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Cape broccoli and winter hardy
cauliflowers; improving survival and
reducing risk of crop losses.

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AUTHENTICATION

I declare that this work was done under my supervision according to the procedures described herein and that this report represents a true and accurate record of the results obtained.

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(on behalf of Dr M R Shipway,
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Summary

Winter hardy cauliflower, Lincoln County 'A' and Inca, and Cape broccoli supplied by Tozer were grown from seven planting dates from mid-June to late August. Two thirds of the trial was covered using Agryl P30 from December, one third was left uncovered. Covers were removed from half the plots on 28 February and half on 16 March. Winter losses and crop performance were recorded.

In non-covered treatments planting in June increased winter losses compared to conventional mid-July planting but later planting reduced it. Planting in mid-August reduced winter losses and increased marketable yield and percent Class 1 heads. Later planting reduced quality as plants were small. Covering increased winter losses possibly due to increased physical damage from cover movement or by modifying the microclimate beneath them. Inca was less susceptible to winter losses than Lincoln County 'A'. Cape broccoli performance was poor, producing a high proportion (86%) of buttons in the crop, but winter losses were low.

These results are from one growing season and should be treated with caution.

Introduction

An estimated 5500ha of winter hardy cauliflowers are grown in England and Wales mostly in Lincolnshire, Cornwall and Kent. Winter losses of plants due to low temperature reduces the final yield and so may upset scheduling and projected supplies, and thus makes the crop less profitable. Two areas of crop technology were investigated in this trial to reduce the level of winter losses in winter hardy cauliflower and cape broccoli, the use of covers and manipulation of sowing and planting dates.

Polythene and polypropylene covers are widely used to protect newly planted crops against cool growing conditions in early spring (eg potatoes, cauliflowers, lettuce) or overwinter (eg carrots). In this trial polypropylene (Agryl P30) covers were used from late autumn to early spring to protect the growing crop from frost damage. It was also envisaged that smaller plants, from later planting, could be overwintered at less risk from frost damage, and under covers these plants would grow more quickly in the early spring to produce heads at the normal time. By using a factorial experimental design seven planting dates of three varieties were grown with and without covers so a straightforward assessment of planting date could be made.

Materials and methods

Cultivations

Seeds of cultivars Cape broccoli (Tozers), and winter hardy cauliflowers Lincoln County 'A' and Inca were sown on seven dates from 24 April to 10 July 1991 (see table 1) in GPG 308 modular trays. They were chitted for two days at 20°C and then transferred to an unheated Venlo glasshouse. Plants were raised to a good commercial standard, using liquid feeds of 100: 200 mg/l N : K₂O up to three times a week. Planting dates are given in table 1.

The whole trial area was fertilised and worked prior to the first planting. The trial was laid out as a split plot design with planting date as the main plots, covering as sub plots and varieties as sub-sub plots. There were three replicates.

Table 1. Sowing and planting dates

Treatment	sowing date	planting date
Mid June	24 April	13 June
Late June	8 May	26 June
Mid July	29 May	15 July
Late July	12 June	31 July
Early August	19 June	7 August
Mid August	28 June	19 August
Late August	10 July	28 August

Varieties:

Cape broccoli
 Lincoln County 'A'
 Inca

Covering treatments:

Covered with Agryl P30 December, removed 28 February
 Covered with Agryl P30 December, removed 16 March
 Not covered.

The trial was planted by hand at 610mm between row spacing by 460mm within row spacing. Each sub-sub plot consisted of two rows of 17 plants, 30 of which were recorded. To avoid the edge effects of covering small plots, as many adjacent plots

as possible were covered under a single continuous sheet. At the February uncovering, the covers were cut and rolled back to expose those plots only. Meteorological records are routinely kept at this site and temperature records for November to February (incl) are given (Appendix 1). The crop was grown to a good commercial standard using the husbandry described in Appendix 2.

