QUALITY BREEDING IN BROWN SARSON

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India is one of the major producers of Brassica oilseeds in the world. The main species cultivated are Brassica juncea and Brassica campestris. The latter includes three distinct cultivars, viz., Brown Sarson, Yellow Sarson and Toria which are cultivated in rather distinct ecogeographical areas. These campestris groups of plants in India, are collectively referred to as rape, while Brassica juncea is known as mustard. These two cultivated species, like other species of sub-tribe Brassicinae are characterized by the presence of significant amount of long chain monoethenoid acids with 20 and 22 carbon atoms, trienoic (C 18:3) fatty acid and glucosinolates; and lower proportions of monoenoic (C 18:1) and dienoic (C 18:2) fatty acids. Because of the presence of aforesaid anti-nutritional compounds, rape and mustard are not able to compete with premium oilseeds like soybean, cottonseed, groundnut and sunflower in the international trade. Thus, in order to make the rape and mustard premium oilseed crops, it is essential to change the fatty acid composition and glucosinolates pattern through plant breeding. Studies in this direction were initiated as early as 1958 in Canada, followed by Sweden, Germany, France, Japan and Poland, resulting in the release of a large number of varieties of Brassica napus and a few varieties of Brassica campestris free from erucic acid and low in glucosinolates. As for Indian rape, a quality improvement programme on similar lines was initiated by the author in 1975 in Japan (Kumar 1977). Prior to this, a study for the evaluation of the fatty acid composition of a wide array of wild (Kumar and Tsunoda 1976, 1977) and cultivated species of the family Cruciferae, collected by Japanese and Spanish scientists (Mizushima and Tsunoda 1967, Tsunoda et al. 1975) during the plant exploration, was undertaken. The growth and yield behaviour of crucifers showing nutritionally favourable fatty acid composition, are being examined as potential 'new' oilseed crops.

In the present paper, the mode of inheritance of erucic acid content in Brown Sarson (Brassica campestris L. var. dichotoma Watt.) is discussed.

MATERIALS AND METHODS

Seeds of low erucic acid (1.05%) variety, Span, obtained through the courtesy of Dr. R.K. Downey, were reciprocally crossed with a highly adaptive, high-yielding variety, Pusa Kalyani of Brown Sarson containing high erucic acid (46.8%). Some plants of both parents were self-pollinated in the greenhouse (21-26^{o}C and 15-21^{o} C day and night temperatures, respectively) of the Faculty of Agriculture, Tohoku University, Sendai, Japan, during the winter of 1975-76.

F_1 seeds and seeds obtained from self-pollination of the parents were sown in the glasshouse on April 2, 1976 and harvested in August 1976.

F_1 plants were self-pollinated and backcrossed reciprocally to both parents. The genetic analysis of F_2 and the backcrossed generations were based on the fatty acid composition of the oil of single cotyledon (Downey and Harvey 1963) resulting from self-pollination of F_1 plants and backcrossing of the F_1s with the recurrent parent, Pusa Kalyani.

The method described by Kumar and Fujimoto (1977) were followed for the extraction and methylation of seed oil. Methyl esters of fatty acids were separated by GLC (model JGC 20 KF) using 1 m x 3 mm glass column packed with 10% LAC-2R-446 on 80-100 mesh, acid- washed Chromosorb W. A column temperature of 190°C was used with nitrogen as carrier gas. Detection was by flame ionization. The period of separation of fatty acid was 15 minutes. The composition of fatty acid was estimated from areas obtained by measuring the heights of peaks of curves and width of half height.

RESULTS AND DISCUSSION

A knowledge of the inheritance of long-chain fatty acids (C 20:1, C 22:1) is essential for breeding for oil quality in rape and mustard. Studies on the inheritance of erucic acid have established that the genetic composition of the developing embryo controlled the synthesis of fatty acid of seed oil (Downey and Harvey 1963). In Brassica napus, Harvey and Downey (1964) demonstrated that two gene pairs, displaying no dominance and acting in an additive manner, controlled the synthesis of erucic acid. Each E^a contributed about 10% erucic acid to the seed oil (Downey and Dorrell 1971). In Brassica campestris, on the other hand, the synthesis of erucic acid as reported by Dorrell and Downey (1964), is controlled by single non-dominant gene. Downey (1966) observed that three alleles, viz., E^b, E^c and e, contributing about 15, 30 and zero percent respectively, were involved in B. campestris in establishing the erucic acid level. The presence of two gene pairs in B. napus, according to Harvey and Downey (1964) is due to its amphidiploid nature containing genomes of Brassica oleracea and B. campestris having at least one gene for erucic acid biosynthesis, respectively. Krzymanski and Downey (1969) demonstrated the presence of another allele, E^d in B. napus which contributes about 3.5% erucic acid to the seed oil.

During the present study, a cross between the low erucic acid variety, Span and high erucic acid variety Pusa Kalyani and its reciprocals, were made. The erucic acid concentration in the oil of 30 F_1 bulk seeds of each cross was found to be 24.5% and 26.3%, respectively. This indicated that the erucic acid content of the F_1 in cultivar Brown Sarson was intermediate between two parents.

