

6.1 74/75 to 77/78 environments

group 1 - Biloela in 74/75.

group 44 - Biloela in 75/76, 76/77.

group 46 - 5 environments from 3 years and 4 locations (mostly central Qld).

group 7 - West Namoi in 74/75.

group 42 - 3 environments from 3 years and 2 locations (Theodore, Darling Downs).

group 47 - St George.

group 37 - 2 environments from 2 years and 2 locations (NSW).

group 48 - 9 environments from 3 years and 5 locations (NSW and Darling Downs).

Grouping of environments into locations is more pronounced than grouping into years.

fusion 51 (groups 1, 44) - Biloela environments.

fusion 54 (groups 1, 44, 46, 7) - mostly central Queensland environments.

fusion 49 (groups 37, 48) - NSW and Darling Downs environments.

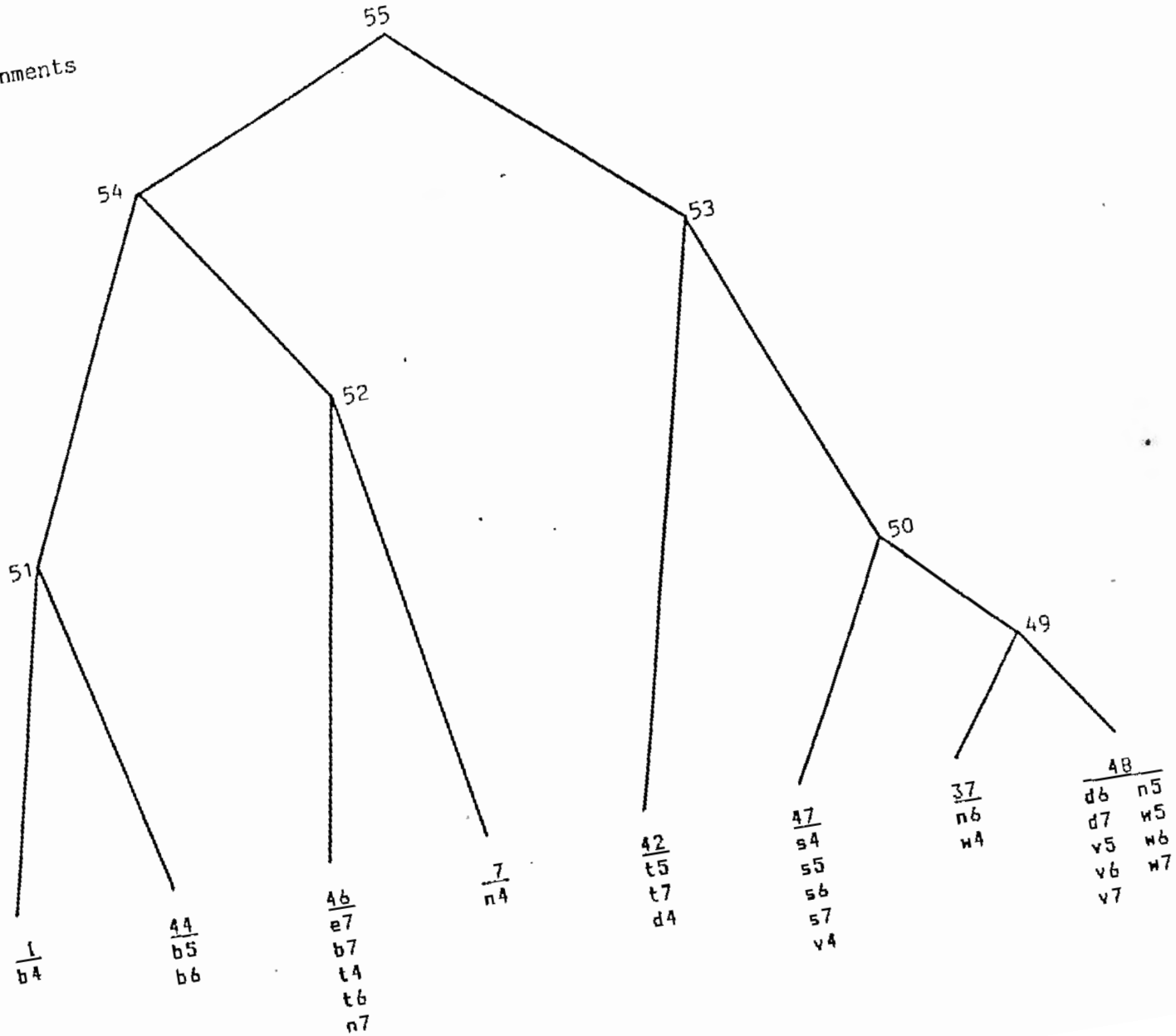
fusion 53 (groups 42, 47, 37, 48) - mostly NSW and southern Qld environments.

The environment with specific location x year interaction is:

West Namoi in 84/85 (group 7).

