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CONTRACT REPORT

No. AR/89/2

Comparison of film cover materials
and removal date for early
production of red lettuce
HDC ref no: FV/29/88
Year 2

Commercial - In Confidence

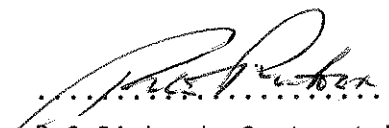
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AUTHENTICATION

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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Summary

Four varieties of red lettuce were sown in early February and propagated at either 12 or 18°C minimum glasshouse temperature. At planting on 20 March the plants were covered with Agryl P17, Polycrop Coverall 500, or Polycrop Coverall 500 over Agryl P17 (double cover) or left uncovered, or they were planted through a black polythene mulch with Agryl P17 film cover over the top of them. The film covers were removed after 3, 5 or 7 weeks for Polycrop Coverall 500 or 5, 7 or 8 (one week before expected harvest) weeks for the Agryl P17 treatments. The first heads were cut from under the double cover treatment because they were ready five days earlier than the lettuce under the single cover treatments, which in turn were about ten days ahead of the nil covered plants. The best cover removal dates, in terms of number of marketable heads, were after 5 or 7 weeks for the Polycrop Coverall 500 and Agryl P17 single covers as earlier removal generally reduced yield and delayed maturity. However, early removal of the Polycrop Coverall 500 in the double cover treatment was crucial otherwise severe leaf scorch or complete head loss occurred. Removing the Agryl cover a few days prior to the anticipated first harvest reduced the problem of loose and poorly coloured heads that occurred in 1988 when the covers remained on until the first harvest. The black polythene ground mulch controlled weeds very well but considerably reduced plant stands. The varieties Lotto (Lollo Rossa type), Kamino (oakleaf type) and Manto (butterhead type) all yielded well. Quattro Stagioni (butterhead type) suffered badly from leaf bronzing and speckling of the outer leaves. These results follow a similar pattern to those obtained in 1988 although maturity was a few days earlier in 1989 but the yields were generally slightly lower.



Objective

To assess the effect of temperature during propagation, type of film cover and removal date on maturity and yield of four varieties representing three types of red lettuce.

Introduction

Red lettuce types have been grown by the amateur gardener for many years but there has been a recent interest in commercial production, mainly in response to the supermarket requirement for an extensive range of salad crops.

The red lettuce group can be broadly divided into three main types - red butterhead, frilly Lollo Rossa and oakleaf type. The main market for the first two types is the fresh market, whereas the oakleaf types are only really suitable for processing as the large leaf area results in wilting within a short time of harvesting.

At present the husbandry of the crop is based on very limited Dutch information. This trial, now in its second year, is aimed at producing the crop as early as possible by evaluating two types of film covers with a range of uncovering dates. The effect on maturity, yield and quality will be assessed using varieties of each type.

Materials and Methods

Site

The trial was conducted on the Arthur Rickwood EHF on a loamy peat (30-66 cm) over sand and gravel. (Adventurers' Shallow).

Trial design

The trial consisted of four blocks with a different variety used for each block. The trial was therefore not designed to compare varieties, but rather to use them as a basis for the other studies. Combinations of propagation temperature and film covers formed the main plots. Each main plot was sub-divided into 3 sub-plots for the date of film cover removal. Each sub-plot consisted of 56 plants (7.1 m²). (See Appendix I).

