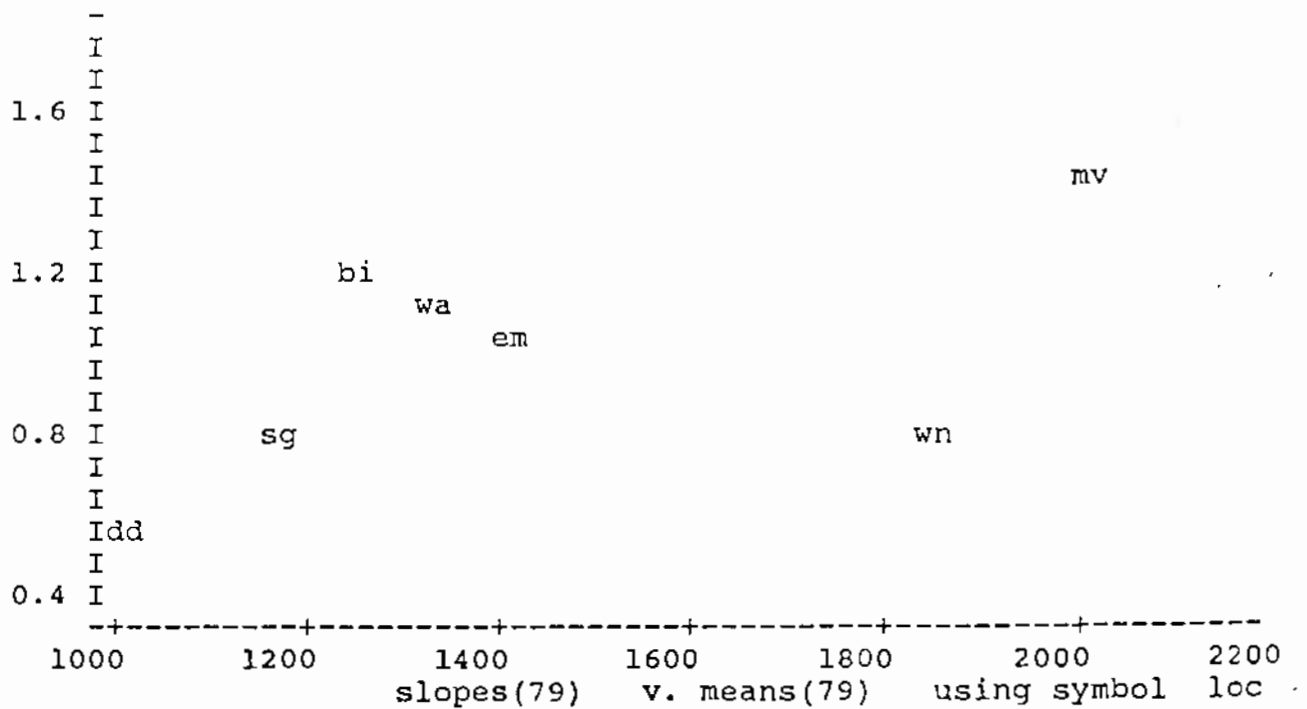
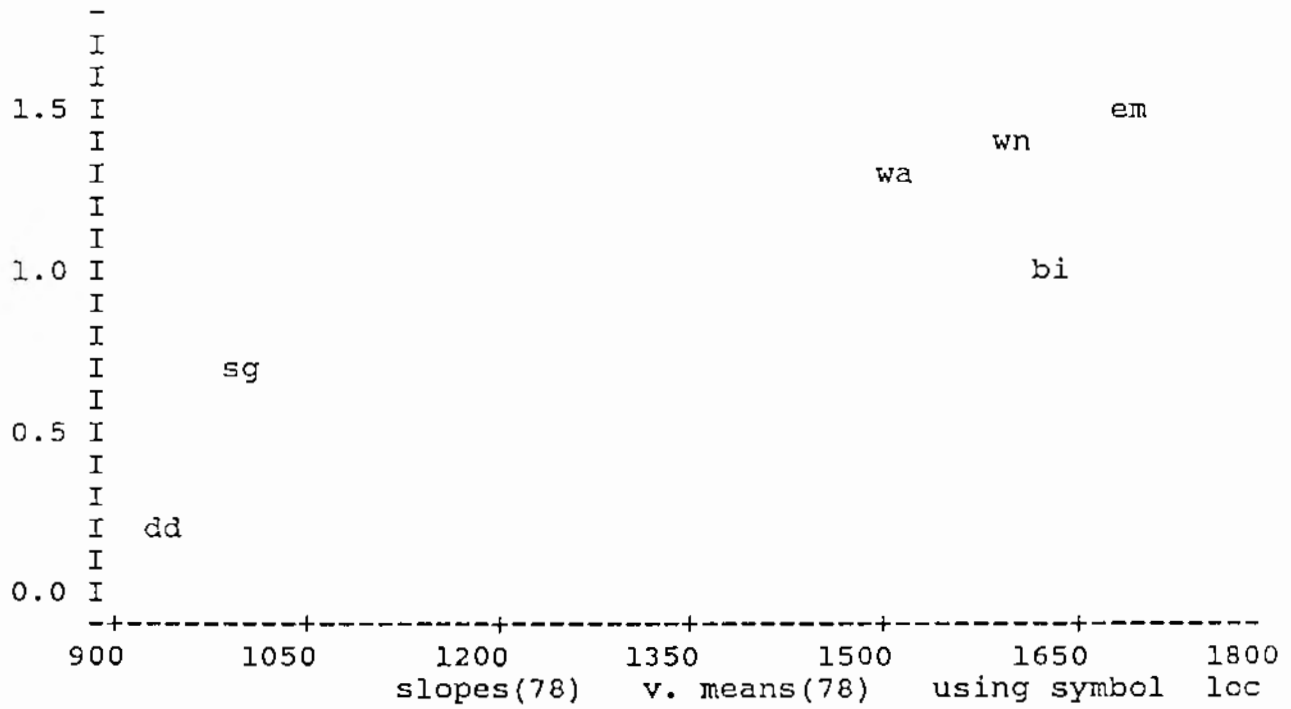


