PROPOSED DEVELOPMENT OF A HIGH LINOLEIC ACID SUNFLOWER HYBRID

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SUMMARY

Australian processors require sunflower oil with linoleic acid content greater than 62% for the manufacture of polyunsaturated margarine. This level is difficult to attain for spring planted crops which mature under hot conditions. By non destructive analyses of the fatty acid content of single seeds, restorer lines with up to 81% linoleic acid content under hot maturation conditions have been produced. To enable development of high linoleic acid hybrids, it is proposed to use single seed analyses to select female lines high in linoleic acid content. These will then be converted to a cytoplasmic male sterile background and crossed with the high linoleic acid restorer lines.

Les producteurs australiens ont besoin d'une huile de tournesol d'une teneur en acide linoléique supérieure à 62% pour la production de margarine polyinsaturée. Il est difficile d'avoir cette teneur dans le tournesol qui est planté au printemps et qui mûrit dans des conditions de grandes chaleurs. Avec des analyses non destructrices de la teneur en acide gras de graines isolées, des variétés fortifiantes qui contiennent jusqu'à 81% d'acide linoléique dans des conditions de grandes chaleurs ont été produites. Afin de permettre la production d'hybrides à haute teneur en acide linoléique, on propose l'utilisation d'analyses de graines isolées pour choisir des variétés femelles à haute teneur en acide linoléique. Ensuite ces variétés seront introduites dans un milieu stérile mâle et cytoplasmique et croisées avec les variétiés fortifiantes à haute teneur en acide linoléique.

INTRODUCTION

In Australia, the market for polyunsaturated products such as margarine requires that sunflower oil be higher than 62% linoleic acid content. Because the linoleic acid level decreases at higher temperature (Keefer et al. 1976; Harris et al. 1978; Goyne et al. 1979), this level is difficult to obtain when crops mature under high summer temperatures which are normal for spring planted crops in Eastern Australia. By contrast, crops grown in the higher latitudes of the Northern Hemisphere are high in linoleic acid due to maturation under lower temperatures.

Simpson and George (1985) found considerable variability in linoleic acid content (2.2 - 76.0%) within single heads of 3 sunflower genotypes. This seed variability appeared unrelated to position in the head and indicated the influence of genetic rather than environmental factors. More detailed research confirmed this earlier finding (George et al. 1988). Thus selection for high linoleic acid content was feasible.

Miller et al. (1987) found oleic acid content to be controlled by a major gene, ol, with partially dominant gene action and a recessive gene, ml. They concluded that oleic acid composition was largely under embryonic control. Single seed selection would thus be appropriate.

The objective of this paper is to propose a scheme for developing a sunflower hybrid high in linoleic acid content under hot maturation conditions.

MATERIALS AND METHODS

Simpson and George (1985) outlined a selection technique in which the non-embryo half of a single seed could be analysed for fatty acid composition and the embryo half germinated and grown through to maturity. Thus a method of selection for high linoleic acid content of single seeds rather than of a head or plot was available.

In 1984 a project was initiated using this technique to try to develop male fertility restorer lines high in linoleic acid content under hot conditions (Simpson et al. 1988). Selection commenced in the F2 generation and continued until F6. Under hot maturation conditions, linoleic acid content of high linoleic selections (head basis) reached up to 81% compared to 49% for the control hybrid, Hysun 32 (Table 1). Linoleic acid content for Hysun 32 varied more over the three plantings than it did for the breeding lines. Higher maturation temperatures for the first planting reduced mean linoleic acid content by 11% (actual) for Hysun 32 compared to the second planting but only by 1% for the breeding lines. The low linoleic acid lines were a limited number selected from the 1985/86 planting to determine whether the selection technique could produce two distinct populations.

Table 1. Linoleic acid content* of F6 selections from 3 field plantings in the 1986/87 summer at Hermitage, Queensland, Australia (Lat. 28°S, Long. 152°E).

	High linoleic acid lines			Low linoleic acid lines			Control - Hysun 32			Maturation temperature range
		Linoleic Acid			Linoleic Acid			Linoleic Acid		
	No. of Heads	Mean %	Range %	No. of Heads	Mean %	Range %	No. of Heads	Mean %	Range %	°C+
1st planting	260	63	45-80	45	44	33-63	19	42	38-49	20-32
2nd planting	190	64	47-80	47	45	31-57	21	53	47-59	18-30
3rd planting	278	69	50-81	35	51	38-63	18	50	47-53	17-29

* Linoleic acid content as percent of total fatty acids in oil.

\+ Average minimum and maximum temperatures °C for period from 2 to 5 weeks after flowering.

Parent offspring correlations (F6 row versus F5 head) were significant for the 3 plantings (Figure 1). Heritability estimates were about 40%.

Over two-thirds of the 728 F6 heads have linoleic acid content greater than 62% and are male fertility restorer lines. To develop a high linoleic acid hybrid with commercial application, both parents will need to be high in linoleic acid (due to the recessive nature of inheritance).