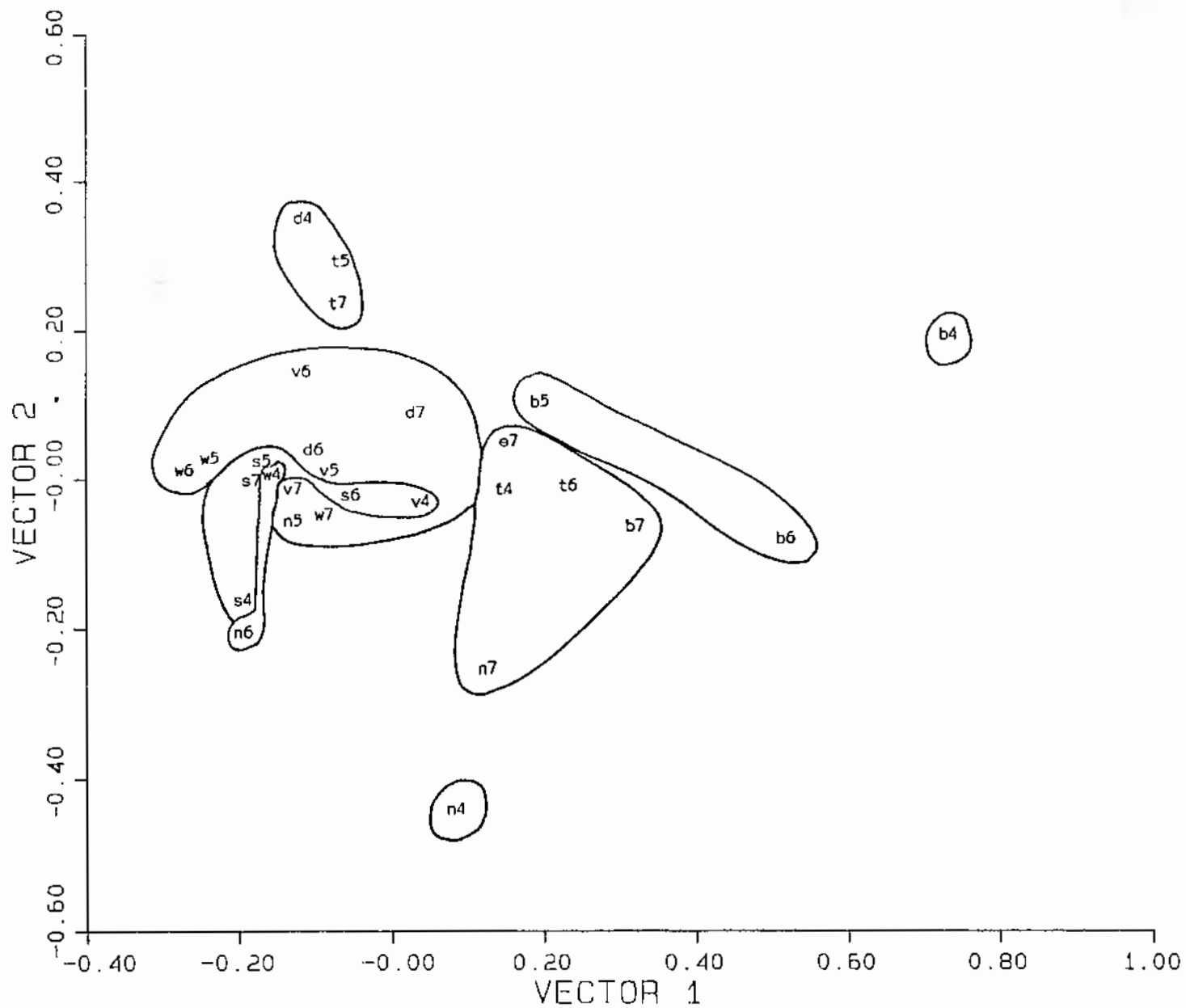
74/75 - 77/78 environments

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74 TO 77 L/YLD (GE) ENVIRONMENT ORDINATION

ge accounted by two vectors 49%



6.2 74/75 to 80/81 environments

group 1 - Biloela in 74/75.

group 94 - mixture of 14 environments from 7 years and 9 locations.

group 89 - Queensland environments from 3 locations and 4 years.

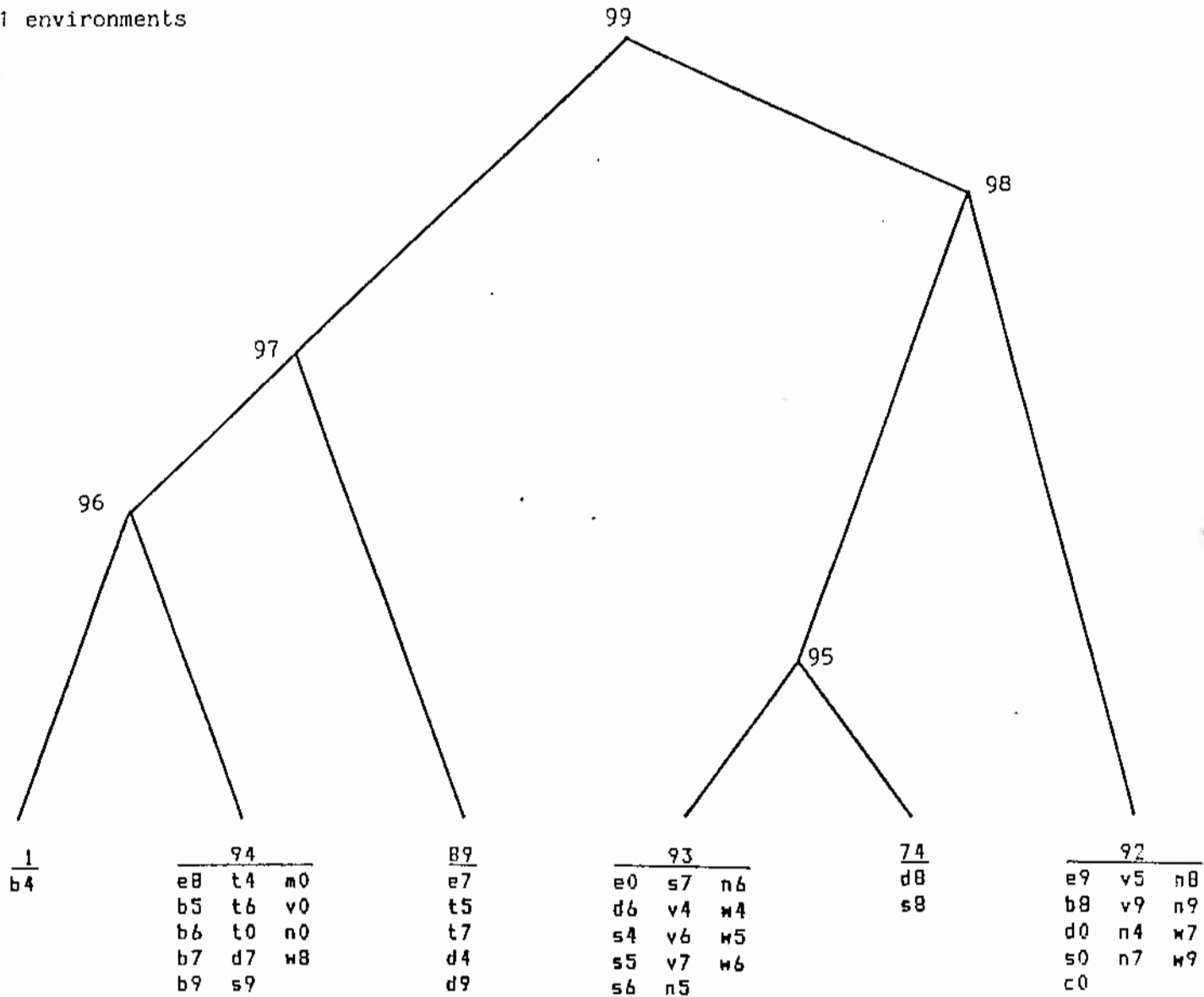
group 93 - mixture of 15 environments from 5 years and 7 locations.

group 74 - Darling Downs and St George in 78/79 (see section 5.5).

group 92 - mixture of 13 environments from 5 years and 8 locations.