Recording

Harvesting began on 4 March and finished on 5 May. Each plot was inspected twice a week to check for maturity. A curd was considered marketable when it reached the minimum marketable size of 110mm diameter. Where smaller curds were exposed by the parting of the inner leaves these were left to see if they would eventually reach the marketable size. At this time it was graded according to EC standards (class 1, class 2 or unmarketable) and sized (marketable heads size 4 = 110-129mm, size 5 = 130-149mm, size 6 = 150-169mm, size 7 >170mm). Yield was calculated as crates per hectare with each crate containing 12 heads. Reasons for downgrading from Class 1 to Class 2 or from Class 2 to unmarketable were recorded, a maximum of two defects per curd being recorded.

Dates for percentage crop cut were calculated on a basis of marketable curds cut, unmarketable curds were not included.

Statistical analysis

All data were subjected to analysis of variance where appropriate. Percentages were transformed using the angular transformation before analysis. Differences discussed below are significant at $p < 0.05$.

Results

General results

Yield and quality was disappointing in this trial. The covering of early planted treatments resulted in a high level of winter losses (ie judged to be frost killed) and the Cape broccoli did not perform well. The Cape broccoli, although not particularly prone to frost damage (6.5% frost killed), produced mainly undersized curds (86% buttons) and as a result produced very few marketable curds. Cape broccoli was excluded from the analysis of marketable produce, comments on its performance are given later.

Frost killed

Percentages of frost killed plants are given in Table 2. All three factors; variety, planting date and covering affected the number of frost killed plants.

Lincoln County 'A' was more prone to frost damage than Inca and was more variable in its response to planting date and covering treatments, ranging from 1.1 to 62.2% whereas Inca ranged from 0 to 32.2%. Early planting also increased the percentage of frost killed plants. Planting earlier than, the conventional, mid July increased the percentage of frost killed plants and planting in early August reduced it; planting in mid and late August reduced it to low levels overall (3-4%).

Covering increased the percentage of frost killed plants, but there was no difference between the two removal dates. Covering early planted treatments was more damaging than for later plantings with the first two plantings of Lincoln County 'A' being particularly badly affected.

Table 2. Percentage of plants frost killed, analysed as angle transformed data, as shown in parenthesis.

Variety/ planting date	Covering			
	Feb Removal	Mar Removal	Not Covered	Mean
Lincoln County A				
Mid June	61.1 (52.2)	52.2 (46.3)	33.3 (35.1)	48.9 (44.5)
Late June	55.6 (48.3)	62.2 (52.9)	33.3 (35.0)	50.4 (45.4)
Mid July	38.9 (37.8)	20.0 (26.5)	15.6 (22.7)	24.8 (29.0)
Late July	18.9 (24.9)	38.9 (37.0)	7.8 (15.6)	21.9 (25.8)
Early Aug	18.9 (24.6)	17.8 (24.0)	4.4 (9.7)	13.7 (19.4)
Mid Aug	5.6 (10.7)	10.0 (17.8)	2.2 (7.0)	5.9 (11.8)
Late Aug	4.4 (9.7)	3.3 (6.1)	1.1 (3.5)	3.0 (6.4)
mean	29.1 (29.7)	29.2 (30.1)	14.0 (18.4)	24.1 (26.1)
Inca				
Mid June	32.2 (35.6)	23.3 (27.8)	7.2 (14.8)	20.9 (25.4)
Late June	8.9 (16.5)	12.2 (19.6)	5.6 (10.7)	8.9 (15.6)
Mid July	23.3 (28.1)	15.6 (21.7)	6.7 (12.1)	15.2 (20.6)
Late July	5.6 (10.7)	13.3 (18.8)	3.3 (8.5)	7.4 (12.6)
Early Aug	5.6 (13.5)	7.8 (9.6)	4.4 (10.0)	5.9 (11.0)
Mid Aug	2.2 (5.0)	2.2 (7.0)	0 (0)	1.5 (4.0)
Late Aug	2.2 (7.0)	4.4 (12.0)	5.6 (8.0)	4.1 (9.0)
mean	11.4 (16.3)	11.3 (16.6)	4.7 (9.2)	9.1 (14.0)
Mean				
Mid June	46.7 (42.9)	37.8 (37.0)	20.3 (24.9)	34.9 (35.0)
Late June	32.3 (32.4)	37.2 (36.2)	19.5 (22.8)	29.7 (30.5)
Mid July	31.1 (32.9)	17.8 (24.1)	11.2 (17.4)	20.0 (24.8)
Late July	12.3 (17.8)	26.1 (27.9)	5.6 (12.1)	14.7 (19.2)
Early Aug	12.3 (19.0)	12.8 (16.8)	4.4 (9.8)	9.8 (15.2)
Mid Aug	3.9 (7.8)	6.1 (12.4)	1.1 (3.5)	3.7 (7.9)
Late Aug	3.3 (8.3)	3.9 (9.1)	3.4 (5.8)	3.6 (7.7)
Mean	20.3 (23.0)	20.3 (23.4)	9.4 (13.8)	16.6 (20.1)
LSD 5%	Variety -(2.62) *** cover -(4.93) *** pdate -(6.95) *** pdate x cover -(12.72) NS pdate x var -(8.50) *** cover x var -(5.88) NS pdate x cover x var -(15.29)NS			

