MODIFICATION OF LINOLEIC AND α-LINOLENIC ACID LEVELS IN SPRING TURNIP RAPE BY LONG-TERM SELECTION

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ABSTRACT

An average linoleic (LA)/α-linolenic (LLA) acid ratio of 3 in spring turnip rape pedigrees has been obtained under free- and control-pollinated conditions in the field through single plant selections based on the highest LA/LLA ratio and lowest LLA content. The increase in the ratio was mainly due to the reduction in LLA levels. In controlled crosses, including high LA selections, the mean LA content ranged from 29 to 34% during subsequent years. The results show considerable variation for LA/LLA ratio (up to 5) and total amounts of these fatty acids. These materials would be valuable for further modifications of the LA and LLA levels in spring turnip rape.

INTRODUCTION

The proportion of LLA and its ratio to LA in rapeseed oil is of great importance in the development of new rapeseed cultivars. LLA is technically undesirable but it may have significant health benefits.

In our breeding programme, designed to produce zero-erucic spring turnip rape cultivars with modified fatty acid composition (Hovinen and Laakso, 1987, 1991), the primary aim during the last 4-year period has been to lower the LLA levels. Since 1992, controlled, bag-isolated pair-crosses have also been made within pedigrees. In this study the results of fatty acid breeding during 1991-94 are presented.

EXPERIMENTAL

Single plant selections, crosses in the field and fatty acid analyses have formed the basis of the breeding work (Hovinen and Laakso, 1987, 1991). For controlled pair-crosses, single plants from long-term selection experiments with the most desirable fatty acid compositions have been used as source material. The main criterion has been a high LA / LLA ratio. Bag-isolated plants in each pair were reciprocally hand-pollinated, and the yields were threshed together and their fatty acid composition analysed. Two spring turnip rape populations (type 00) of Canadian origin have been used as controls. Common cultivars and breeding material for high palmitic acid selections were also grown in the field.

TABLE 1. Linoleic and α-linolenic acid levels in selected lines, controls and cultivars in 1991-94 (free pollination). Selection of parents based on the highest LA/LLA ratio (a) or lowest LLA (b) content.

Generation	SELECTED LINES						CONTROLS		
	N	LA (%) Range	LA (%) Mean	LLA (%) Range	LLA (%) Mean	LA/LLA ratio	N	LA (%) Mean	LLA (%) Mean
M15a	147	20.9-30.9	26.1	6.2-12.4	9.8	2.7	81	21.1	11.3
b	113	20.0-33.2	24.3	7.6-11.6	9.4	2.6	53*	21.5	11.6
M16a	59	19.9-33.7	27.0	8.6-13.9	11.5	2.3	47	22.5	12.6
b	84	20.7-31.1	26.3	6.3-13.3	9.8	2.7	51*	21.6	13.0
M17a	87	24.9-35.1	30.4	7.1-13.8	10.7	2.8	30	24.5	12.7
b	121	20.6-34.4	28.1	6.8-13.1	9.9	2.8	30*	24.1	12.4
M18a	81	24.0-35.8	28.3	5.0-10.6	7.8	3.6	44	23.9	13.4
b	98	21.9-31.2	26.1	6.1-12.4	8.4	3.1	41*	20.0	11.3

N = number of individual plants; *turnip rape cultivars ('Kelta' and 'Kulta')

The LA/LLA ratio is a good basis for selection since it results in a ratio of more than 3 for the first time in this trial. The increase is due to a reduction in LLA rather than to an increase in LA levels. Low LLA contents (5-7%) are continuously found under free-pollinated field conditions.

TABLE 2. Linoleic and α-linolenic acid levels in seed material from controlled crosses in 1992-94. Selection of parents: a-b as in Table 1; c: based on high LA content only.

