GLUCOSINOLATE VARIABILITY IN RAPESEED IN AUSTRALIA

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Rapeseed Production

Rapeseed is a relatively new crop to Australia with the first commercial crops grown as recently as 1969. With the introduction of wheat quotas in the country in 1969-70 and the collapse of the wool market in 1970-71, rapeseed was seen as a good alternative crop for farmers. The return of good wool prices in 1972 and removal of wheat quotas in 1974-75 resulted in a depression in rapeseed production. Although production fluctuated considerably over the next 10 years, low wheat prices together with the agronomic advantages of growing rapeseed have resulted in a renewed interest in the crop. In 1985 a record 80,000 tonnes was produced in Australia. Research indicates that with new varieties with better adaptations to the Australian environment and improved disease resistance, a potential of 300,000 tonnes could be achieved.

Initially cultivars grown in trials in Australia were Canadian and European types. In 1970 Target was the most widely grown cultivar. By 1978 Midas, Tower and Span were the recommended cultivars. Since that time rapeseed breeding programs have been successful in producing cultivars better adapted to the Australian growing conditions. Two Australian *Brassica campestris* and several *Brassica napus* types have been released with new and more promising types to be released in the near future.

Each year the New South Wales Department of Agriculture conducts trials throughout NSW and interstate to assess current cultivars and potential new lines for yield and quality. The rapeseed producing areas in Australia cover a wide range of environments from the high rainfall areas (750 mm) in north eastern NSW to the dry western sites (375 mm) in NSW. Sowing and harvest dates may extend from April-October and November-February respectively due to differences in environmental conditions.

As a result, considerable variation in quality is observed each year in glucosinolate levels as well as oil content and fatty acid profile. As shown in Table 1, there are considerable differences between existing cultivars particularly Bunyip *(B. campestris)* to the others *(B. napus)*. The cultivars also show wide variation across the range of sites. Stability in quality is a major aim for future cultivars.

Investigations have been carried out over the last 2 years into the environmental influences responsible for quality variation particularly in relation to glucosinolates. The main factors studied included: temperature, sulphur and water stress.

Table 1: Quality differences between Australian rapeseed cultivars[A] (total glucosinolates are measured as glucose, range shown in brackets)

Cultivar	Glucosinolates (μmol/g)	Oil Content (%)	Erucic Acid (%)
Bunyip	56 (41-73)	40.9 (33.0-46.5)	0.82 (0.3-1.3)
Marnoo	42 (22-61)	43.0 (34.6-50.6)	1.72 (1.1-2.6)
Wesbrook	29 (16-45)	42.6 (35.0-52.1)	0.26 (0.1-0.4)
Tatyoon	38 (24-59)	42.0 (34.8-48.6)	0.67 (0.2-1.0)
BLN270 [B]	18 (9-26)	41.9 (33.1-50.6)	0.35 (0.2-0.4)
BLN273 [B]	17 (10-24)	42.3 (32.4-51.9)	0.25 (0.0-0.8)

[A] New South Wales Trials 1986 (6 cultivars, 17 sites)
[B] Cultivars to be released in 1987

Sulphur

The influence of sulphur on glucosinolate levels has previously been shown (Josefsson and Appelqvist, 1968) but no similar work has been done in Australia.

Glasshouse experiments were conducted using 2 cultivars and 6 rates of sulphur (Table 2). Plants were grown in 10" pots in a mixture (50:50) of washed sand and perlite. The nutrient solution was based on that of P. Randall (unpublished) using a high rate of nitrogen. Yield and oil content reached a maximum at only 15 ppm sulphur however glucosinolates continued to rise at much higher levels. At 200 ppm, yield and glucosinolates showed some reduction. Sulphur appeared to have little influence on the oil fatty acid profile.

Table 2. The effects of sulphur on glucosinolates, yield and oil content

Sulphur (ppm)	Glucosinolates (μmoles/g)	Yield (g)	1000 grain wt. (g)	Oil (%)
	WESBROOK			
4	1.0	2.0	2.1	23.5
8	2.8	9.3	2.9	28.3
15	13.8	25.8	3.3	34.8
25	18.3	28.6	3.5	35.3
100	32.3	30.3	3.4	36.4
200	18.3	30.4	3.5	34.8
	BUNYIP			
4	7.0	9.1	2.2	38.0
8	11.5	15.1	2.3	38.3
15	38.8	23.3	2.1	41.9
25	65.3	24.3	2.2	40.7
100	78.8	23.9	2.3	38.8
200	71.5	20.9	2.1	38.0

To determine the sulphur status of the rapeseed trial sites in NSW in 1986, leaf tissue samples from young plants were analysed for total sulphur. Satisfactory levels have been shown to be 0.84% (Schultz and French, 1978) and 0.65% (Schnug, Sauce and Pissarek, 1985). The average sulphur levels at field test sites were found to be 0.54% with a range of 0.22-0.94%.