Significance levels: * p<0.05, **p<0.01, *** p<0.00, NS not significant at p<0.05

Yield and quality

For Lincoln County 'A' and Inca the percentage of plants producing marketable and class I heads showed opposite trends to the percentage of frost-killed ones (Table 3). The only other major cause of unmarketable curds was undersized curds (buttons) which was not greatly affected by variety or planting date, although uncovered plots produced 6% more buttons in Inca and 12% more buttons in Lincoln County 'A' (Table 4). In general, 10-20% of the crop was Class 2, regardless of treatment, and the percentage of Class I heads varied most with treatment (Table 5).

Inca produced more Class I heads than Lincoln County 'A' over the whole trial. Covering the crop overwinter reduced the number of Class I heads significantly in both varieties, removal in February was less damaging than March removal. Growing Inca without covers consistently produced high yields of Class I heads except from the first planting date. However, Lincoln County 'A' grown from a mid August planting without covers produced the highest percentage of Class I heads in the trial.

Very late planting (late August) reduced the overall quality, as seen in more medium depth curds and a higher proportion of smaller curds from this planting date in both varieties (Tables 6 + 4). These plants were very small throughout the winter, they did not even give full ground cover and did not have a large framework of leaves when the curd was produced.

Table 3 Marketable yield, in crates per hectare and percentage marketable, presented by variety, planting and covering. Percentages analysed as angle transformed data as shown in parenthesis

Planting Date	Yield crates/ha			% Marketable		
	Lincoln County 'A'	Inca	Mean	Lincoln County 'A'	Inca	Mean
Mid June	984	1765	1375	33(34)	59(51)	46(42)
Late June	957	2035	1496	32(33)	69(57)	50(45)
Mid July	1672	1914	1793	56(49)	64(54)	60(51)
Late July	1540	2167	1853	52(46)	73(59)	63(53)
Early Aug	1815	2277	2046	61(52)	77(63)	69(57)
Mid Aug	2156	2255	2205	73(60)	76(62)	74(61)
Late Aug	1980	2420	2200	67(55)	82(65)	74(60)
Mean	1586	2119	1853	53(47)	71(59)	62(53)
LSD 5% variety	117.8 **			- (2.8) ***		
planting date	346.1 **			- (8.0) **		
planting date x variety	410.5 ***			- (9.5) **		
Covers						
Feb removal	1428	2046	1737	48(44)	69(57)	59(50)
Mar removal	1202	1886	1544	41(38)	64(53)	52(46)
Not covered	2128	2425	2277	72(59)	82(66)	77(62)
LSD 5% cover	199.3 ***			- (2.3) ***		
cover x variety	246.0 *			- (5.7) NS		

Table 4 Size of heads shown as buttons (under 110mm diam), Size 4 (110-130mm diam) and Size 5 (130-150mm diam) as percentages of plants planted. Percentages analysed as angular transformed data, as shown in parenthesis