Treatments

1. Film cover materials
 - a. Nil
 - b. Agryl P17 - a fibrous cover - 17 g/m²
 - c. Polycrop Coverall 500 - perforated polythene with 500 holes/m²
 - d. Polycrop Coverall 500 over Agryl P17 - double cover
 - e. Agryl P17 with a black polythene mulch - 38 micron thick

2. Cover removal date
 - a. 3 weeks
 - b. 5 weeks
 - c. 7 weeks
 - d. One week before expected first harvest.

a-c for film cover material treatments using Polycrop Coverall 500 (1c and 1d).

b-d for film cover material treatments using Agryl P17 (1b and 1e).

c for the Agryl P17 cover in the double film cover treatment (1d)

3. Temperature during propagation

- a. Germination at 18°C followed by 12°C glasshouse minimum
- b. Germination at 18°C followed by 18°C glasshouse minimum

4. Varieties

The trial was based on the varieties Lotto (Lollo Rossa type), Manto and Quattro Stagioni (red butterhead type) and Kamino (oakleaf type).

Husbandry

The trial was sown into peat blocks (4.3 cm) on 6 February and left in a cool environment for 24 hours. After this, all of the blocks were moved to a glasshouse with a minimum thermostat setting of 18°C. The propagation treatments were started once the plants had reached the fully expanded cotyledon stage when plants were either kept at 18°C or moved to 12°C, both with ventilation at 21°C. The plants were later placed at a minimum of 5°C with ventilation at 12°C prior to planting.

Base nitrogen at 50 kg/ha (100 kg/ha for Lotto) nitrogen was incorporated before planting with a pre-planting application of chlorpropham used for weed control except where the black polythene ground mulch was used.

The trial was planted on 20 March at a spacing of 300 x 300 mm.

The film covers were removed on the dates as shown in Table 1.

Table 1. Date of film cover removal.

Film cover	Cover removal date		
	First	Second	Third
Nil	-	-	-
Agryl P17	21 April	5 May	9 May
Polycrop 500	11 April	21 April	5 May
Polycrop 500 + Agryl P17*	11 April + 5 May	21 April + 5 May	5 May + 5 May
Agryl P17 + black polythene	21 April	5 May	9 May

* first date corresponds to Polycrop 500, and the second date refers to Agryl P17

Assessments

The plots were harvested as they matured with a minimum trimmed weight of 180 g and with a maximum of three harvests for each plot.

Statistical analysis

All the data was subjected to an analysis of variance using the computer programs developed by the Biometrics Department of the Institute of Horticultural Research - Wellesbourne. As Kamino was such a different form of lettuce this variety was treated separately from the other three varieties.

Results and Discussion

The exceptionally dry and mild weather in early March would have allowed a slightly earlier planting date than was achieved but it was felt more prudent to wait until 20 March to reduce the possible loss or damage to the plants due to frosts. At planting there were only slight differences between the two propagation regimes with those plants raised at 12°C marginally smaller but with a deeper red coloration than those grown at 18°C. Establishment was excellent for all treatments and encouraged by the very favourable soil and air temperatures after planting (Appendix III).

The differences in plant size at the various uncovering dates followed a similar pattern to that observed in 1988 when, at the first uncovering, the plants were still at a small stage but more advanced than those with a nil covering. As the uncovering date was delayed so the plants were larger but generally the leaves were less red, although the red coloration increased markedly within a week of uncovering.

Earliness of maturity is shown by the dates of 10% harvest (Table 2) with the dates of 25% harvest given in Table B, Appendix IV. The variety Kamino has not been included as it was difficult to determine head weight and so it was all harvested on one occasion.

Table 2. The dates of 10% harvest meaned across temperatures and varieties (except Kamino).

Film cover	Cover removal date		
	First	Second	Third
Nil	30 May	30 May	30 May
Agryl P17	26 May	20 May	18 May
Polycrop 500	23 May	21 May	19 May
Polycrop 500 + Agryl P17	15 May	16 May	30 May
Agryl P17 + black polythene	24 May	24 May	25 May

The first harvests were taken on 10 May from the Polycrop 500 + Agryl P17 double film cover treatment which also had the earliest 10% harvest date. The first heads were cut from the first and second uncovering dates of this treatment.

The number of marketable lettuces harvested are given in Table 3.

Table 3. Number of marketable lettuce (%) for all varieties (except Kamino).