Figure 3.4.1 (cont)  
 lyld:slopes:means 1974 - 1983



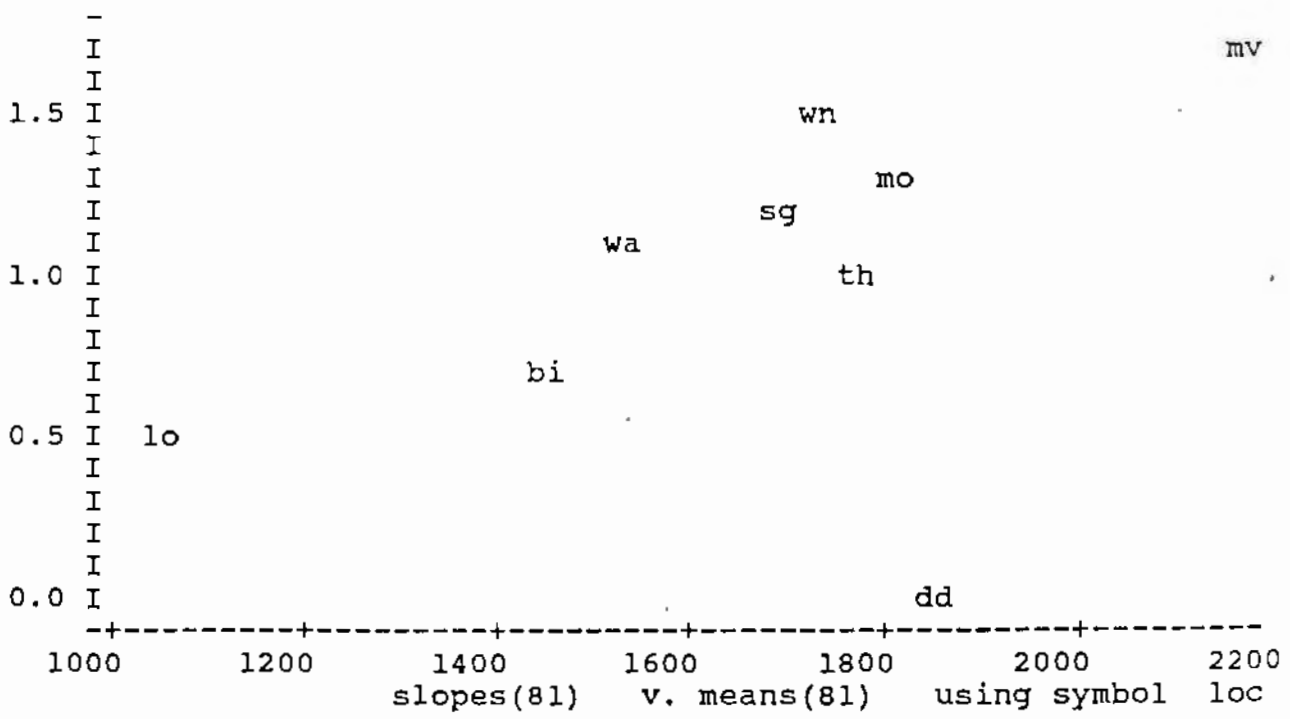
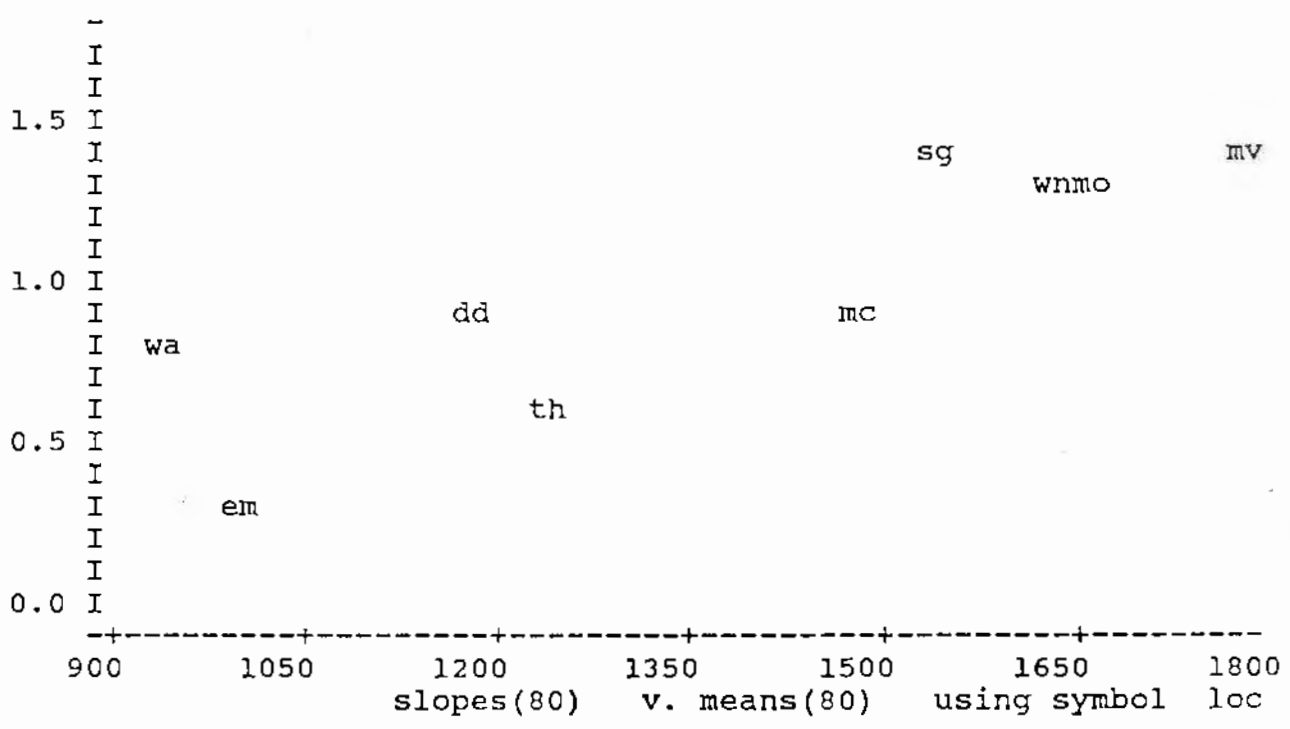
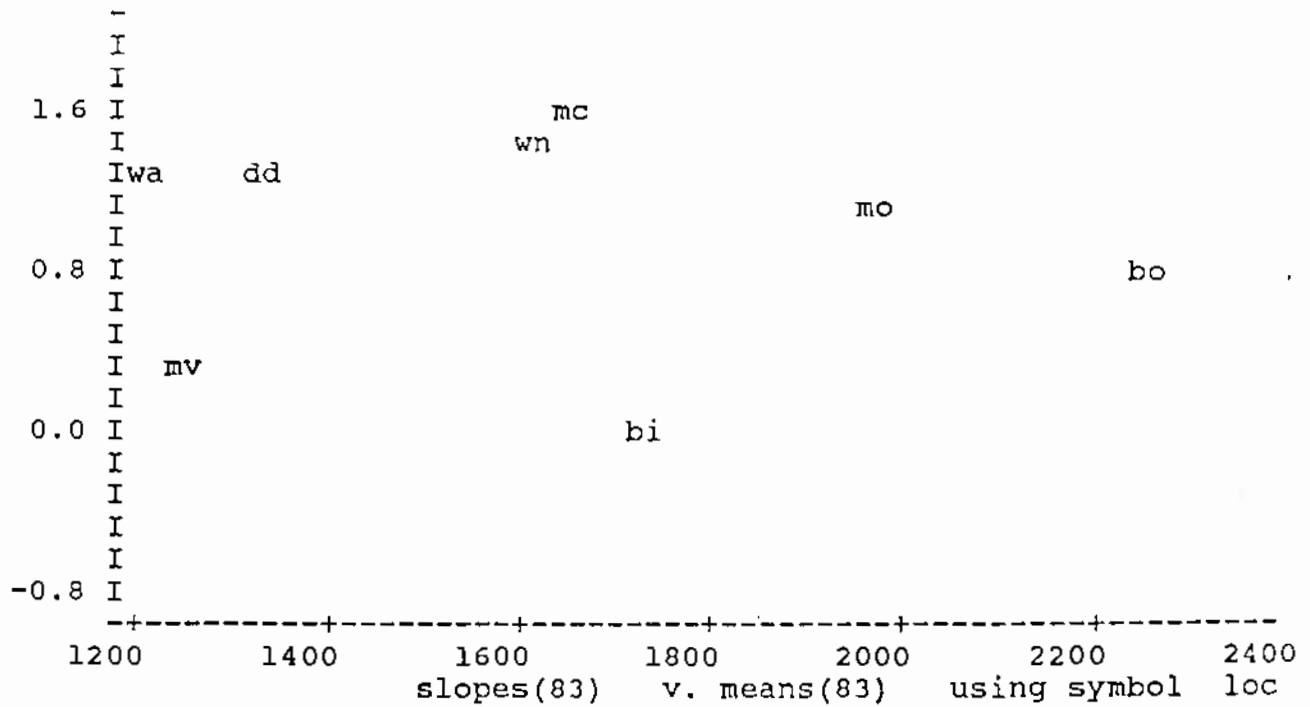
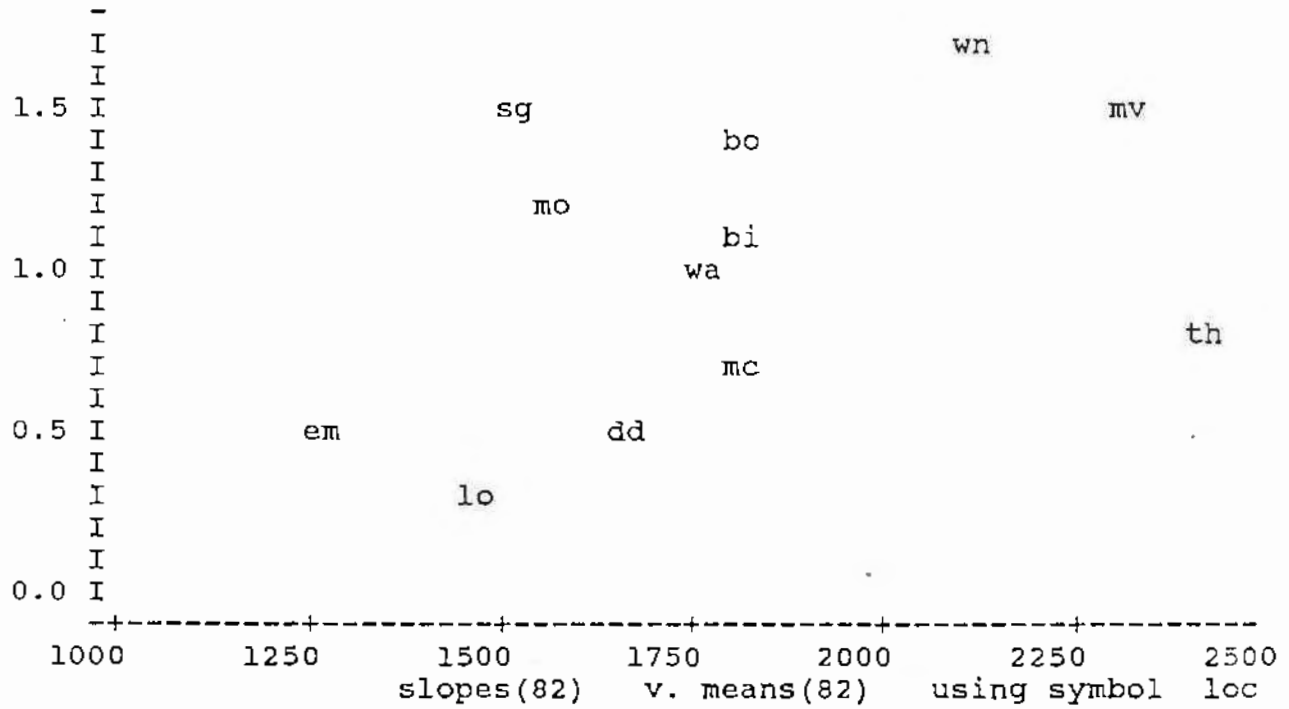


Figure 3.4.1 (cont)

lyld:slopes:means 1974 - 1983



#### 4.1 Introduction

In Section 3 we concentrated on the CxL tables separately for each year. It is worth repeating the reason why we have chosen to break up the analysis of the complete CxLxY data set into pieces:

(i) The structure of the data sets is such that in any particular year there is a complete CxL table, i.e. in any year the same cultivars were tested at each of the locations used in that year.