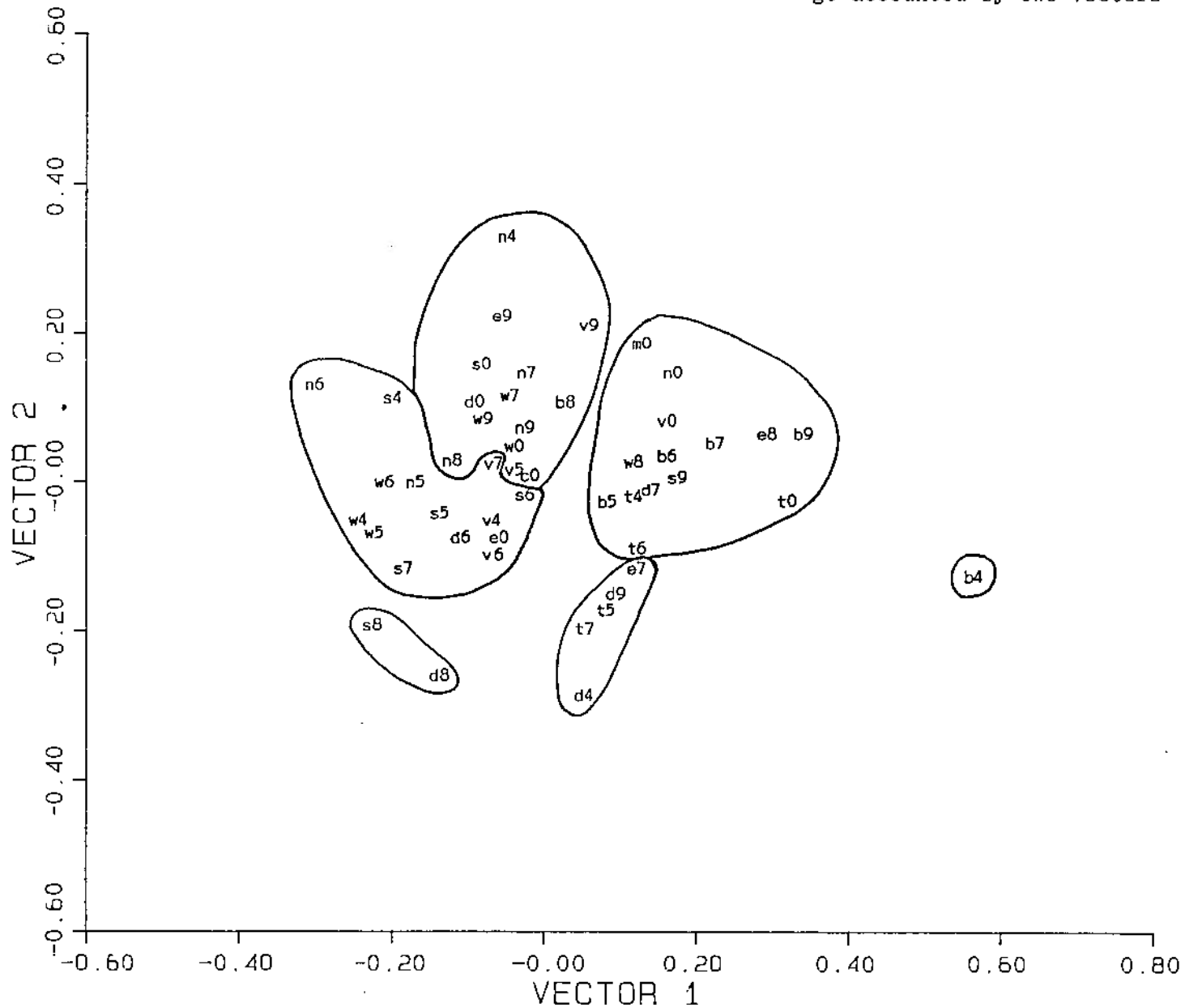
There is no pronounced grouping of environments into either locations or years.

74/75 - 80/81 environments



74 TO 80 L/YLD (GE) ENVIRONMENT ORDINATION

ge accounted by two vectors 71%



6.3 80/81 to 84/85 environments

group 85 - 84/85 locations.

group 80 - five environments over three years (80/81, 82/82, 84/85) and four locations.

group 82 - mixture of 12 environments over 5 years and 6 locations.

group 84 - four environments including Theodore in all years of trials.

group 77 - southern Queensland in 82/83.

group 83 - 12 environments in NSW and St George in 80/81, 81/82, 82/83.

group 81 - southern Qld and NSW environments in 83/84.
- plus Darling Downs in 81/82.

Grouping into years is more pronounced than grouping into locations. For example, at the three group level there is:

fusion 81 - environments in 83/84.

fusion 89 (groups 77, 82, 83, 84) - environments in 80/81, 81/82, 82/83.

fusion 87 (groups 80, 85) - environments in 84/85.

However, within the three years 80/81, 81/82, 82/83 there is some grouping into locations.

group 77 - southern Qld in 82/83.

group 84 - Theodore.

group 84 - mixture of locations.

group 83 - mixture of locations.

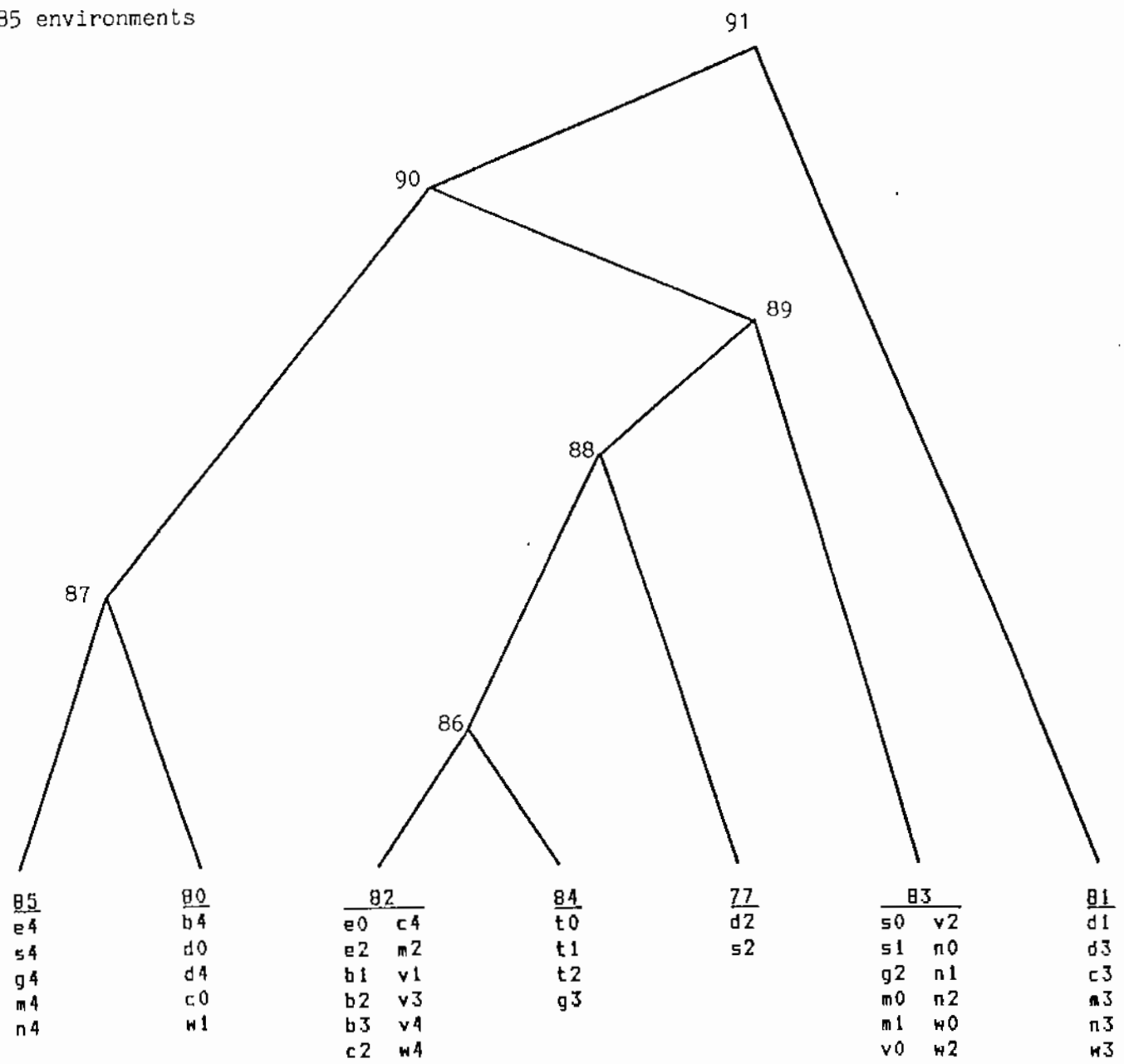
Environments with specific year x location interactions are:

Darling Downs in 81/82

Darling Downs in 80/81

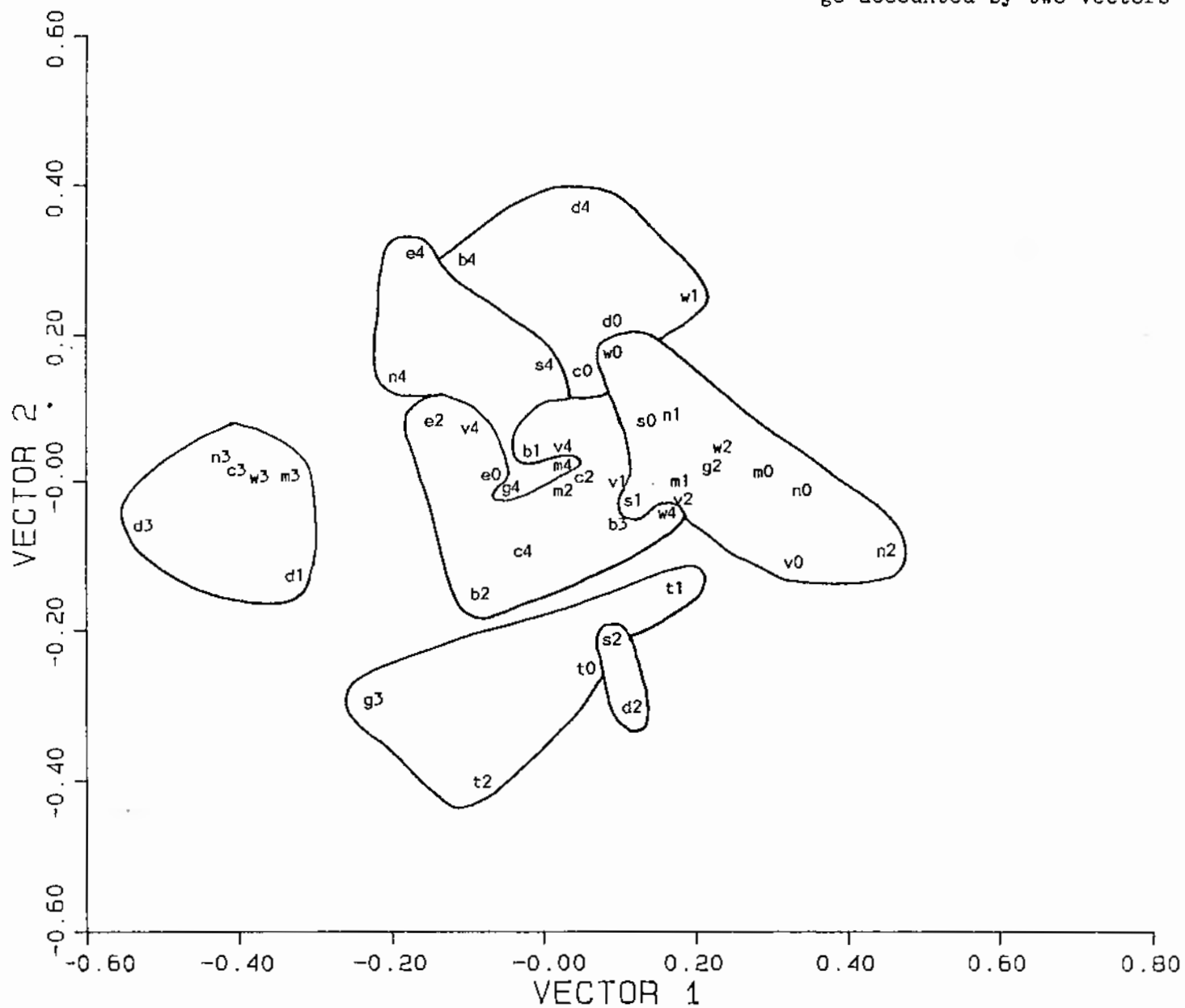
Moomin Creek in 80/81

80/81 - 84/85 environments



80 TO 84 L/YLD (GE) ENVIRONMENT ORDINATION

ge accounted by two vectors 63%



6.4 80/81 to 85/86 environments

group 100 - six environments in 80/81 or 81/82 in NSW or southern Qld.
- plus Darling Downs in 84/85.

group 103 - mostly central Qld locations in 82/83 or 84/85.

group 98 - 84/85 environments in NSW and southern Qld.

group 102 - mixture of 11 environments from 4 years and 9 locations.

group 105 - all NSW and southern Qld locations.
- most environments from 83/84.

group 106 - mixture of 13 environments from 6 years and 8 locations.

group 107 - mixture of 11 environments from 4 years and 8 locations.

There is some grouping into years and some grouping into locations, though not very pronounced in either direction.

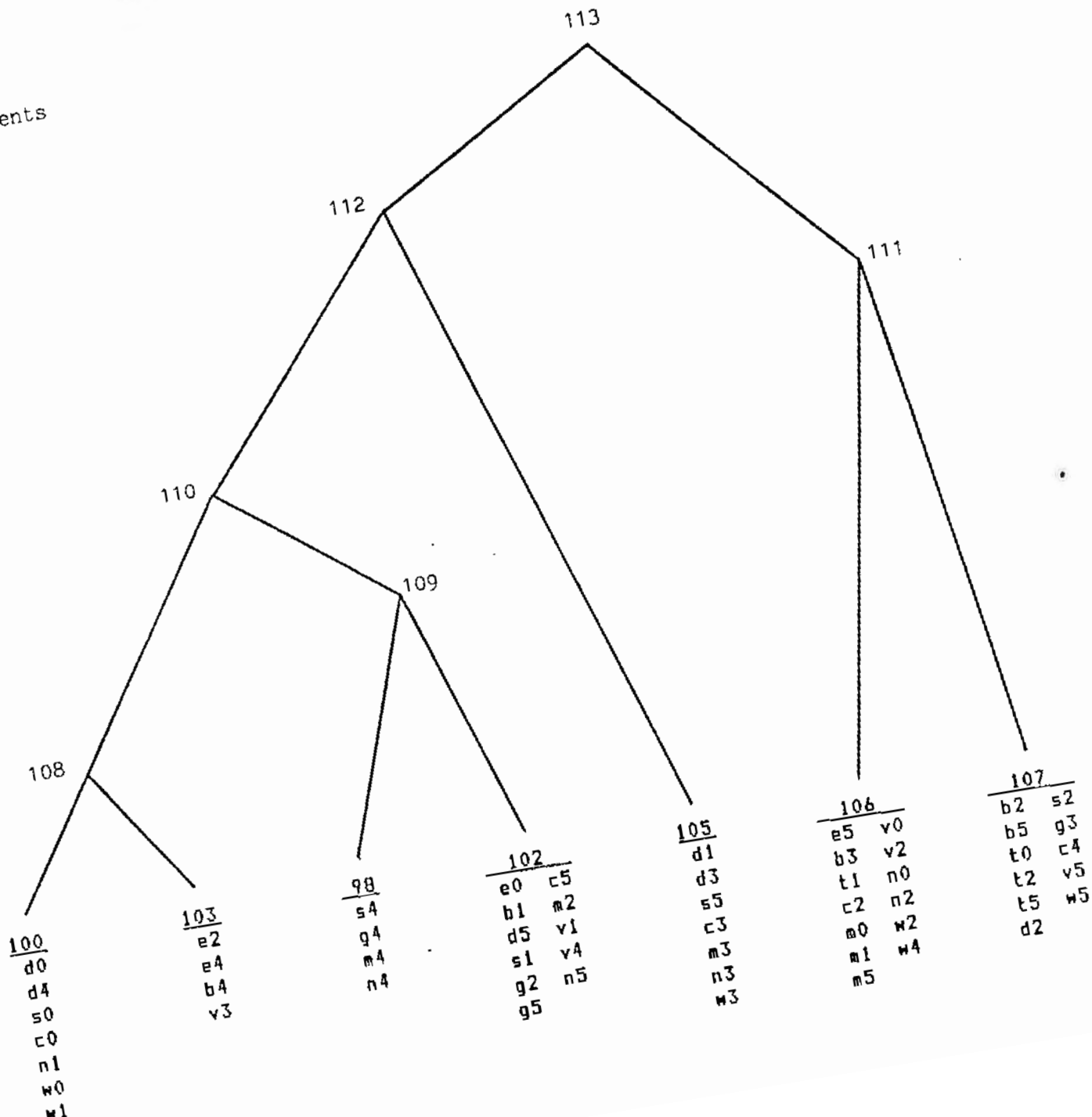
Environments with specific year x locations interactions are:

Myall Vale in 83/84

Darling Downs in 81/82

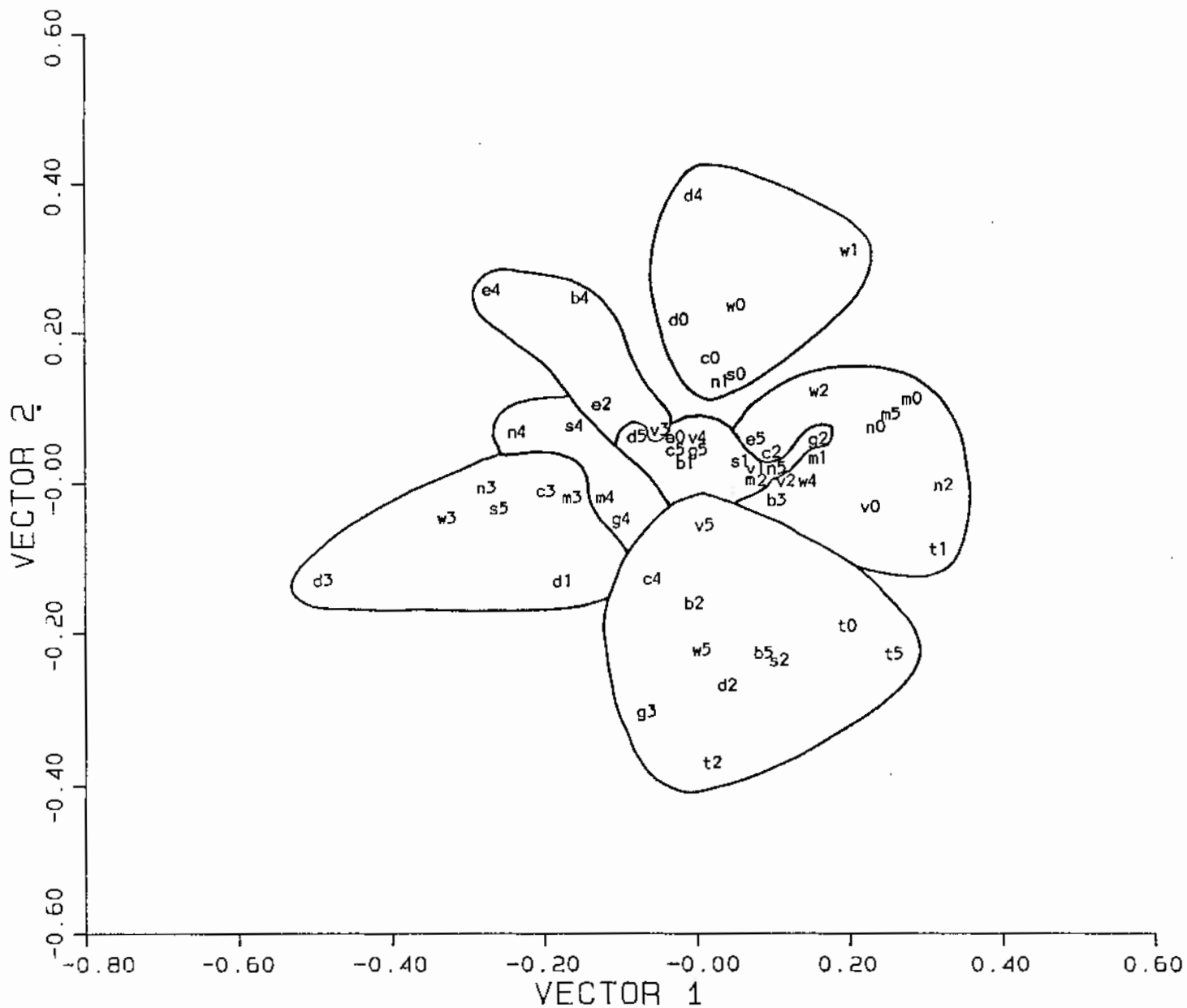
St George in 85/86

80/81 - 85/86 environments



80 TO 85 L/YLD (GE) ENVIRONMENT ORDINATION

ge accounted by two vectors 81%



6.5 82/83 to 85/86 environments

group 75 - mixture of 7 environments from 7 locations and 4 years.

group 74 - mixture of 16 environments from 4 years and 9 locations.

group 72 - 84/85 locations.

group 73 - 83/84 locations.

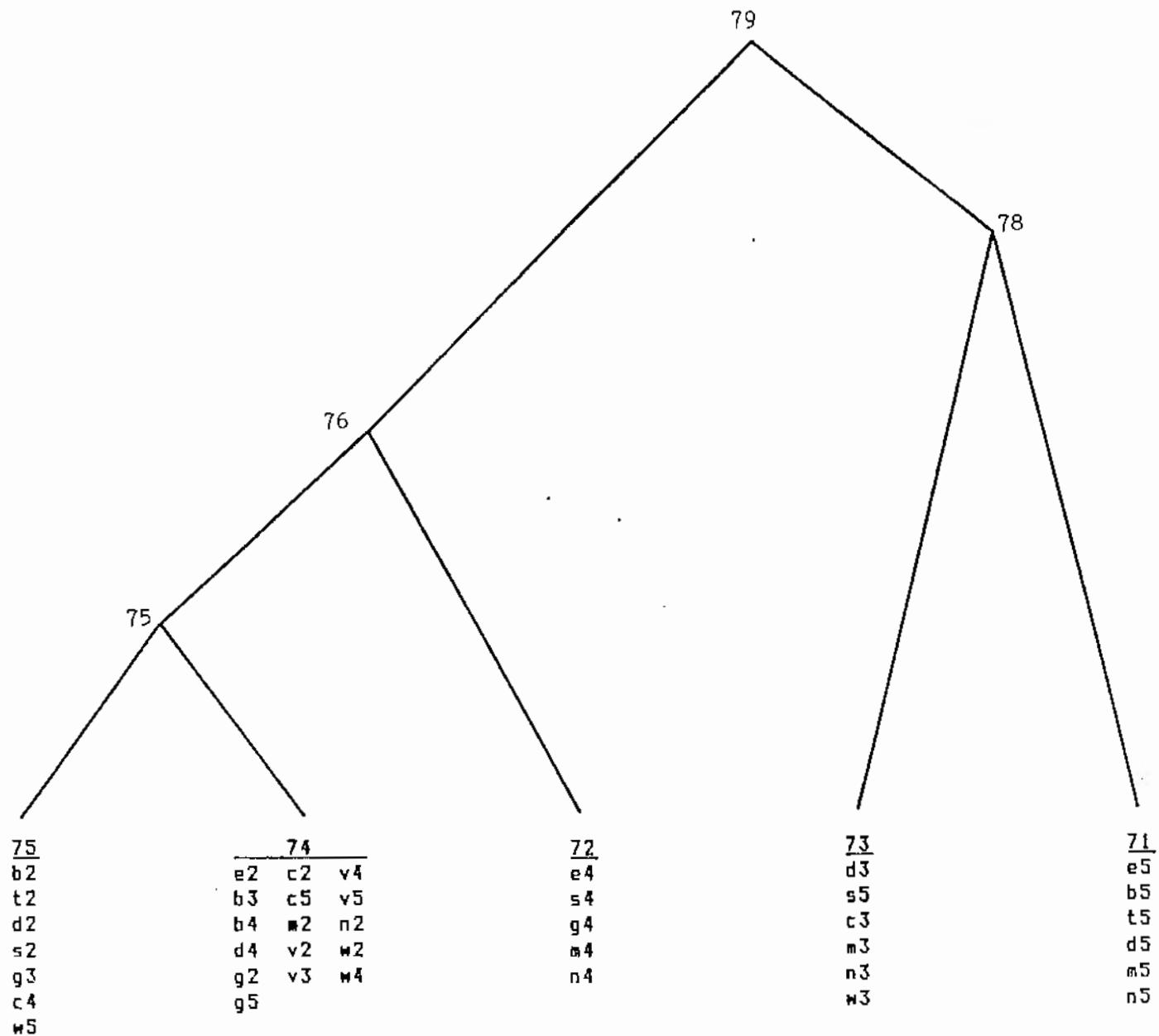
group 71 - 85/86 locations.