Planting Date	% Buttons			% Size 4			% Size 5		
	C. Broc	Lincoln County 'A'	Inca	C. Broc	Lincoln County 'A'	Inca	C. Broc	Lincoln County 'A'	Inca
Mid June	80(64)	13(20)	11(19)	1(5)	21(27)	36(37)	0(0)	11(17)	22(26)
Late June	83(66)	12(20)	13(21)	3(5)	19(24)	34(35)	1(3)	12(18)	29(33)
Mid July	81(65)	13(19)	16(23)	1(3)	27(31)	38(38)	0(0)	21(27)	24(29)
Late July	88(70)	20(26)	12(20)	2(6)	23(28)	37(37)	0(0)	26(28)	30(32)
Early Aug	87(70)	18(25)	12(18)	3(7)	30(33)	39(38)	1(2)	25(30)	34(36)
Mid Aug	91(75)	16(20)	15(21)	3(5)	37(37)	32(35)	0(0)	31(33)	37(37)
Late Aug	92(76)	23(27)	7(13)	1(3)	45(42)	43(41)	0(0)	20(24)	34(35)
Mean	86(69)	16(22)	12(19)	2(5)	29(32)	37(37)	0(1)	21(25)	30(33)
LSD 5% variety planting date x variety	-(2.4) ***			-(2.5) ***			-(1.9) ***		
	-(6.3) ***			-(7.0) **			-(5.9) ***		
Covers									
Feb removal	87(71)	17(24)	12(19)	2(4)	27(30)	39(38)	0(1)	19(25)	27(31)
Mar removal	86(69)	24(28)	17(23)	0(2)	28(31)	38(38)	0(0)	12(17)	24(28)
Not covered	85(68)	8(15)	8(16)	4(9)	31(34)	34(35)	1(1)	32(34)	39(39)
LSD 5% cover x variety	-(4.2) ***			-(4.4) *			-(3.6) ***		

Table 5 Percentage of Class One heads (of plants planted), analysed as angular transformed data, as shown in parenthesis

Variety/ Planting date	Covering Feb removal	Mar removal	Not covered	Mean
Lincoln County 'A'				
Mid June	7(14)	16(22)	32(34)	18(24)
Late June	11(19)	12(17)	30(33)	18(23)
Mid July	30(32)	21(27)	52(46)	34(35)
Late July	32(34)	11(18)	68(55)	37(36)
Early Aug	31(34)	18(25)	59(50)	36(36)
Mid Aug	49(44)	33(35)	83(67)	55(49)
Late Aug	56(48)	34(36)	58(50)	49(45)
Mean	31(32)	21(26)	55(48)	35(35)
Inca				
Mid June	27(30)	39(38)	57(49)	41(39)
Late June	47(43)	48(44)	70(57)	55(48)
Mid July	46(42)	40(39)	63(53)	50(45)
Late July	62(52)	42(40)	66(54)	57(49)
Early Aug	64(54)	42(40)	71(58)	59(51)
Mid Aug	58(50)	42(40)	73(59)	58(50)
Late Aug	67(55)	54(48)	69(56)	63(53)
Mean	53(47)	44(41)	67(55)	55(48)
Mean				
Mid June	11(22)	18(30)	30(42)	30(31)
Late June	20(21)	20(30)	33(45)	36(36)
Mid July	25(37)	20(33)	39(50)	42(40)
Late July	31(43)	18(29)	44(55)	47(42)
Early Aug	32(44)	20(33)	43(54)	48(43)
Mid Aug	36(47)	25(38)	53(63)	57(49)
Late Aug	41(52)	30(42)	42(53)	56(49)
Mean	42(39)	32(36)	61(52)	45(42)
LSD 5%	Variety - (2.49)*** Cover -(4.15)*** pdate -(5.3)*** pdate x cover -(10.42) NS pdate x var -(7.08)** cover x var -(5.15)* pdate x cover x var -(13.18) NS			

Table 6 Quality records, percentages of loose, deep and medium heads, analysed as angular transformed data as shown in parenthesis.