Film cover	Cover removal date			Mean
	First	Second	Third	
<u>Propagation temperature 12°C</u>				
Nil	42	42	42	42
Agryl P17	77	67	72	72
Polycrop 500	65	76	63	68
Polycrop 500 + Agryl P17	55	55	25	45
Agryl P17 + black polythene	29	37	36	34
Mean	54	55	48	52
<u>Propagation temperature 18°C</u>				
Nil	52	52	52	52
Agryl P17	69	70	65	68
Polycrop 500	56	65	61	60
Polycrop 500 + Agryl P17	57	68	41	55
Agryl P17 + black polythene	46	48	45	46
Mean	56	61	54	56
Overall mean	55	58	51	54

CV %	17
SED (44 df) for comparing means of film covers	8.0
SED (44 df) for comparing overall means of cover removal dates	6.5
SED (44 df) for comparing all treatments (interactions)	9.2

The mean number of marketable lettuces harvested was 54%. The nil film cover treatment and Agryl P17 with black polythene yielded significantly ($P < .05$) lower than all the other treatments. The best covering appeared to be either Agryl P17 or the Polycrop 500 (70% and 64% respectively). There were no significant differences ($P < .05$) between the propagation temperatures or cover removal dates. However, there were significant interactions between film cover and removal date with all removals of the

Agryl covers, and the mid removal of the Polycrop 500 covers producing significantly ($P < .05$) higher percentages marketable than the uncovered control.

Lotto produced 62% marketable heads, Manto 60% and Quattro Stagioni 40%. The number of marketable Kamino, which were all cut on 23 May, are given in Table 4 combined for the two propagation temperature regimes.

Table 4. Number of marketable lettuce (%): Kamino.

Film cover	Cover removal date			Mean
	First	Second	Third	
Nil	34	34	34	34
Agryl P17	64	64	64	64
Polycrop 500	49	68	77	65
Polycrop 500 + Agryl P17	67	46	43	52
Agryl P17 + black polythene	32	49	45	42
Mean	49	52	53	51
CV %				29
SED (12 df) for comparing means of film covers				3.6
SED (12 df) for comparing means of cover removal dates				5.2

The mean number of marketable Kamino heads was 51%. The film cover treatments Agryl or Polycrop 500 produced significantly higher ($P < .05$) percentages of marketable heads than those covered with the double cover of Polycrop and Agryl, which, in turn, produced significantly ($P < .05$) more heads than the Agryl and black polythene or those that were not covered.

The head defects included lack of weight, rotting and speckling of leaves. The number of small heads is shown in Tables 5 and 6.

Table 5. Number of small heads (%) combined for varieties (except Kamino)

Film cover	Cover removal date			Mean
	First	Second	Third	
Nil	5	5	5	5
Agryl P17	0	2	2	1
Polycrop 500	2	2	0	1
Polycrop 500 + Agryl P17	0	0	2	1
Agryl P17 + black polythene	15	14	20	16
Mean	4	5	6	5

CV % 124
 SED (44 df) for comparing means of film covers 3.7
 SED (44 df) for comparing means of cover removal date 3.1

The mean number of small heads was low at only 5%. The nil film cover treatment and the Agryl P17 and black polythene had significantly ($P < .001$) higher numbers of underweight heads than all the other cover treatments. There were no significant ($P < .05$) differences between the three cover removal dates. The varieties Lotto, Manto and Quattro Stagioni all gave similar results with the results for Kamino given below.



Table 6. Number of small heads (%) of Kamino.