Grouping of environments into years is quite pronounced.

Environment with specific year x location interactions is:

St George in 85/86.

82/83 - 85/86 environments



6.6 83/84 to 85/86 environments

group 11 - Darling Downs in 84/85.

group 48 - 85/86 locations.

group 53 - mixture of 13 environments over 3 years and 7 locations.
- includes all years for Boggabilla and Myall Vale.

group 49 - 84/85 locations.

group 52 - 83/84 locations in NSW and southern Qld.

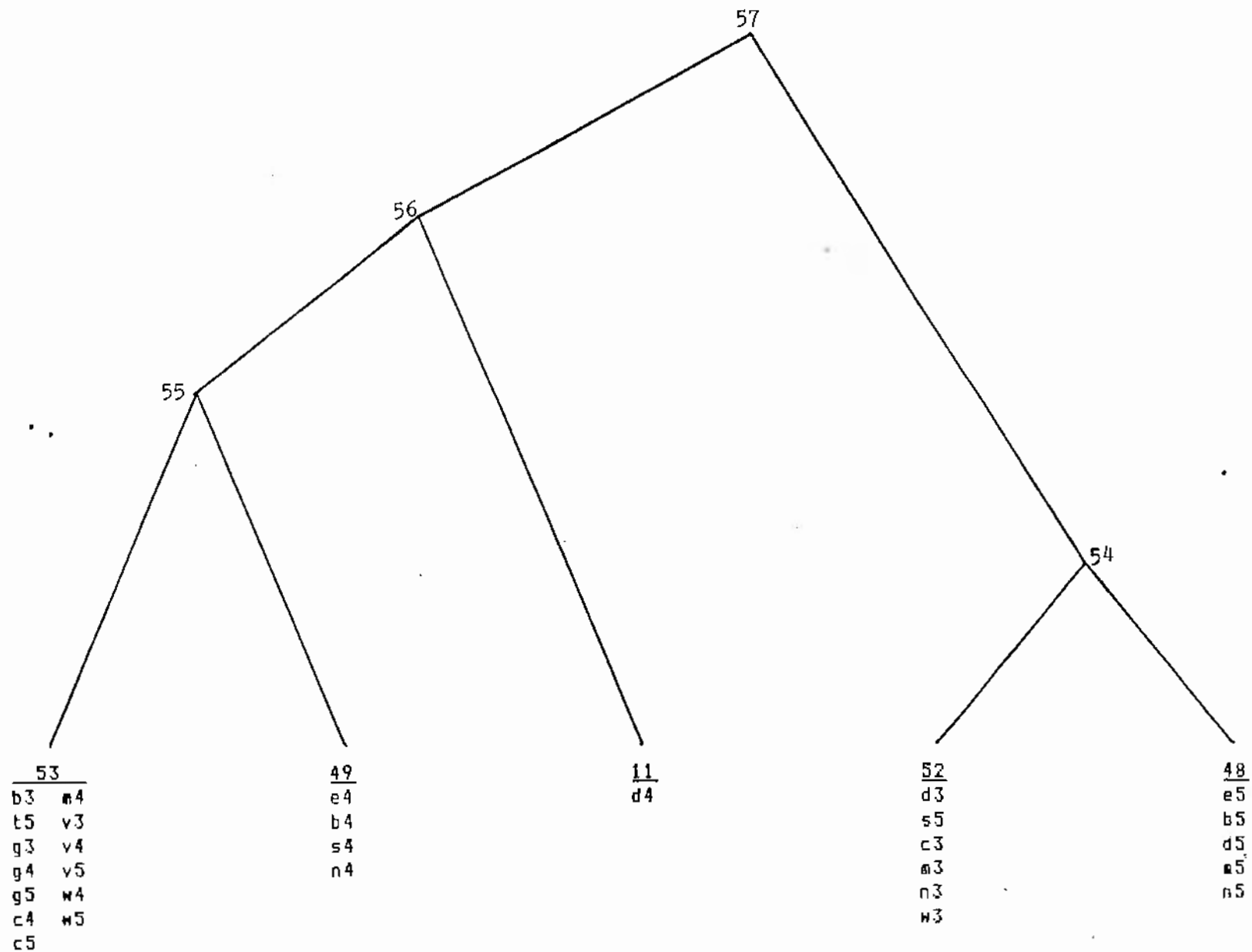
Grouping of environments into years is very pronounced.

Environments with specific location x year interactions are:

Darling Downs in 84/85

St George in 85/86

83/84 - 85/86 environments



6.7 Summary

In the years 74/75 to 77/78 and the years 80/81 to 82/83 grouping of environments into geographical locations is more pronounced than grouping environments into different years.

However, in the years 83/84 to 85/86 grouping of environments into years is definitely more pronounced than grouping environments into geographical locations.

Examination of the within group composition of all data sets in the last six years 80/81 to 85/86 indicates that the Darling Downs has a specific location x year interaction in approximately 50% of the years (in 80/81, 81/82, 84/85). Its ge is often related to the ge of NSW locations in other years.

7. CONTRIBUTIONS of ENVIRONMENTS to GENOTYPE CLASSIFICATION

Contributions of single member environment groups to differences among genotype groups were estimated using the method of Shorter, Byth, and Mungomery (1977) and Shorter, DeLacy and Eisemann (1981). These contributions, for each fusion in each single-year data set, are listed in Table 7.