(ii) The cultivars tested varied quite dramatically over the 10 years.

We could have attempted to analyse the complete CxLxY table using a package such as REML to estimate variance components, however this approach seems to suffer due to sparseness of the data ((ii) above) as well as ignoring the valuable structure available ((i) above).

In order to overcome the problem of changing cultivars from year to year (see Table 1.3.2), it seems best to not try and estimate parameters for the full CxLxY table, but rather look separately at various components; for example in the last Chapter we concentrated on the CxL (within years) tables. In this Section we look at the analyses of LxY tables. We justify considering such tables, even though the cultivars change from year to year by:

(i) Allowing the cultivars in any year to be random, with a constant variance over years; this last point is supported by observing that in Appendix C, the cultivar mean square (column (5)) does not vary dramatically from year to year.

(ii) Being aware that in estimating margins from a LxY table, the estimated year effects may include a component from the cultivars represented in that year, i.e. by assuming cultivars are random we are not excluding the possibility (probability) that average cultivar performance has varied (increased?) over years.

In the next Section we look at the analysis of LxY tables, fitting margins and in Section 4.3 a generalization of the Finlay-Wilkinson approach is applied to LxY tables.

## 4.2 Fitting margins

The statistical package GENSTAT was used to estimate year and location means from an L×Y table. The model that simply says that an entry in a two-way table consists of an effect due to the appropriate two margins plus an error term is usually called the process of fitting margins. For our tables there are a number of blank cells so that the analysis is non-orthogonal (i.e. not just simple row and column averages). Although the degree of incompleteness is nowhere near as bad as is the situation with the C×L×Y tables, it is still best to exclude rows or columns with just one or two entries. In the case of the tables in Appendix F this corresponds to dropping out several of the locations, depending on which variate is being analysed.

It should be pointed out here that the model we have used to analyse our L×Y tables assumes independent errors for the entries in the table. This is not strictly correct since by assuming that cultivars are random, there is an induced correlation structure whereby entries in the table are related according to the number of cultivars they have in common. However we have not concerned ourselves with this aspect since mean values would be affected very little and the style of this report does not demand precise standard errors - whatever they might be. Patterson and Silvey (1980, Section 5.4.4) use a similar procedure for estimation of variety means over years.

The estimated location and year means obtained by analysing the tables in Appendix F are given in Tables 4.2.1. and 4.2.2 respectively. Analysis of variance details are also of interest and these are given in Table 4.2.3 along with a reproduction of the information on the average C×L mean square (which is really the combination of the C×L and C×L×Y lines in a full three-way analysis of variance table) and the average residual mean square (the error term in a three-way analysis of variance table) from Table 3.3.1.

Estimated Location Means

	<u>boll</u>	<u>elon</u>	<u>leng</u>	<u>ltpc</u>	<u>lyld</u>	<u>mike</u>	<u>strg</u>	<u>unir</u>	<u>yain</u>	<u>yast</u>
bi	5.33	6.87	1.11	37.5	1325	4.19	23.0	44.7	104	2217
bo										
dd	4.98	6.82	1.10	38.5	1181	3.81	22.1	45.0	108	2305
em	4.24	6.46	1.08	38.6	1186	4.06	22.5	43.8	102	2294
lo										
mc			1.12	37.4	1452	3.85	24.4	45.3		
mo		6.57	1.14	36.8	1533	4.20	24.0	46.1		
mv	5.12	6.77	1.13	38.7	1545	4.28	23.4	46.6	104	2334
sg	4.52	6.91	1.09	38.3	1287	4.10	22.6	44.5	105	2290
th	5.48	6.38	1.09	40.0	1470	4.47	22.3	45.0	104	2186
un										
wa	4.64	6.94	1.12	37.5	1234	4.13	23.0	45.7	107	2329
wn	5.14	6.74	1.13	38.1	1614	4.05	23.6	45.9	103	2376

Table 4.2.2

Estimated Year Means

	<u>boll</u>	<u>elon</u>	<u>leng</u>	<u>ltpc</u>	<u>lyld</u>	<u>mike</u>	<u>strg</u>	<u>unir</u>	<u>yain</u>	<u>yast</u>
74	5.00	6.62	1.13	36.5	1361	4.24	23.5	46.9	105	2372
75	4.94	6.96	1.09	38.2	1041	3.85	22.1	47.0	97	2047
76	4.84	6.46	1.10	38.4	922	3.98	23.0	46.0	103	2237
77	5.35	6.55	1.10	38.4	1182	4.34	22.6	45.6	111	2337
78	4.80	6.39	1.11	37.4	1462	3.90	22.3	44.9	101	2315
79	4.95	6.64	1.09	38.8	1468	4.50	22.5	44.9	103	2251
80	4.63	6.83	1.13	39.3	1364	4.53	24.0	45.3	111	2439
81		7.36	1.11	40.8	1726	4.18	23.5	44.5	105	2334
82		6.67	1.13	40.9	1809	4.29	23.9	43.9		
83			1.11	40.4	1496	3.36	23.6	43.6		

Summary of Stratum Error Terms so far\*

	Y	L**	L Y	C L	Residual
boll	0.54	0.86	0.17	0.10	0.07
elon	0.64	0.28	0.09	0.13	0.09
leng	1.72	2.12	0.51	0.32	0.16
ltpc	10.97	4.51	2.11	0.71	0.48
lyld	59.52	19.13	7.73	1.28	0.41
mike	9.38	2.48	1.25	0.45	0.22
strg	4.50	2.84	0.76	0.54	0.29
unir	9.02	5.04	1.04	0.61	0.37
yain	15.69	2.31	1.56	1.49	1.04
yast	9.06	2.62	1.08	0.85	0.40

\* scaled as in Table 2.3.1

\*\* after fitting years

#### 4.3 Interpretation of Tables 4.2.1 - 4.2.3

Firstly looking at Table 4.2.3 we can observe that the magnitudes of the LxY and CxL mean squares are small in comparison to those for L and Y. This is particularly the case for lyld, the most important variate, so that although lyld showed the largest CxL interaction, we probably have to get this result in perspective when considered against the L and Y mean squares. This possibly explains why there was no discernible explanation for the significant CxL interaction when measured against the residual mean square (see Table 3.3.1) - it's really quite small relative to the L and Y values.