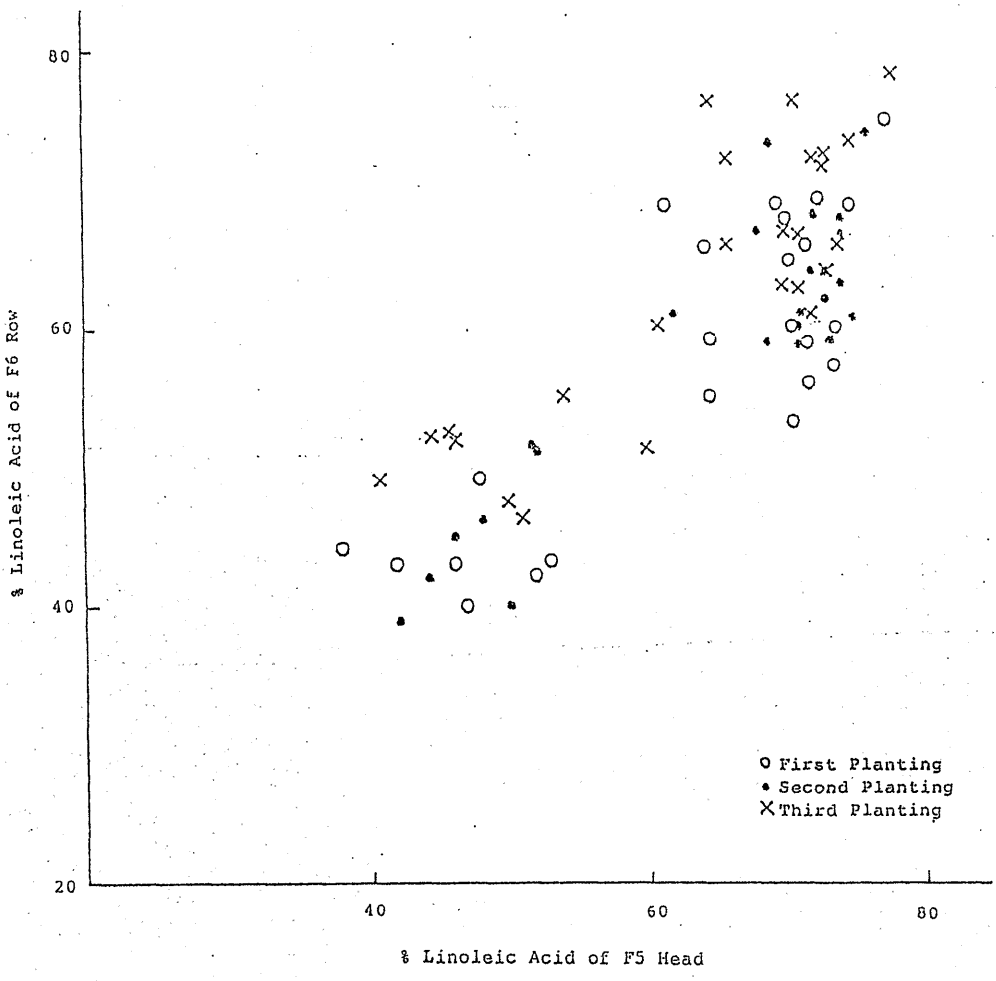

Figure 1. Linoleic acid content for F6 Rows vs F5 Heads for three plantings during 1986/87 summer (as % of total fatty acids in the oil).

RESEARCH DIRECTION

Single seed selection for high linoleic acid content has begun on HA89, a female line widely used as a parent of commercial hybrids. Four selection cycles (with self-pollination) followed by male sterilization are proposed (Figure 2). The male sterile analogue (high linoleic acid) will then be testcrossed with high linoleic F6 male restorer lines. The resultant hybrids will be evaluated in several environments for agronomic and chemical characters. Superior hybrids

