Inheritance Law of Oleic Acid Character on Brassica napus

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MATERIALS AND METHODS

Material

0ne high oleic acid line 04-863 designated as P_1 obtained from Xiangyou No.15 (B. napus) variety, which was treated by ^{60}Co ionization radiation, to enhance the oleic acid content (80.5%) in seeds (16% sub-oleic acid, 3.3% linolenic acid). Another test variety was 04-1020, which is called as P, It was obtained by self-pollination of sixth generation of Xiangyou No.15. The oleic acid content is 62.7% (palmitic acid content 8.4%, sub-oleic acid 20.8% and linolenic acid 5.0%). All the seeds were obtained from the Oilseed Crop Research Institute, Hunan Agricultural University.

Method

First the two parents, P_1 and P_2 were crossed, that is line 04-863×line 04-1020 and 04-1020×04-863 (reciprocal cross between P_2 ×P_1). Five inflorescences were crossed in each combination and 5 flowers of each inflorescence; therefore, a total number of 50 flowers were crossed to obtain F_1 seeds. Then F_1 generation was backcrossed to one of parents (04-1020). Total number of inflorescences back-crossed was 5 and number of flowers crossed was also 5 in each inflorescence. A total of 25 flowers were backcrossed to obtain BC F_1 seeds. Parents and F_1 were planted in $4M^2$ test region size which 2m wide with 6 line and 12 plants in each line, there were 72 plants. F_2 and BC_1 were planted in $8M^2$ test region size which 2m wide with 12 lines of each test region and 12 lines of each test region and 12 plants of each line making a total 144 plants. All the test region designs were not repeated. The fatty acid contents were analyzed by Foss near infrared analysis instrument. Measuring continuous variation of oleic acid character in rapeseed; measuring broad sense heritability of oleic acid character in rapeseed (components of variation, goodness of fit test for separate proportion of oleic acid character in rapeseed).

RESULTS

Analysis of oleic acid content in rapeseed parents

The results showed that the oleic acid content in the seeds from 30 test plants of line04-863 is 80.5%, which showed variation in different plants. Distribution in 5 plants was 71-75%, in 3 plants it was 76-80%, and only 2 plants showed 81.5%.

Table 1. The oleic acid content of parent rapeseed

Parents	Oleic Acid average content(%)	Oleic	Acid	Content	Distribution	
		60-65	66-70	71-75	76-80	> 81
04-863*	80.5	0	0	5	23	2
04-1020*	62.7	25	5	0	0	0

*30 Plants were tested respectively.

Other parent line 04-1020 showed 62.7% oleic acid. Oleic acid contents were tested in 30 plants. Variation in oleic acid content was recorded in 25 plants as 62.7%, only 5 plants 66-70%, which showed that in line 04-1020 oleic acid content character is pure in heredity, having a homogeneous or uniform composition, not mixed(Table 1, Fig.1, Fig.2).

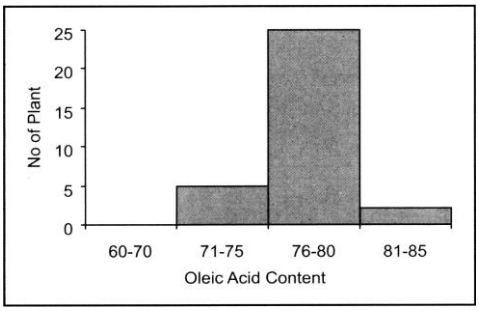

Fig.1. Oleic acid distribution of 04-863 line (written : P_1)

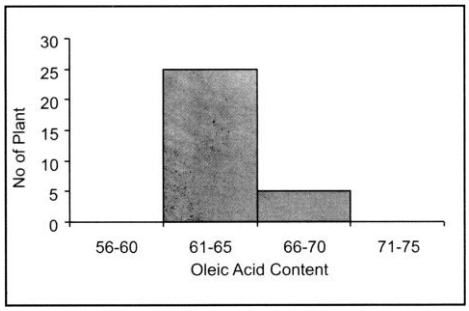

Fig.2. Oleic acid distribution of 04-1020 (written: P_2)

Analysis of character expression of oleic acid content in F_1 generation

From Table 2, Figs. 3 and 4, it is clear that F_1 oleic acid content is in the middle between high oleic acid content parent and low oleic acid content parent, but high oleic acid content line is female, and the F_1 oleic acid content reflect to female. If low oleic acid content line is female, the F_1 oleic acid content is a little reflectable to female of low oleic acid content. From above it is clear that oleic acid content in female is more or less similar to F_1 oleic acid content and has some influence.