Despite the obvious importance of sulphur in determining glucosinolate levels in rapeseed, the difference in plant tissue sulphur did not explain all the variation in glucosinolate levels.

Temperature

Four cultivars of rapeseed were grown at 2 temperature regimes in controlled environment cabinets. The plants were grown in potting mixture and supplied weekly with nutrient solution to ensure there was adequate sulphur available. Despite apparent increases in glucosinolates with higher temperatures, the differences were not significant. There were however significant effects on yield, oil content and the fatty acid profile of the oil. Plants in the hot treatment appeared slightly wilted despite adequate water applied to the pots. A second study of temperature is currently in progress using lower temperatures to determine if the glucosinolate differences may have in fact been due to water stress.

Table 3: The effects of temperature on rapeseed quality

Treatment cold 18/10°C hot 27/15°C	Glucosinolates concentration (μmol/g)	Seed yield (g/plant)	1000-seed weight (g)	Oil concentration (%, w/w)
		WESBROOK		
Cold	33.0 (17-40)	16.18	4.73	37.30
Hot	58.3 (40-79)	5.61	3.61	28.52
		BLN 270		
Cold	16.0 (13-18)	19.21	4.38	37.90
Hot	21.9 (21-22)	5.17	4.07	25.30
		MARNOO		
Cold	50.3 (22.69)	18.41	4.47	40.42
Hot	60.2 (27-87)	4.89	3.75	29.02
		BUNYIP		
Cold	91.8 (72-105)	8.32	3.52	36.55
Hot	93.0 (70-120)	2.67	2.38	24.82
Cultivar	**	**	**	*
Temperature	n.s.	**	**	**
Interaction	n.s.	**	n.s.	n.s.

* - $P < 0.05$; ** - $P < 0.01$; n.s. - not significant.

Water stress

Rapeseed in Australia is grown through the winter period and is harvested in early to mid-summer when water stress conditions are common. Water stress was therefore considered to be a possible influence on glucosinolate levels as high glucosinolates occur characteristically over successive years at lower rainfall sites (Fig 1). A growth cabinet experiment was carried out (Mailer and Cornish, 1987) using 2 cultivars of rapeseed and 3 treatments; a control which was well watered, plants maintained at permanent wilting point throughout their development, and plants reduced to permanent wilting point after flowering. Leaf water potentials were determined on sample plants from each treatment throughout the experiment to ensure proper control of water stress. Significant increases in glucosinolate levels were found between the stressed and non-stressed plants (Table 4). Significant reductions in oil content and yield were also found. Although water availability does not explain all the variation which occurs between the sites, it is accepted that interactions with other factors take place. However, the findings of this experiment, together with the high correlation between dry sites and high glucosinolate content, indicate that water availability is a major factor in the variability of glucosinolates as well as oil and yield in Australian rapeseed.

Table 4: The effect of water stress on glucosinolate and oil content and yield

Water Stress Treatment	Glucosinolate Concentration (μmol/g)	Seed Yield (g/plant)	1000-Seed Weight (g)	Oil Concentration (%, w/w)
	Wesbrook			
Control	8.80 (6-15)	6.54	5.10	38.84
Stressed throughout	23.30 (10-40)	0.74	3.35	31.22
Stressed post-flowering	21.20 (11-28)	0.87	3.37	32.14
	Bunyip			
Control	27.60 (11-47)	3.98	3.03	34.86
Stressed throughout	54.40 (40-65)	0.79	2.47	32.72
Stressed post-flowering	41.10 (28-50)	1.15	2.34	29.40
Cultivar	**	*	**	n.s.
Water regime	**	**	**	**
Interaction	n.s.	**	n.s.	n.s.

* - $P < 0.05$; ** - $P < 0.01$; n.s.- not significant.

References

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Figure 1: Average glucosinolate levels of 8 cultivars grown at 16 sites (NSW Trials, 1985)