The values in Table 4.2.3 are more for an indication of levels of magnitude rather than any exact considerations, because we must remember that the analyses of this Chapter have excluded some of the locations. Nevertheless it is interesting to look at the rankings of the analysed locations, i.e. ranking the estimated location means in Table 4.2.1 from highest to lowest; this is done in Table 4.3.1. There are some interesting results apparent from this table especially when we underline the Queensland locations. It is clear that for leng, strg, unlr and yast in particular there is a separation into NSW and QLD locations. This issue has been raised in discussion with the plant breeders from NSW and QLD but it seems that no satisfactory explanation for the implications in Table 4.2.4 has been given. Further thought is required here in order to deduce what the results of Table 4.2.4 are attempting to say. The explanation probably depends on information not under consideration in this report, but it seems to be a primary area for further detailed investigation.

Similarly we could produce rankings for the results in Table 4.2.2 and try to relate the conclusions to other information such as geographic variables or climate (day degrees?).

Ranking Estimated Location Means

	<u>boll</u>	<u>elon</u>	<u>leng</u>	<u>ltpc</u>	<u>lyld</u>	<u>mike</u>	<u>strg</u>	<u>unir</u>	<u>yain</u>	<u>yast</u>
Rank										
1	<u>th</u>	wa	mo	<u>th</u>	wn	<u>th</u>	mc	mv	<u>dd</u>	wn
2	<u>bi</u>	<u>sg</u>	mv	mv	mv	mv	mo	mo	wa	mv
3	wn	<u>bi</u>	mn	em	mo	mo	wn	wn	<u>sg</u>	wa
4	mv	<u>dd</u>	mc	<u>dd</u>	<u>th</u>	<u>bi</u>	mv	wa	<u>th</u>	<u>dd</u>
5	<u>dd</u>	mv	wa	<u>sg</u>	mc	wa	<u>bi</u>	mc	<u>bi</u>	<u>em</u>
6	wa	wn	<u>bi</u>	wn	<u>bi</u>	<u>sg</u>	wa	<u>dd</u>	mv	<u>sg</u>
7	<u>sg</u>	mo	<u>dd</u>	wa	<u>sg</u>	<u>em</u>	<u>sg</u>	<u>th</u>	wa	<u>bi</u>
8	<u>em</u>	<u>em</u>	<u>sg</u>	<u>bi</u>	wa	wn	<u>em</u>	<u>bi</u>	<u>em</u>	<u>th</u>
9		<u>th</u>	<u>th</u>	mc	<u>em</u>	mc	<u>th</u>	<u>sg</u>		
			<u>em</u>	mo	<u>dd</u>	<u>dd</u>	<u>dd</u>	<u>em</u>		

#### 4.4 Appendix B Tables for lyld

The tables in Appendix B contain F values and the mean square error from the individual experimental designs and as such constitute another set of LxY tables which can be analysed by fitting margins. We will only consider frep, fclt and fmse for the variate lyld, i.e. the F values for replicates and cultivars and the mean square errors for lint yield from each experiment. The results from fitting margins are given in Tables 4.4.1 and 4.4.2. The analyses have been carried out on the natural logs of 100 times the tables in Appendix B (the multiplier 100 is purely for convenience of presentation, the logarithmic transformation is desirable for frep and fclt but not so necessary for fmse).

The values given in Table 4.4.1 and 4.4.2 for fclt and fmse have been graphed in Figure 4.4.1. The most desirable situation is for the low values of fmse and high values for fclt. These would be expected to be negatively correlated as seen from Figure 4.4.1. Interpreting Figure 4.4.1, it seems that mv has a low fmse, whereas mo and wn have good discriminating power between cultivars. Bad locations are dd and sg. On the other hand considering years, we see that 1975 and 1976 had low fmse; whereas 1976 and 1983 were the best years for discriminating between cultivars. These results should presumably be related to climatic conditions in the various years. For example 1975 and 1976 were probably wet years and 1981 a dry year.