Character expression of oleic acid content in F_2 generation

Table 3 and Fig. 5 showed the inheritance of oleic acid content in F_2. It is the same with F_1 as the variance of time number distribution have all nearly accorded with normal distribution that is a few extremeness types and many middle types. But F_2 is slightly different from F_1. It is separation of oleic acid content in F_2 more than F_1. Otherwise, the highest time number distribution has tendency of high oleic acid parent (maternal).

Expression of oleic acid character in first backcross generation (BCF_1)

Back cross between 04-863×04-1020 is used as maternal line, while line 04-1020 is paternal. Both crosses and there obtained BCF_1 plants no.120. Fig. 6 showed plants number of different oleic acid content. The separation of oleic acid content in BCF_1 is different in both F_1 and F_2. The distribution of variance times number showed double peaks.

Table 2. The oleic acid content of F_I high oleic acid line and low oleic acid variety in reciprocal crosses

Generation	Plants No.	Different oleic acid content Plant No.						Average of oleic acid content
		< 60	61-65	66-70	71-75	76-80	> 81	
P_1 04-863	60	0	0	0	2	55	3	80.1
P_2 04-1020	60	10	49	1	0	0	0	62.4
$F_1(P_1 \times P_2)$	60	0	0	10	36	13	1	76.5
$F_1(P_2 \times P_1)$	60	1	13	34	12	0	0	68.8

Table 3. Oleic acid separation of F_1 from high oleic acid crossed low oleic acid variety

	< 60	61-65	66-70	71-75	76-80	> 81	Total (No. Plant)
No. Plant	1	9	21	59	30	0	120*h
Average oleic Acid content	59.3	62.8	67.8	72.6	76.9	0	

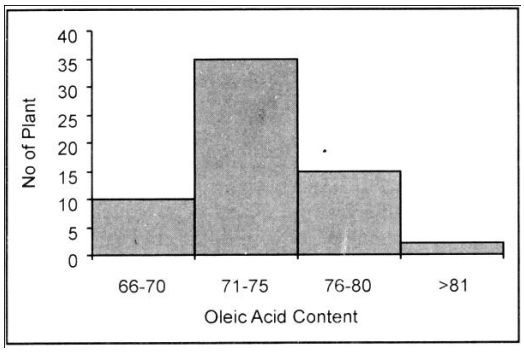

Fig.3. F_I (P_I × P_2) Separation of oleic acid in rapeseed

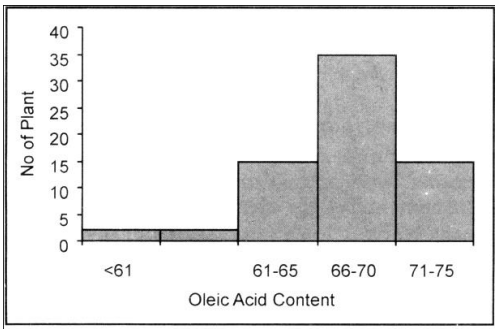

Fig.4. F_I (P_2 × P_I) Separation of oleic acid in rapeseed

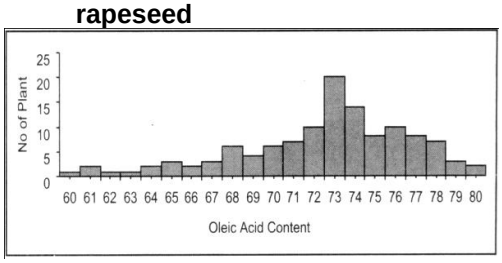

Fig.5. Oleic acid separation of F_I of high oleic acid line (04-863) and low oleic acid line 04-1020