Planting Date	% Loose			% Deep			% Medium		
	Lincoln County 'A'	Inca	Mean	Lincoln County 'A'	Inca	Mean	Lincoln County 'A'	Inca	Mean
Mid June	2 (5)	3 (9)	3 (7)	29 (31)	47 (43)	38 (37)	5 (10)	12 (20)	10 (15)
Late June	1 (2)	3 (8)	2 (5)	29 (31)	56 (49)	43 (40)	3 (5)	12 (20)	8 (13)
Mid July	3 (8)	3 (7)	3 (8)	49 (44)	46 (43)	48 (44)	7 (12)	18 (25)	13 (18)
Late July	6 (11)	6 (11)	6 (11)	42 (40)	47 (43)	45 (41)	10 (18)	26 (30)	18 (24)
Early Aug	7 (14)	7 (15)	7 (15)	42 (40)	49 (44)	46 (42)	19 (25)	28 (32)	24 (28)
Mid Aug	13 (19)	13 (19)	13 (19)	46 (42)	47 (43)	47 (43)	26 (30)	29 (32)	28 (31)
Late Aug	16 (23)	11 (18)	21 (20)	36 (34)	40 (39)	38 (37)	30 (32)	41 (40)	36 (36)
mean	7 (12)	7 (12)	7 (12)	39 (38)	48 (44)	44 (41)	14 (19)	24 (28)	19 (24)
LSD 5% variety planting date			-(2.8) NS			-(2.3) ***			-(2.3) ***
planting date x variety			-(5.3) ***			-(6.5) NS			-(4.9) ***
			-(7.4) NS			-(7.8) ***			-(6.5) NS
Covers									
Feb removal	6 (11)	7 (13)	7 (12)	34 (35)	44 (42)	39 (39)	13 (18)	25 (29)	19 (24)
Mar removal	9 (14)	9 (15)	9 (14)	21 (25)	37 (37)	29 (31)	19 (23)	26 (30)	23 (26)
Not covered	6 (11)	4 (9)	5 (10)	61 (52)	61 (52)	61 (52)	10 (16)	20 (26)	15 (21)
LSD 5% cover cover x variety			-(2.8) *			-(3.8) ***			-(2.8) **
			-(4.4) NS			-(4.7) ***			-(3.9) NS

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Harvest Dates

Lincoln County 'A' was seven days earlier to cut than Inca (Table 7) but both varieties had the same length of cut. Early planting advanced the 50% cutting date by up to eight days. Planting earlier than the conventional mid July did not advance cutting but later planting delayed it. Early planting increased the length of cutting for both varieties. Covering advanced cutting by two to three days.

Table 7 Harvest dates, date of 50% of marketable heads cut and length of cutting of marketable heads.

Planting date	50% cut date			Length of cut (days)		
	Lincoln County 'A'	Inca	Mean	Lincoln County 'A'	Inca	Mean
Mid June	7 April	16 April	11 April	17.7	15.5	16.6
Late June	9 April	16 April	12 April	16.4	13.7	15.1
Mid July	8 April	16 April	12 April	14.0	11.8	12.9
Late July	11 April	18 April	14 April	12.8	11.7	12.3
Early Aug	11 April	19 April	15 April	12.3	13.2	12.8
Mid Aug	13 April	20 April	16 April	9.3	12.5	10.9
Late Aug	17 April	21 April	19 April	9.1	12.7	10.9
mean	11 April	18 April	14 April	13.1	13.0	13.1
LSD 5% variety			0.7 ***			1.1 NS
planting date			1.6 ***			2.8 *
variety x planting date			2.1 NS			3.4 **
Covers						
Feb removal	11 April	18 April	14 April	13.0	12.9	12.9
Mar removal	9 April	17 April	13 April	13.3	13.1	13.2
Not covered	12 April	19 April	16 April	12.9	13.1	13.0
LSD 5% cover			1.0 ***			1.5 NS
cover x variety			1.3 NS			2.0 NS

Cape broccoli

Cape broccoli produced virtually no marketable heads above 11cm diameter in this trial. A large proportion, up to 92% of the crop was undersized, (ie button). A small proportion of the crop was frost killed, with later planting dates being less affected than earlier plantings.

The crop was cut from 4 March until 10 April but no dates for 50% cutting or length of cut are presented as these have to be based on marketable heads only.