Table 4.4.1

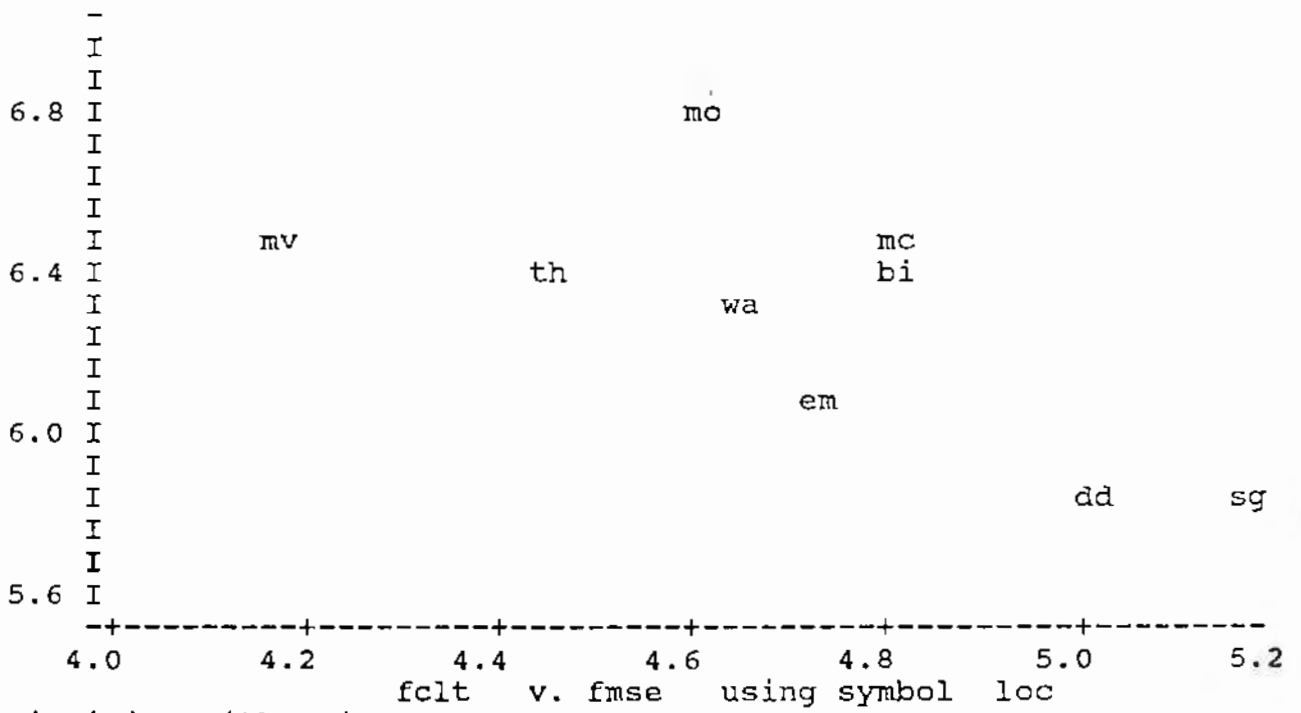
Estimated Location Means

	<u>frep</u>	<u>fclt</u>	<u>fmse</u>
bl	5.87	6.43	4.81
bo			
dd	5.84	5.86	4.99
em	5.19	6.08	4.71
lo			
mc	6.80	6.47	4.79
mo	6.41	6.79	4.58
mv	6.38	6.48	4.18
sg	6.52	5.82	5.14
th	6.13	6.40	4.42
un			
wa	6.07	6.34	4.66
wn	6.36	6.78	4.58

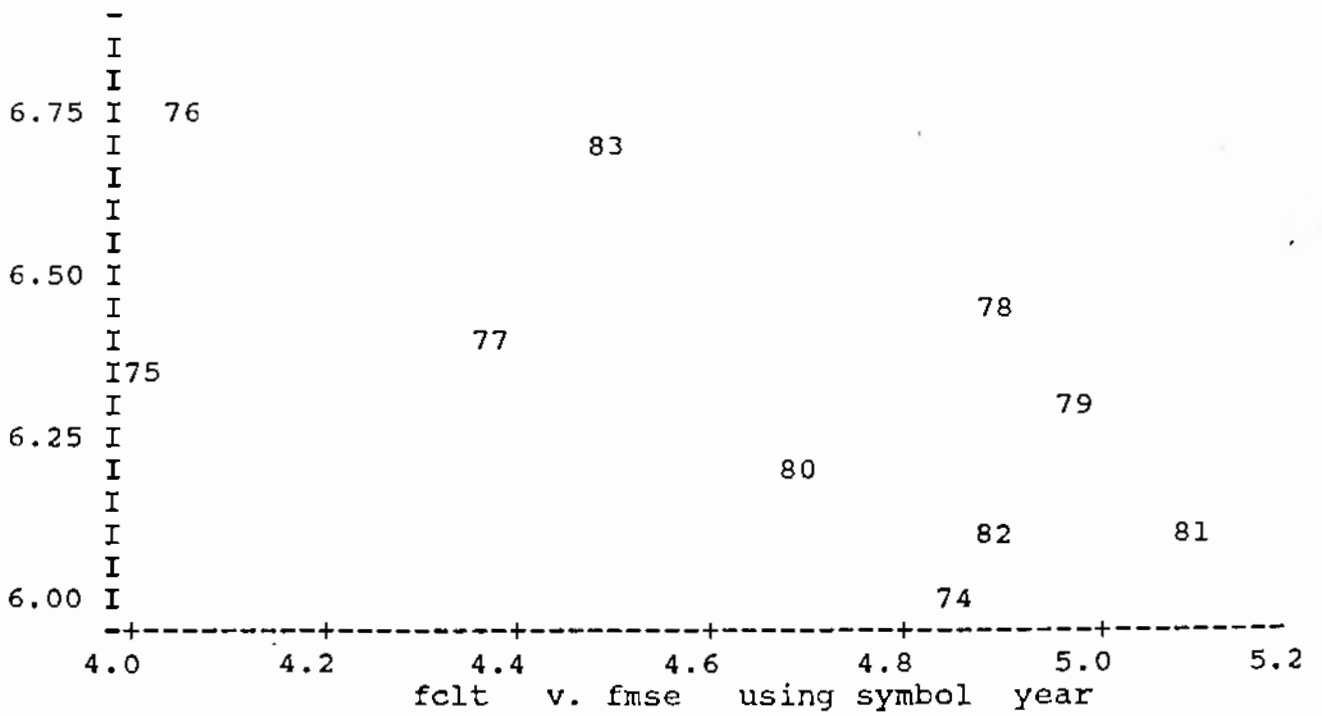
Table 4.4.2

Estimated Year Means

	<u>frep</u>	<u>fc1t</u>	<u>fmse</u>
74	4.01	6.02	4.84
75	6.39	6.36	4.02
76	6.40	6.75	4.05
77	6.82	6.42	4.37
78	3.83	6.44	4.89
79	6.20	6.28	4.96
80	6.34	6.22	4.68
81	7.22	6.11	5.07
82	7.74	6.11	4.88
83	6.61	6.72	4.49



points coinciding with point mo  
wn



#### 4.5 Digby Analyses

The Findlay-Wilkinson model (3.2.1) which was applied to the C×L tables could be used on any two-way table where we suspect that a significant interaction can be modelled as a linear regression on one of the margins. Thus for the L×Y tables we could possibly argue that different locations show different reactions over years; one location could be stable and give similar results in good or bad years whereas another location could be susceptible and vary markedly in good and bad years. The model would be

$$y_{jk} = \mu + \theta_j + \delta_j \omega_k + \epsilon_{ij} \quad (4.5.1)$$

where  $y_{jk}$  is an element of a L×Y table; and  $\delta_j$  is a regression coefficient for location  $j$ ; and  $\omega_k$  is a parameter for year  $k$ .