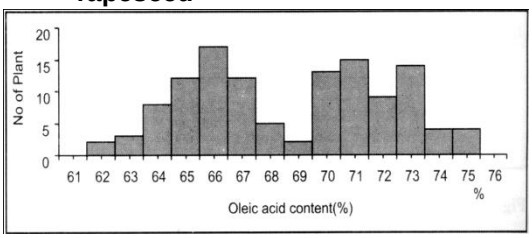

Fig.6. Oleic acid separation of BCF_I

Table 4. Distribution of oleic acid in rapeseed

Generation	Distribution of oleic acid content (%)						N		S	V
	56-60	61-65	66-70	71-75	76-80	81-85				
P_1 04-863				2	55	3	60	78.8	1.44	2.08
P_2 04-1020	10	49	1				60	62.25	2.05	4.18
F_1 (P_1×P_2)			10	36	13	1	60	73.41	3.33	11.08
F_1 (P_2×P_1)	1	13	34	12			60	67.75	3.47	12.04
F_2 (P_1×P_2)	1	9	21	59	30		120	66.75	7.28	52.81
Backcross [(P_1×P_2)F_1]×P_2		24	35	61			120			

Heredity analysis of distribution of oleic acid content

Table 4 shows variation of oleic acid character in parents (P_I and P_2), direct cross (P_1×P_2) F_1 and reciprocal cross (P_2×P_1) F_1 and backcross [(P_1×P_2)F_1]×P_2, which reveals a continuous variation respectively. The distribution of oleic acid content of direct cross (P_1×P_2) F_1 deviates normal distribution and squints towards high oleic acid parent(P_1). But the distribution of oleic acid content of reciprocal cross (P_2×P_1) F_1 squints towards Low oleic acid parent (P_2). The F_2 from self-pollination of (P_1×P_2) F_1 which distribution of oleic acid content wider than both parents (P_1, P_2) and F_1 (P_1×P_2 or P_2×P_I).

The backcross combination [(P_1×P_2)F_1]×P_2, the distribution of oleic acid content is a little squint from high oleic acid to Low oleic acid.

The F_2 generation contains all possible genotypes and can be used to calculate Broad sense heritability:

$$H^2 = \frac{V_G}{V_{F_2}} = \frac{V_{F_2} - \left[\frac{1}{3}(V_{P_1} + V_{P_2} + V_{F_1})\right]}{\frac{1}{2}V_A + \frac{1}{4}V_D + V_E}$$

Direct cross: $\frac{19.67 - 5.78}{19.67}$ Reciprocal cross : $\frac{19.67 - 5.78}{19.67}$

Above results showed variation of heretability of oleic acid character about 69-71% from heredity difference and 31-29% from environment difference.

Mean and phenotypic variance

Generation Item	Parent		Direct cross F_1(P_1×P_2)	Reciprocal cross F_1(P_2×P_1)	Direct cross F_2(P_1×P_2)	Back cross [(P_1×P_2)F_1]×P_2
	P_1	P_2				
Mean	78.08	62.65	73.41	67.75	66.75	69.54
Phenotypic variance	2.08	4.18	11.08	12.04	52.81	15.33

Direct cross F_1 : $V_E = \frac{1}{3}(V_{P_1} + V_{P_2} + V_{F_1}) = \frac{1}{3}(2.08 + 4.18 + 11.08) = 5.78$

Reciprocal cross F_1 : $V_E = \frac{1}{3}(V_{P_1} + V_{P_2} + V_{F_1}) = \frac{1}{3}(2.08 + 4.18 + 12.04) = 6.1$

F_2 : $V_E = \frac{1}{3}(V_{P_1} + V_{P_2} + V_{F_1}) = \frac{1}{3}(2.08 + 4.18 + 52.75) = 19.67$

Calculation of Variance constitute

Item	Variance constitute	Test value of variance
V_{F_2}	$\frac{1}{2}V_A + \frac{1}{4}V_D + V_E$	19.67
$\frac{1}{3}(V_{P_1} + V_{P2} + V_{F_1})$	V_E	Direct cross 5.78
Reciprocal cross 6.1		
$V_{F_2} - \frac{1}{3}(V_{P_1} + V_{P2} + V_{F_1})$	V_G	19.67-5.78=13.89 19.67-6.1=13.57

Conclusion

From the studies on oleic acid content, in F_1 and F_2 and BCF_I we presume that the character of oleic acid content is controlled by a pair major gene and 2-3 minor genes which have added effect. It is also influenced by cytoplasm of maternal and environmental conditio