Generation	SELECTED LINES					LA/LLA RATIO	
	N	LA (%) Range	LA (%) Mean	LLA (%) Range	LLA (%) Mean	Selections	Controls
M16a	34	26.5-36.7	32.0	7.4-16.2	12.3	2.6	1.8
b	17	22.6-36.0	29.4	8.5-12.9	10.9	2.7	
M17a	23	27.4-37.4	33.5	8.3-14.7	11.5	2.9	1.9
b	44	27.0-38.0	33.5	8.1-17.1	11.5	2.9	
c	11	28.0-37.9	33.8	12.2-17.3	14.1	2.4	
M18a	27	28.6-38.1	32.6	7.8-14.4	10.6	3.1	1.8
b	33	25.0-35.8	30.2	7.0-12.8	10.0	3.0	
c	15	29.8-38.7	33.2	8.7-18.1	13.5	2.5	

N = number of paired plant yields

LA levels of more than 30% have been obtained in subsequent years. This increase in the LA/ LLA ratio up to 3 is also a result of the reduction in LLA. The highest polyunsaturated fatty acid contents (about 47%) have been produced by LA selections (c).

FIGURE 1. Offspring-parent regression for linoleic acid in controlled crosses in 1994.

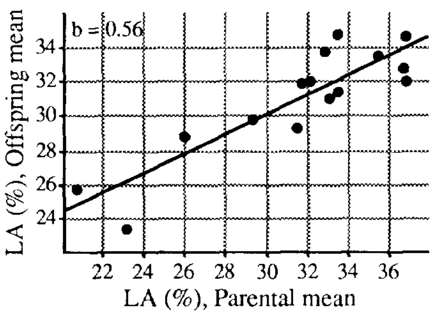
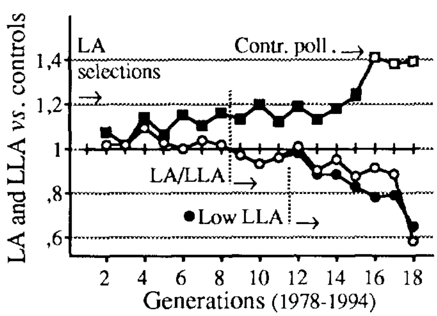
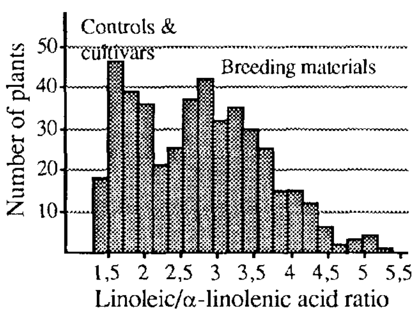


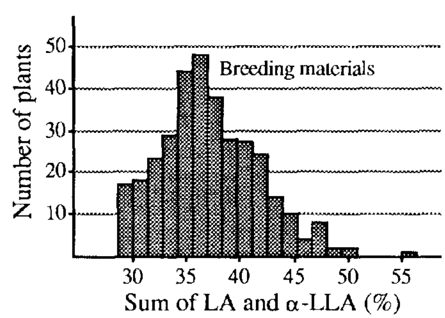
FIGURE 2. Long-term effects of selection on linoleic and α-linolenic acid levels.



The LA mean of parents (seeds from 2-4 plants) and their offspring (3-8 paired yields) are presented in Figure 1. The high response indicates that the selection for LA levels of clearly higher than 30% is feasible. Figure 2 shows that the decreasing trend in LLA contents did not occur until after selections for high LA/LLA ratio and for low LLA contents. In 1994, a mean LLA level of 8%, which was about 60% of that of the controls, was found in material consisting of 180 plants (Table 1).

FIGURE 3. LA/LLA ratio in single plant yields (N = 444) and summed proportions of LA and LLA in breeding materials (N=337) obtained from the field in 1994.





The distributions in Figure 3 indicates a high variation in the LA/LLA ratio, even up to 5, and a wide range of the summed proportions of LA and LLA in the breeding materials. These traits can be utilised for breeding new cultivars with improved oil quality.

REFERENCES

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