There is an added problem with the L×Y tables that did not arise with the C×L tables, i.e. the L×Y tables are incomplete. Digby (1979) looked at the generalization of the Findlay-Wilkinson analysis to non-orthogonal tables. We have programmed the Digby method and analysed the tables in Appendix F. Results seem to be difficult to interpret and we feel at this stage it would be premature to present any summaries in this report. It does seem that any conclusions would concur with those obtained from fitting margins as in Section 4.2.

## 5.1 Introduction

In the last Chapter we explained the reasons for concentrating on the  $L \times Y$  tables rather than the full  $C \times L \times Y$  table and why in that situation it was convenient to assume the cultivars within years to be random effects (with a mean shift incorporated into fixed year effects). Of course from the plant breeding point of view relative cultivar performances are important so some effort has to be made to estimate cultivar effects from a  $C \times Y$  table in spite of the very sparse nature of this table (see Table 1.3.2). Therefore we have decided to fit margins to the  $C \times Y$  table, but so that the estimation is reasonable we have restricted our attention to those cultivars that appear in at least three of the ten years of testing. This reduces the number of cultivars to 31 for most of the variates. In fitting margins to the  $C \times Y$  tables most of the points made in Section 4.2 about  $L \times Y$  tables are again relevant.

Results are presented in Tables 5.1.1 and 5.1.2 for estimated cultivar and year means respectively. Analysis of variance details are given in Table 5.1.3 along with the information we have already summarized in Table 4.2.3. We now have two estimates of the mean square for years, one from the  $L \times Y$  table and the other from the  $C \times Y$  table. Such awkward situations seem inevitable with a very sparse  $C \times L \times Y$  table; the different estimates for  $Y$  mean square have effectively come from different data sets, due to the elimination of poorly represented location on the one hand and cultivars on the other.

Table 5.1.1

Estimated Cultivar Means

	<u>boll</u>	<u>elon</u>	<u>leng</u>	<u>ltpc</u>	<u>lyld</u>	<u>mike</u>	<u>strg</u>	<u>unir</u>	<u>yain</u>	<u>yast</u>
dp16	4.99	8.02	1.16	37.6	1345	4.82	22.9	47.8	101	2255
dpsm	4.67	8.00	1.14	37.3	1309	4.80	22.8	48.2	102	2287
dpsl13	4.79	7.19	1.14	37.5	1284	4.78	22.8	47.9	101	2270
kim11	4.63	7.78	1.12	38.5	1343	4.76	22.1	48.1	101	2212
hop	5.75	5.67	1.13	37.3	1221	4.60	26.9	50.6	106	2697
gl06	4.52	5.82	1.11	33.7	1063	4.90	23.4	49.5	102	2353
m8sup	4.53	7.21	1.11	38.3	1181	4.54	22.1	46.7	100	2243
del277	5.19	7.83	1.18	37.5	1262	4.48	24.6	48.8	106	2510
st7A	4.67	6.26	1.15	36.6	1274	4.82	22.5	48.4	101	2287
st7Ane	4.58	5.61	1.13	36.4	1268	5.06	22.6	49.0	102	2302
basml	4.75	6.47	1.19	36.4	1174	4.19	23.8	46.9	100	2481
ac70	5.27	5.31	1.16	37.9	1225	4.32	26.1	48.9	104	2653
nam	5.39	5.12	1.18	36.2	1302	4.63	28.2	48.7	102	2881
cr79	5.22	5.87	1.14	35.7	1164	4.75	22.2	47.8	102	2268
cr74	5.39	5.74	1.14	35.7	1188	4.72	22.2	47.4	100	2265
rexsm	5.33	6.40	1.12	35.6	1246	4.63	21.6	48.3	102	2200
h62	4.58	6.59	1.18	33.9	1197	4.69	23.9	48.1	102	2427
han	5.22	6.29	1.12	37.1	1225	4.57	22.8	48.7	101	2340
mcn1032	4.57	6.72	1.10	36.9	1291	4.87	23.7	49.7	103	2393
rivg	4.66	6.02	1.02	33.9	1055	4.93	21.9	49.7	99	2167
dp61	4.78	7.66	1.15	39.3	1431	5.09	23.0	48.7	100	2242
tamsp37	4.97	7.41	1.12	37.9	1241	4.32	22.0	48.0	101	2226
m8	4.88	7.03	1.12	37.0	1246	4.55	22.3	47.8	100	2241
c310	4.81	6.63	1.21	38.1	1343	4.82	23.8	47.8	100	2399
mcn220		5.88	1.14	38.6	1412	4.86	24.3	48.9		
sicot2		7.44	1.16	38.7	1422	4.91	22.9	48.1		
sicot1		7.62	1.17	38.8	1420	4.92	22.7	47.1		
dp55		6.17	1.15	39.7	1440	4.78	23.0	47.1		
c315		6.57	1.20	40.3	1454	4.85	25.1	48.9		
dp41			1.16	40.4	1446	4.79	23.2	47.4		
n40439h			1.15	40.3	1522	4.74	22.6	46.8		

	<u>boll</u>	<u>elon</u>	<u>leng</u>	<u>ltpc</u>	<u>lyld</u>	<u>mike</u>	<u>strg</u>	<u>unir</u>	<u>yain</u>	<u>yast</u>
74	5.10	9.45	1.16	38.2	1421	4.60	22.2	45.7	103	2122
75	5.23	10.06	1.14	40.4	1151	4.15	21.1	45.9	97	1833
76	5.12	9.38	1.14	38.7	1036	4.22	21.8	44.7	102	1995
77	5.55	9.40	1.13	38.3	1211	4.55	21.6	44.0	111	2143
78	5.08	9.23	1.16	37.8	1552	3.93	21.4	43.2	101	2149
79	5.14	9.50	1.12	38.6	1561	4.59	21.4	43.5	105	2081
80	4.77	9.50	1.15	38.1	1437	4.60	22.8	44.0	112	2245
81		9.68	1.13	39.4	1679	4.25	22.3	43.0	106	2179
82		9.27	1.14	39.3	1792	4.45	21.9	42.7		
83			1.13	37.6	1588	3.48	22.3	42.7		