Table 7 Combined contributions of environments to each fusion in the genotype classification

Year	Fusion No.	Combined Effects										
		e	b	t	d	s	g	c	m	v	n	w
74/75	35		1	8	0	9				8	50	1
	34		29	1	0	10				0	1	3
	33		19	6	0	2				0	6	0
75/76	49		38	13		15				26	8	3
	48		1	0		3				10	6	10
	47		8	2		0				3	1	0
	46		0	1		1				1	1	5
76/77	49		66	21	4	15				1	22	3
	48		12	10	5	18				3	2	5
	47		14	1	2	1				1	6	7
	46		5	5	11	4				0	0	0
77/78	49	11	40	2	18	17				6	43	20
	48	0	8	4	11	3				1	5	5
	47	2	5	3	12	3				1	2	8
	46	0	13	3	0	0				0	3	7
	45	2	6	0	5	0				2	0	1
78/79	31	64	11		0	3					32	23
	30	4	28		5	0					13	0
	29	0	5		5	9					18	8
79/80	31	24	49		5	0				10	0	2
	30	1	1		1	1				19	7	21
	29	0	0		1	10				7	17	7
	28	3	7		2	3				1	0	3
80/81	49	0		1	18	33		21	24	37	35	12
	48	2		8	10	16		4	22	10	10	4
	47	0		8	3	3		2	1	3	1	9
	46	0		11	0	1		0	0	4	4	0
	45	0		0	3	0		1	8	1	3	3
81/82	49		2	6	5	16			22	20	35	13
	48		3	7	3	3			6	6	4	9
	47		1	8	13	2			0	0	0	12
	46		1	1	1	1			0	2	9	9
82/83	49	0	16	4	5	21	21	3	14	29	36	13
	48	0	2	0	16	0	7	7	9	13	8	3
	47	18	2	0	1	6	5	0	6	2	3	0
	46	0	4	17	9	6	0	0	0	0	0	1
	45	0	0	2	9	11	1	0	1	1	2	0
	44	1	0	1	4	3	2	1	2	1	7	1
83/84	49		1		45		15	37	20	1	27	40
	48		0		2		2	35	8	3	29	9
	47		7		2		3	2	0	0	5	1
84/85	59	0	3		36	22	18	16	19	8	45	8
	58	0	9		45	2	13	2	5	3	4	3
	57	22	10		8	4	2	1	0	3	7	4
	56	3	3		22	0	2	6	1	1	1	2

7.1 Averaging contributions

For each single-year data set in Table 7, the contributions of single environmental locations were averaged over fusions and expressed as a percentage of the total contribution (Table 7.1.1).

Table 7.1.1 was then summarized by averaging over years to give an average contribution of locations to the classification of genotypes (Table 7.1.2).

Table 7.1.2 Average contributions of locations to genotype classification.

74/75 - 79/80		80/81 - 85/86	
location	average contribution	location	average contribution
biloela	29	darling downs	17
west namoi	20	west namoi	16
emerald	17	moree	11
warren	11	warren	10
myall vale	11	biloela	10
theodore	10	st george	10
st george	9	moomin creek	9
darling downs	7	theodore	8
		emerald	8
		myall vale	8
		boggabilla	7

West Namoi is obviously an important location in distinguishing between genotype performance (Table 7.1.2). Darling Downs was not important in the early years of these trials (74/75 to 79/80) but in later years has become a very important location (Table 7.1.1 and Table 7.1.2).

Table 7.1.1 Summarized contributions of locations to genotype classification (no weighting over fusions)

years	locations										
	e	b	t	d	s	g	c	m	v	n	w
74/75		32	9	0	13				5	37	3
75/76		30	10		13				25	11	11
76/77		39	15	9	15				2	12	6
77/78	6	26	4	17	8				4	19	15
78/79	30	19		4	5					28	14
79/80	14	28		4	7				18	12	16
80/81	8		8	10	16		8	16	17	16	8
81/82		3	11	10	10			13	12	22	19
82/83	5	7	7	12	13	10	3	9	13	15	5
83/84		3		17		7	25	9	1	21	17
84/85	7	7		30	8	9	7	7	4	16	5
85/86	13	32	6	21	3	0	1	11	1	5	6

Table 7.2.1 Location selection based on combined contributions

Year	Fusion No.	Combined Effects											% ge
		e	b	t	d	s	g	c	m	v	n	w	
74/75	35		1	8	0	9				8	50	1	40
	34		29	1	0	10			0	1	3	100	
	33		19	6	0	2			0	6	0	37	
75/76	49		38	13		15			26	8	3	13	
	48		1	0		3			10	6	10	45	
	47		3	2		0			3	1	0	76	
	46		0	1		1			1	1	5	33	
76/77	49		66	21	4	15			1	22	3	25	
	48		12	10	5	13			3	2	5	12	
	47		14	1	2	1			1	6	7	93	
	46		5	5	11	4			0	0	0	43	
77/78	49	11	40	2	18	17			6	43	20	13	
	48	0	8	4	11	3			1	5	5	20	
	47	2	3	3	12	3			1	2	8	47	
	46	0	13	3	0	0			0	3	7	98	
	45	2	6	0	5	0			2	0	1	100	
78/79	31	64	11		0	3				32	23	32	
	30	4	28		5	0				13	0	99	
	29	0	5		5	9				18	8	28	
79/80	31	24	49		5	0			10	0	2	46	
	30	1	1		1	1			19	7	21	32	
	29	0	0		1	10			7	17	7	38	
	28	3	7		2	3			1	0	3	77	
years selected		1	6	0	2	2			0	4	4		
years selected (%)		33	100	0	40	33			0	67	67		

○ selected location

□ location with opposite ge to selected location

Year	Fusion No.	Combined Effects											% ge
		e	b	t	d	s	g	c	m	v	n	w	
80/81	49	0		1	18	33		21	24	37	35	12	19
	48	2		8	10	16		4	22	10	10	4	10
	47	0		8	3	3		2	1	3	1	9	94
	46	0		11	0	1		0	0	4	4	0	42
	45	0		0	3	0		1	8	1	3	3	84
81/82	49		2	6	5	16			22	20	35	13	38
	48		3	7	3	3			6	6	4	9	39
	47		1	8	13	2			0	0	0	12	88
	46		1	1	1	1			0	2	9	9	79
82/83	49	0	16	4	5	21	21	3	14	29	36	13	17
	48	0	2	0	14	0	7	7	9	13	8	3	72
	47	18	2	0	1	6	5	0	6	2	3	0	28
	46	0	4	17	9	6	0	0	0	0	0	1	71
	45	0	0	2	9	11	1	0	1	1	2	0	73
	44	1	0	1	4	3	2	1	2	1	7	1	57
83/84	49		1		45		15	37	20	1	27	40	27
	48		0		2		2	35	8	3	29	9	29
	47		7		2		3	2	0	0	5	1	98
84/85	59	2	3		34	22	18	16	19	8	45	8	60
	58	0	8		45	2	13	2	5	3	4	3	88
	57	22	10		8	4	2	1	0	3	7	4	25
	56	3	3		22	0	2	6	1	1	1	2	35
85/86	31	28	114	22	33	12	1	2	38	4	14	9	27
	30	20	8	1	47	1	0	3	4	0	5	12	72
years selected		2	3	2	6	1	0	1	1	2	4	4	
years selected(%)		50	60	50	100	20	0	20	17	33	67	67	