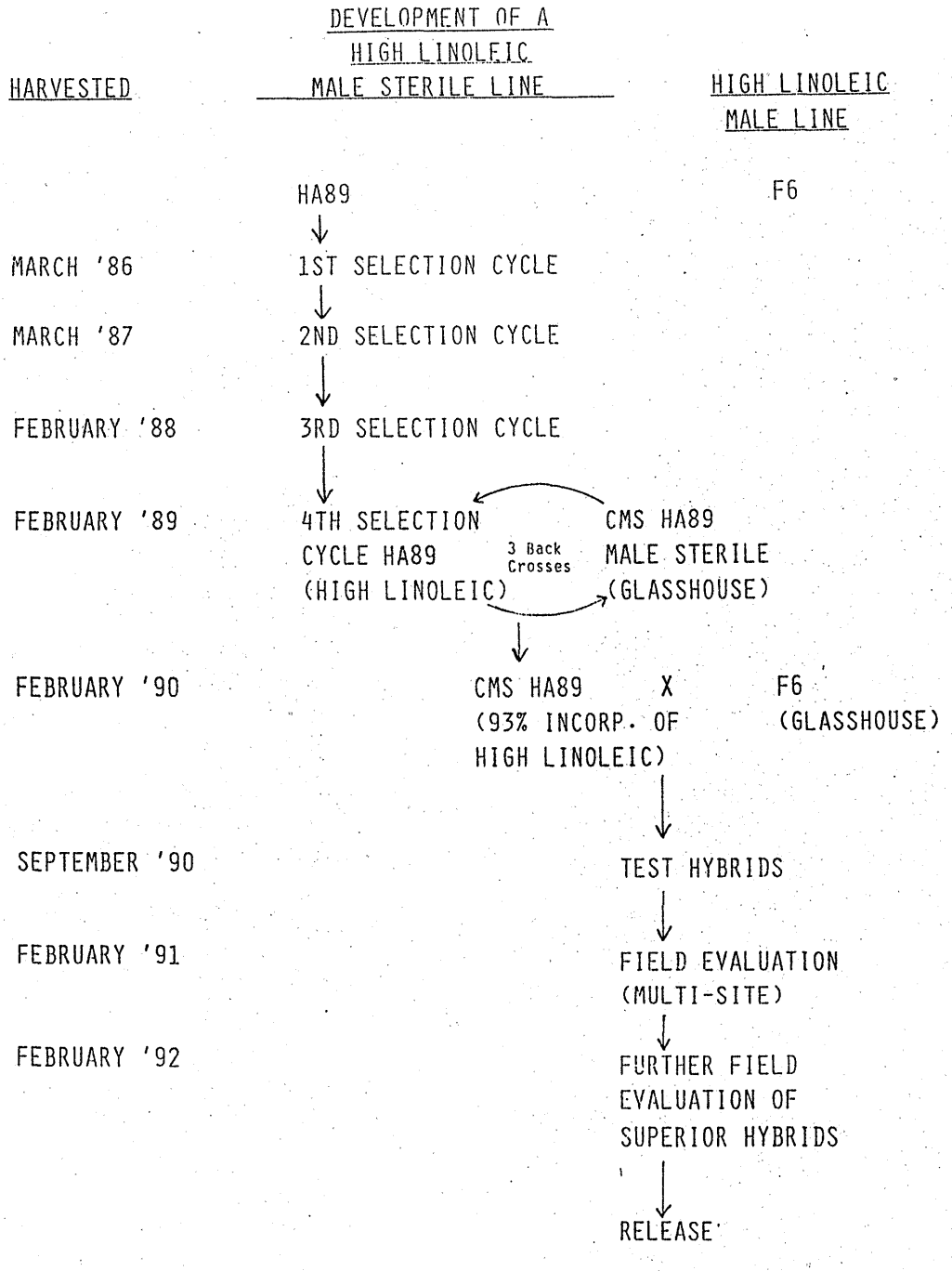

Figure 2. Proposed development of a high linoleic acid hybrid.

will be tested a further season at more sites to determine candidates for release. In the evaluation of material high in linoleic acid content (under hot conditions), heads need to be self-pollinated. Cross-pollination from adjacent genotypes would confound fatty acid levels. Commercially, crops of high linoleic acid hybrids will need to be isolated (to prevent cross-pollination) from unselected hybrids to maintain the high level of linoleic acid.

Analyses from the 1986/87 summer (similar temperature conditions to 3rd planting - see Table 1) indicate variability for linoleic acid content in HA89 (Table 2) and lines high and low in linoleic acid content in 1985/86 were high and low respectively in 1986/87. One line, 906/86-1, was 10% higher (actual) in linoleic acid content than the control hybrid, Hysun 32. All lines were more variable for linoleic acid content than Hysun 32. HA89 appears to have sufficient genetic variability to make genetic advance for high linoleic acid content. Genetic variability for linoleic acid content within an inbred line such as HA89 is unexpected but may reflect residual variability which has been maintained during seed increase since the original release.

Table 2. Linoleic acid content* of high and low selections of HA89 in 1986/87 summer at Hermitage.

Initial Head No.	Seeds in head 1985/86					Heads in row 1986/87			
	No. of Heads	Mean (%)	SD	Rel SD	Range (%)	Mean (%)	SD	Rel SD	Range (%)
Low									
905/86-6	18	32	6.5	20%	22-44	48	5.3	11%	43-58
905/86-10	18	31	3.6	11%	23-36	49	5.4	11%	41-56
High									
905/86-1	22	65	3.0	5%	58-70	53	6.5	12%	43-64
905/86-4	30	65	2.5	4%	58-69	52	7.7	15%	41-69
906/86-1	35	63	2.6	4%	55-66	60	6.6	11%	46-69
906/86-10	31	63	3.6	6%	57-68	58	7.6	13%	46-70
Hysun 32						50	1.9	4%	47-53

* Linoleic acid content as percent of total fatty acids in oil.

It is felt that the development of a high linoleic acid (under hot maturation conditions) hybrid will fulfil an important need for the polyunsaturated oil market.

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