F_2 generation data were obtained from GLC analysis of half-seed produced on F_1 plants of the crosses. On plotting the erucic acid content of the crosses separately, two classes could be visualized in each case, such as 0-3% and 15% or over (Fig.1). When the erucic acid content of individual seed within two classes was examined, it was found that the seeds of the lower class contained no erucic or low erucic acid ($\leq$3%) with a range of 0-2.3%. The seeds of the upper class, on the other hand, contained intermediate and high erucic acid, ranging from 15 to 63%. Due to the overlapping of intermediate and high erucic acid, discrete classes could not be determined (Fig. 1). Based on these two classes, data of F_2 population were fitted to the expected 1:3 ratio which gave

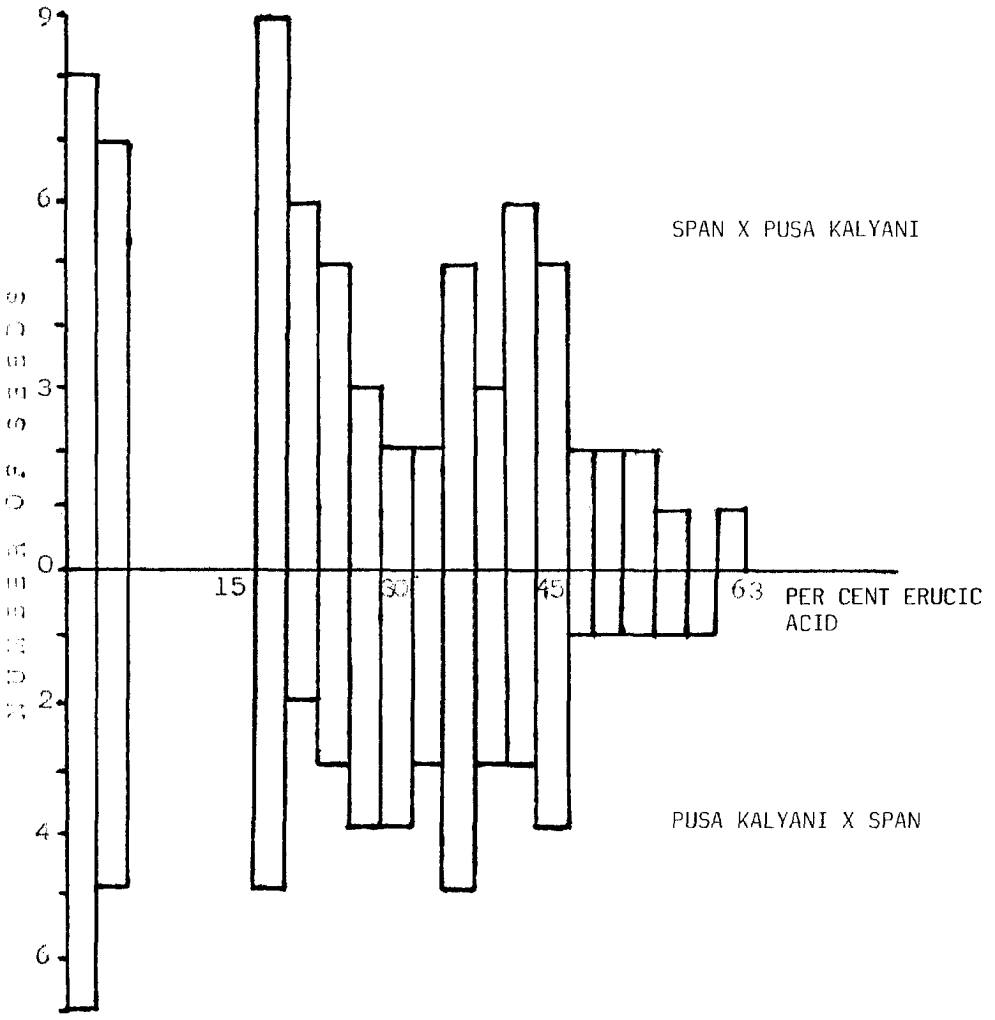

FIG. 1

FREQUENCY DISTRIBUTION OF ERUCIC ACID CONTENT (%) IN F_2 SEEDS FROM THE CROSSES, LOW ERUCIC ACID CANADIAN VARIETY, SPAN X HIGH ERUCIC ACID INDIAN VARIETY PUSA KALYANI

a good fit (Table 1). Like the F_2 generation data, the backcrossed data were also grouped into two classes, assuming 35% erucic acid concentration in the seed oil as the division between intermediate and high erucic acid classes. Subjected to Chi Square test for 1:1 ratio these data gave a good fit (Table 2).

Since the F_1 generation seeds showed intermediate behaviour and as the number of individuals in the 0-3% class represented nearly 1/4 of the total F_2 population, it was concluded that a single major gene displaying no dominance might be controlling the synthesis of erucic acid in Brown Sarson.

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TABLE 1

SEGREGATION FOR ERUCIC ACID CONTENT (%) IN OIL OF F_2 SEEDS OF CROSSES, LOW ERUCIC ACID CANADIAN AND HIGH ERUCIC ACID INDIAN VARIETIES OF BRASSICA CAMPESTRIS, AND RECIPROCALS

Cross	Number of seeds with per cent erucic acid		X^2 value for fit to 1:3 ratio	Probability
	0-3	15 or over		
Span x Pusa Kalyani	15	54	0.391	0.95 - 0.50
Pusa Kalyani x Span	12	41	0.157	0.95 - 0.50
Total	27	95	0.536	0.50 - 0.20

TABLE 2

SEGREGATION FOR ERUCIC ACID CONTENT (%) IN BACKCROSS POPULATIONS

Backcross population	Number of seeds with per cent erucic acid		X^2 value for fit to a 1:1 ratio	Probability
	10-35	36 or over		
(Span x Pusa Kalyani) Pusa Kalyani	61	55	0.216	0.95 - 0.50
(Pusa Kalyani x Span) Pusa Kalyani	33	24	1.421	0.50 - 0.20
Total	94	79	0.769	0.50 - 0.20