Discussion

The aim of the trial was to reduce winter losses in overwintered cauliflower by protecting the normal crop with covers or by altering the growth pattern. It was envisaged that later planted, smaller plants might survive the winter under covers and, with the protection of covers, could grow away faster in the spring. By using a spread of planting dates, plants went into the winter at very different sizes

however there was very little growth in December to February, even with covers, and so these differences were maintained. In the spring, late planted treatments were producing curds from quite small plants, hence the loss of quality from the last planting.

The use of covers actually increased the number of frost-killed plants compared to the non-covered plots. This was particularly so from the earlier plantings where the larger plants may have suffered more damage from the covers than the smaller plants. Frost-killed plants fall into two categories those killed outright by frost and those that appear to die due to rotting of the main stem. It is assumed that this occurs because pathogens enter the plant at points of damage, either from frost or physical damage. Covering may have caused more of the second type, due to physical damage from the movement of the covers or by creating a microclimate more conducive to pathogen growth.

In this trial winter losses for Lincoln County 'A' on non-covered plots were less from mid August planting than from the conventional mid July planting. The percentage marketable and class 1 heads increased reflecting these lower losses. It may be that later planting would be one way of reducing winter losses. Earlier work on determining planting dates for overwintered cauliflower would have used bare root transplants whereas module raised plants are now widely used. It may be that these establish more quickly than the bare root transplants and this results in larger, more frost susceptible plants being overwintered. In this trial there was a four day delay in 50% cutting date from planting in mid August instead of mid July.

The performance of the Cape broccoli was very poor, it was not clear why this was so although the site where the trial was grown was on heavier silt and may not have been suitable for it. Satisfactory commercial crops are grown on lighter land in the area.

Conclusions

- 1) Covering increased winter losses from overwinter cauliflower.
- 2) Planting in June increased winter losses from covered and uncovered treatments.
- 3) Mid August planting reduced winter losses and increased percentage marketable and class 1 heads.
- 4) These results are based on one year's trial work and would need to be tested over several seasons before recommending a change in planting dates.
- 5) Inca was less susceptible to winter losses than Lincoln County 'A'.

Acknowledgements

Thanks are due to Mr A Clarricoates for technical assistance and to Mr A Whitlock for providing seed of Lincoln County 'A' and his advice on the conduct of the experiment during his visits to view the progress of it.

Recommendations

- 1) Consider alternative varieites for a similar project in the future, coupled with:-
- 2) a comparison of covering dates starting several weeks earlier than used in this trial.

