of chromosome doubling was evident following analysis for glucosinolate content. Plants were found to contain the glucosinolates of their parents rather than segregate some glucosinolate-free plants. Further work with this high chromosome number material has been drastically reduced.

While F_1 plants of interspecific crosses are quite highly sterile, it was noticed that occasional plants regained their fertility very rapidly in the F_2 and F_3 generations. This feature was also noticed when the program was repeated using a yellow-seeded line of B. campestris and the variety Bronowski. A striking feature of the variety Bronowski was the ease with which one can obtain F_1 seed, especially when it is used as the maternal parent. Another line of Oriental mustard was used which crossed more readily with the other two species. These reciprocal crosses produced F_1 seed more readily than previous material and has made it possible to work with larger populations.

Many unusual characteristics were observed in the F_2. Most of these may not have any practical application but some plants show very desirable combinations of certain morphological features. Unfortunately these plants were not found to be free of glucosinolates. With present parental material the chances of obtaining superior types directly through interspecific crosses appears quite remote. However, improvement in parental material such as the development of suitable glucosinolate-free types in both rapeseed species would greatly increase the frequency of desirable plant types that could be obtained through interspecific crosses. This would make it possible to take advantage of the favorable combinations that can be achieved through this process. In the meantime interspecific crosses can be used as a means of introducing characteristics that are not presently available in that species, such as yellow seed and greater shattering tolerance into B. napus.