Table 5.1.3

Summary of Stratum Error Terms\*

	$Y^{\dagger}$	$Y^{\dagger\dagger}$	C**	L**	C×Y	L×Y	C×L	Residual
boll	1.07	0.54	0.56	0.86	0.02	0.17	0.10	0.07
elon	0.83	0.64	3.83	0.28	0.04	0.09	0.13	0.09
leng	3.33	1.72	4.81	2.12	0.05	0.51	0.32	0.16
ltpc	22.07	10.97	9.95	4.51	0.18	2.11	0.71	0.48
lyld	144.40	59.52	3.28	19.13	0.29	7.73	1.28	0.41
mike	15.27	9.38	1.83	2.48	0.08	1.25	0.45	0.22
strg	5.80	4.50	13.89	2.84	0.08	0.76	0.54	0.29
unlr	25.00	9.02	3.67	5.04	0.14	1.04	0.61	0.37
yain	40.72	15.69	1.29	2.31	0.35	1.56	1.49	1.04
yast	25.82	9.06	17.47	2.62	0.19	1.08	0.85	0.40

\* scaled as in Table 2.3.1

\*\* after fitting year

† from C×Y

†† from L×Y

The numbers in Table 5.1.3 must be taken only as a rough guide to sources of variation. Nothing more is possible considering the way the first six columns of the table have been obtained. However it does seem that the C Y interaction term is much smaller than the L Y interaction term. Although the coefficients for the components of variance could only be guessed at in this situation, it looks like there are more differences in behaviour of locations over years than with cultivars. We note also that the variation in the main effects of years is in general the largest single contributor to the total sum of squares in an overall analysis of variance (i.e. if one could have been done).

The means in Table 5.1.1 are probably most easily interpreted by producing rankings; this is done in Table 5.2.1. It may be possible to relate these rankings to the genetic makeup of the cultivars, for example for lyld and scrg, the deltapine cultivars have grouped together, as have sicot1 and sicot2 for a number of variates. Plant breeders may pick up other meaningful associations. We must bear in mind in looking at Table 5.2.1 that two thirds of the cultivars are not listed because they were used in less than three years of trials, so to try and gauge their performance it would be necessary to go back to the particular years where they were present. It would be reasonable to use the estimated year means from Table 5.1.2 to make an adjustment to the cultivars not included in Table 5.1.1 and thereby slot them into the Table 5.2.1. We have not tried this exercise.

Table 5.2.1

## Ranking Estimated Cultivar Means

boll	elan	leng	ltpc	lyld	mike	strg	unir	yain	yast
hop	dp16	c310	dp41	n40439h	dp61	nam	hop	del277	nam
nam	dpsm	c315	n40439h	c315	st7Ane	hop	rivg	hop	hop
cr74	del277	basml	c315	dp41	rivg	ac70	mcn1032	ac70	ac70
rexsm	kim11	del277	dp55	dp55	sicot1	c315	gl06	mcn1032	del277
ac70	dp61	nam	dp61	dp61	sicot2	del277	st7Ane	rexsm	basml
cr79	sicot1	h62	sicot1	sicot2	gl06	mcn220	c315	nam	h62
han	sicot2	sicot1	sicot2	sicot1	mcn1032	h62	ac70	st7Ane	c310
del277	tamp37	sicot2	mcn220	mcn220	mcn220	c310	mcn220	h62	mcn1032
dp16	m8sup	dp41	kim11	dp16	c315	basml	del277	cr79	gl06
tamp37	dpsl13	ac70	m8sup	kim11	st7A	mcn1032	nam	gl06	han
m8	m8	dp16	c310	c310	dp16	gl06	han	dpsm	st7Ane
c310	mcn1032	dp61	tamp37	dpsm	c310	dp41	dp61	tamp37	st7A
dpsl13	c310	n40439h	ac70	nam	dpsm	dp55	st7A	dp16	dpsm
dp61	h62	st7A	dp16	mcn1032	dp41	dp61	rexsm	han	dpsl13
basml	c315	dp55	del277	dpsl13	dp55	dp16	dpsm	st7A	cr79
dpsm	basml	cr74	dpsl13	st7A	dpsl13	sicot2	h62	dpsl13	cr74
st7A	rexsm	mcn220	hop	st7Ane	kim11	dpsm	sicot2	kim11	dp16
rivg	han	cr79	dpsm	del277	cr79	han	kim11	m8	m8sup
kim11	st7A	dpsl13	han	m8	n40439h	dpsl13	tamp37	basml	dp61
h62	dp55	dpsm	m8	rexsm	cr74	sicot1	dpsl13	cr74	m8
st7Ane	rivg	hop	mcn1032	tamp37	h62	n40439h	cr79	m8sup	tamp37
mcn1032	mcn220	st7Ane	st7A	ac70	rexsm	st7Ane	dp16	dp61	kim11
m8sup	cr79	tamp37	basml	han	nam	st7A	m8	c310	rexsm
gl06	gl06	kim11	st7Ane	hop	hop	m8	c310	rivg	rivg
	cr74	rexsm	nam	h62	han	cr79	cr74	cr74	
	hop	han	cr74	cr74	m8	cr74	dp41	dp41	
	st7Ane	m8	cr79	m8sup	m8sup	kim11	dp55	dp55	
	ac70	m8sup	rexsm	basml	del277	m8sup	sicot1	sicot1	
	nam	gl06	rivg	cr79	tamp37	tamp37	basml	basml	
		mcn1032	h62	gl06	ac70	rivg	n40439h	n40439h	
		rivg	gl06	rivg	basml	rexsm	m8sup	m8sup	

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