APPENDIX 1 Daily temperatures (°C) measured from November to February

D A Y	NOVEMBER			DECEMBER			JANUARY			FEBRUARY		
	S C R E E N M A X	S C R E E N M I N	G R A S S M I X	S C R E E N M A X	S C R E E N M I N	G R A S S M I X	S C R E E N M A X	S C R E E N M I N	G R A S S M I X	S C R E E N M A X	S C R E E N M I N	G R A S S M I X
1	15.1	10.1	9.3	7.4	6.0	5.8	9.8	4.7	3.0	2.5	-0.2	-2.5
2	13.2	9.0	7.1	8.0	6.1	5.3	11.1	6.8	4.4	8.8	-1.2	-1.4
3	9.5	6.8	5.2	7.5	6.2	5.3	11.0	8.2	6.8	10.2	2.5	0.9
4	8.0	0.2	-5.2	7.0	5.9	5.0	7.1	3.5	1.3	11.2	2.4	-0.7
5	6.2	3.6	2.0	7.7	5.2	4.5	12.1	3.6	2.5	10.5	6.0	2.2
6	12.7	-0.1	-3.0	6.6	-0.3	-7.6	10.8	6.3	2.3	9.9	5.2	2.5
7	13.2	3.2	3.0	-0.2	-3.2	-7.9	10.4	4.5	2.8	6.5	4.2	1.9
8	10.1	7.4	5.4	2.5	-3.6	-10.0	11.3	5.4	4.6	6.8	0.5	0.1
9	7.4	2.4	-0.8	2.7	-5.6	-10.0	5.4	3.4	2.5	10.4	5.5	1.0
10	9.4	-2.1	-6.9	3.5	-2.3	-7.3	6.2	0.5	-2.3	7.7	0.6	-1.0
11	8.0	5.5	-0.2	-0.5	-3.1	-8.7	3.2	-3.4	-10.7	9.2	2.2	1.9
12	8.5	0.6	-2.0	-0.5	-7.8	-14.4	4.7	-2.4	-0.7	12.3	5.8	5.5
13	6.4	2.1	0.2	3.0	-6.6	-7.5	6.2	-0.1	-0.1	8.8	2.7	0.8
14	7.5	-0.2	-2.4	-0.5	-2.0	-2.0	2.9	-0.3	-7.1	9.5	2.5	0
15	8.9	1.0	-0.5	2.9	-3.5	-4.0	4.3	-2.0	-7.2	8.2	3.8	3.3
16	5.9	-1.1	-7.0	5.4	-1.5	-2.3	6.2	1.4	-0.1	5.1	1.6	0
17	7.1	-2.3	-6.0	9.4	2.7	2.7	4.2	0.5	-3.9	5.3	-0.7	-4.0
18	9.8	-1.5	-5.5	12.5	4.4	1.0	7.2	0.9	-5.5	2.8	-0.7	-5.1
19	6.9	6.7	5.6	12.7	4.3	3.1	8.2	1.0	-1.3	3.7	0.4	0
20	7.2	1.4	-1.2	9.1	2.0	0.1	4.7	4.5	3.2	7.5	0.1	-2.0
21	7.6	-1.6	-9.2	14.2	1.9	0.7	2.1	-0.7	-4.1	9.0	-0.2	-2.7
22	10.7	0	-0.4	14.2	9.1	8.3	2.7	-5.2	-14.6	10.0	2.0	1.0
23	9.9	5.5	3.4	13.1	9.6	5.5	0.5	-4.6	-12.0	12.1	4.2	3.9
24	9.3	3.8	1.8	6.2	1.3	-1.3	0.7	-1.3	-8.6	9.2	4.0	2.1
25	8.9	3.0	1.0	8.9	-1.5	-7.2	2.5	-4.5	-6.0	4.8	-2.7	-7.4
26	11.4	4.3	4.0	10.5	-0.5	-2.0	3.8	-0.8	-5.0	12.5	-1.6	-1.0
27	10.3	5.3	3.7	6.3	1.6	-0.9	2.9	-2.5	-9.2	13.8	2.9	3.1
28	11.7	7.9	7.0	6.7	1.3	-3.0	-0.3	-4.7	-10.6	8.6	3.5	-1.2
29	10.5	8.5	8.0	8.0	4.7	4.4	3.7	-4.0	-3.8	10.4	1.3	-3.5
30	7.0	6.0	4.0	6.2	4.3	-0.2	1.8	-2.0	-3.6			
31				7.6	4.5	4.0	1.4	0.4	0.6			

COMMERCIAL IN CONFIDENCE

APPENDIX 2 TRIAL CROP DIARY

Soil type

Previous cropping: 1990 Grass, 1989 Brassicas, 1988 Wheat

Soil Analysis: pH 7.5, P index 4, K index 2
soil mineral nitrogen (May 1991) 207kg/ha N index 1-2

Cultivations: Flat lifted October 1990.
Ploughed November 1990.

Fertilizer: base: 150kg/ha N, 25kg/ha P₂O₅, 200kg/ha K₂O

Planting: see treatments

Herbicide: Propachlor as 9l/ha Ramrod plus chlorthal-dimethyl as 6kg/ha
Dacthal applied after planting at each date.

Insecticides: Demeton-S-methyl as 560ml/ha Metasystox 55 plus cypermethrin
as 250ml/ha Ambush C in 600l water/ha applied 23 July, 1
August, 22 August, 12 September.
Demeton-S-methyl applied as above 23 October

Fungicides: Mancozeb and metalaxyl as 2kg/ha Fubol plus Chlorothalonil
as 2l/ha Bombardier applied 6 August, 11 November

Covering: covers applied 17 December (Rep 1), 24 December (Rep 2)
covers removed 28 February, 16 March 1992.

Harvesting: 4 March - 5 May 1992