- selected location
- location with opposite ge to selected location

Table 7.2.2 Preferential selection of locations from combined contributions

Year	Fusion No.	Combined Effects										% ge	
		e	b	t	d	s	g	c	m	v	n		w
74/75	35		1	8	0	9				8	50	1	40
	34		29	1	0	10			0	1	3	100	
	33		19	6	0	2			0	6	0	37	
75/76	49		39	13		15			26	8	3	13	
	48		1	0		3			10	6	10	45	
	47		8	2		0			3	1	0	76	
	46		0	1		1			1	1	5	33	
76/77	49		66	21	4	15			1	22	3	25	
	48		12	10	5	19			3	2	5	12	
	47		14	1	2	1			1	6	7	93	
	46		5	5	11	4			0	0	0	43	
77/78	49	11	40	2	18	17			6	43	20	13	
	48	0	8	4	11	3			1	5	5	20	
	47	2	3	3	12	3			1	2	8	47	
	46	0	13	3	0	0			0	3	7	98	
	45	2	6	0	5	0			2	0	1	100	
78/79	31	64	11		0	3				32	23	32	
	30	4	28		5	0				13	0	99	
	29	0	5		5	9				18	8	28	
79/80	31	24	49		5	0			10	0	2	46	
	30	1	1		1	1			19	7	21	32	
	29	0	0		1	10			7	17	7	38	
	28	3	7		2	3			1	0	3	77	
years selected		0	6	0	2	2			0	4	4		
years selected (%)		0	100	0	40	33			0	67	67		

○ selected location

□ location with opposite ge to selected location

Year	Fusion No.	Combined Effects											% ge
		e	b	t	d	s	g	c	m	v	n	w	
80/81	49	0		1	18	33		21	24	37	35	12	19
	48	2		3	10	16		4	22	10	10	4	10
	47	0		8	3	3		2	1	3	1	9	94
	46	0		11	0	1		0	0	4	4	0	42
	45	0		0	3	0		1	8	1	3	3	84
81/82	49		2	6	5	16			22	20	35	13	38
	48		3	7	3	3		6	6	4	9	9	39
	47		1	8	13	2		0	0	0	12	12	88
	46		1	1	1	1		0	2	9	9	9	79
82/83	49	0	16	4	5	21	21	3	14	29	36	13	17
	48	0	2	0	16	0	7	7	9	13	8	3	72
	47	18	2	0	1	6	5	0	6	2	3	0	28
	46	0	4	17	9	6	0	0	0	0	0	1	71
	45	0	0	2	9	11	1	0	1	1	2	0	73
	44	1	0	1	4	3	2	1	2	1	7	1	57
83/84	49		1		45		15	37	20	1	27	40	27
	48		0		2		2	35	8	3	29	9	29
	47		7		2		3	2	0	0	5	1	98
84/85	59	2	3		36	22	18	16	19	8	45	8	60
	58	0	9		45	2	13	2	5	3	4	3	88
	57	22	10		8	4	2	1	0	3	7	4	25
	56	3	3		22	0	2	6	1	1	1	2	35
85/86	31	28	114	22	33	12	1	2	38	4	14	9	27
	30	20	8	1	47	1	0	3	4	0	5	12	72
years selected		2	3	2	6	0	0	0	0	0	5	3	
years selected (%)		50	60	50	100	0	0	0	0	0	83	50	

○ selected location

□ location with opposite ge to selected location

7.2 Selection of locations using contributions

For each fusion in each year, the location making the largest contribution to the separation of genotype groups was selected (Table 7.2.1). If the ge interaction effects were relatively important in separating genotype groups in that fusion (Table 7.2.1), then two locations were selected which had opposite ge effects (see all figures in Appendix J illustrating genotype response over environments). For example, in fusion 47 in 80/81 (table 7.2.1), both warren and theodore were selected. Results of this selection process were analyzed over the two sets of years, 74/75-79/80 and 80/81-85/86.

In the years 74/75-79/80, Emerald was selected once and in the years 80/81 to 85/86, Moomin creek, Myall vale, Moree and St George were selected only once or twice. By examining the size and direction of the ge interactions it was possible to select another location which made a similar contribution to the separation of genotype groups at the particular fusion in question (Table 7.2.2). For example, in fusion 49 in 80/81 (Table 7.2.2), west namoi was chosen as an alternative location to myall vale. By this process of preferential selection of locations, it was possible to eliminate a number of locations as being non-essential in the classification of genotype groups (Table 7.2.3).

Table 7.2.3 Summary of preferential selection of locations based on contributions analysis.

74/75 - 79/80		80/81 - 85/86	
location	years selected (%)	location	years selected (%)
biloela	100	darling downs	100
west namoi	67	west namoi	83
warren	67	warren	67
st george	50	biloela	60
darling downs	40	theodore	50
emerald	0	emerald	50
theodore	0	myall vale	0
myall vale	0	st george	0
		moomin creek	0
		moree	0
		boggabilla	0

7.3 Summary

The two methods of summarizing the contributions analysis give a similar but slightly different answer.

In summary, we have grouped the locations on their ability to classify genotypes into groups based on their yield response over environments.

Table 7.3 Ability of locations to classify genotypes

category	74/75 - 79/80	80/81 - 85/86
essential	biloela west namoi	darling downs west namoi
important	warren st george darling downs emerald	warren biloela theodore emerald
useful	emerald theodore myall vale	moree st george moomin creek
not required		myall vale boggabilla

The conclusions from the last six years of trials are of particular interest to the cotton breeder.

Darling Downs and West Namoi are the two most important locations for classifying genotypes and should be considered as the main sites for preliminary testing of breeding materials.

Boggabilla and Myall vale made the least contribution to the classification of genotypes. Since Myall vale is the main site for preliminary testing of breeding material from the CSIRO breeding program, the differences between Myall vale and West Namoi must be seriously examined. Maybe the reason for the difference is that Myall vale is located on a research station and West Namoi is located on a commercial farm.

8. CONCLUSIONS

The numerical classification analysis is identifying and summarizing patterns of genotype-environment interactions which can be meaningfully interpreted by the cotton breeder.

In the first six years of trials, 74/75 to 79/80, grouping of environments by geographical locations is more pronounced than grouping the environments by years. This would suggest that separate breeding programs are required for different geographical areas, namely (1) Namoi and Macquarie and (2) Central Queensland. However, this conclusion may not be relevant in 1987 because in the early trial years, most of the genotypes being evaluated were of USA origin and not particularly well adapted to Australian environments.

In contrast, the last few years of trials mostly included advanced breeding selections from the CSIRO breeding program which were better adapted to Australian environments. In the last three years of trials, 83/84 to 85/86, grouping of environments by years is definitely more pronounced than grouping environments by geographical location. This suggests that only one breeding program is required for irrigated cotton in Australia.

Within the next one to two years, advanced breeding selections developed by Qld DPI at Biloela will be available for inclusion in these trials. Perhaps this will alter the conclusions about the number of cotton breeding regions in Australia.

The number of locations required for testing could be reduced. Some locations, in particular darling downs and west namoi, are very useful for differentiating between genotype response to environments; whereas, other environments, boggabilla, myall vale, moomin creek, st. george, moree, do not contribute to the separation of genotypes. Therefore, the current set of eleven test locations, could be reduced to six locations, darling downs, west namoi, warren, biloela, theodore, and emerald. These locations basically cover the geographical diversity of cotton areas in Australia.

To gain a better understanding about the grouping of environments, it may be useful to relate these groups to an independent measure of environments such as day-degrees. The pattern analysis has identified a number of specific environments, eg. darling downs in 80/81, 81/82, and 84/85, which don't fit the normal $g \times e$ patterns expected from examining either locations or years independently. The growing conditions of these environments should be examined carefully to try and gain a better biological understanding why these environments are different from the normal.

The pattern analysis can easily be run on future data sets and the classification of genotypes and environments compared to results from previous years.

9. ACKNOWLEDGEMENTS

The statistical analyses were carried out by Ian DeLacy, University of Queensland and I gratefully acknowledge his contribution.