Film cover	Cover removal date			Mean
	First	Second	Third	
Nil	56	56	56	56
Agryl P17	26	26	26	26
Polycrop 500	41	22	11	25
Polycrop 500 + Agryl P17	22	44	47	38
Agryl P17 + black polythene	32	26	24	27
Mean	35	35	33	34

CV %	43
SED (12 df) for comparing means of film covers	3.1
SED (12 df) for comparing means of cover removal date	4.9

The mean number of small Kamino heads was 34%. There were significant ($P < .001$) differences between the cover treatments with the nil cover resulting in more small heads than any other treatment. However, it should be borne in mind that all the Kamino was harvested on the same day so the results indicate the effect of the cover treatment on maturity rather than future potential yields. The number of rotten heads (Appendix V) was low (mean 3%) and similar ($P < .05$) for all the film cover and cover removal treatments. The red butterhead types (Manto and Quattro Stagioni) had on average 2% rotten heads, Lotto had 6% whilst Kamino had none.

The other disorder observed at harvest was a bronzing and speckling on the leaves which was thought to be due to cold stress produced during early May. The results for the varieties Manto, Quattro Stagioni and Lotto are shown in Table 7.

Table 7. Number of heads (%) downgraded due to leaf speckling or leaf scorch (except Kamino).

Film cover	Cover removal date			Mean
	First	Second	Third	
Nil	40	40	40	40
Agryl P17	17	21	20	19
Polycrop 500	29	18	27	25
Polycrop + Agryl P17	30	27	56	38
Agryl P17 + black polythene	29	28	21	26
Mean	29	27	33	30

CV %	34
SED (44 df) for comparing means of film covers	7.2
SED (44 df) for comparing means of cover removal date	5.9
SED (44 df) for comparing all treatments (interactions)	11.2

The mean number of heads downgraded due solely to leaf speckling was 30%. There were no significant ($P < .05$) differences between the film covering treatments or cover removal dates. However, there were significant ($P < .001$) interactions with all removals of Agryl, the second removal of the Polycrop 500 and the late removal of the Agryl + black polythene producing lower percentages than the non-covered controls. The late removal of the Polycrop 500 + Agryl P17 double cover produced a high percentage of heads that were badly scorched.

There were significant ($P < .001$) differences between the varieties with Lotto producing 17% speckled heads, Manto with 26% and Quattro Stagioni with 46%.

The number of missing plants (Appendix VII) was nil for all the film cover treatments except where black polythene had been used. The use of the plastic as a mulch reduced plant numbers by on average 26% across all

the varieties although weed control was good. The reason for the reduced plant stands was that the plants often got trapped beneath the plastic and then rotted.

The results for the mean head weights were similar (mean 261 g) and are given in Appendix VII.



Conclusions

1. Temperature of 12 and 18°C during propagation had no differential effect on plant growth post planting, and there was no bolting in any treatment.
2. The first heads were cut on 10 May from the double cover of Polycrop 500 and Agryl P17, when the Polycrop was removed after 3 or 5 weeks and the Agryl P17 removed in May, an advance of maturity of 15 days over the non-covered plots.
3. Maturity was advanced by up to 12 days when using a single film cover, with the later removal dates producing the earliest heads.
4. Failure to remove the Polycrop 500 in the double cover treatment by late April caused severe plant damage and thereby reduced yields.
5. The black polythene ground mulch prevented weed growth but reduced plant numbers by 26% as many plants failed to keep above the plastic. The ground mulch was not as successful for Kamino as it had been in 1988.
6. The Lollo Rossa variety Lotto yielded much better in 1989 than in the previous year and appeared to benefit from the higher rate of nitrogen used (100 kg/ha N). The variety Manto yielded well but Quattro Stagioni was very susceptible to bronzing and speckling of the leaves which reduced yields considerably. Kamino of the oakleaf type again proved very suitable for this early production period.

Recommendations for future action

Future R and D

1. The trial should be repeated under more normal spring conditons with necessary amendments to the least successful treatment.
2. The main market demand at present is for the Lollo Rossa type so new as well as existing varieties should be tested for their suitability to early outdoor production.
3. Temperatures and the concentration of oxygen and carbon dioxide should be measured under film covers so as to determine and overcome the cause of crop failure when the double cover combination of Polycrop 500 over Agryl P17 was left on until early May, and thereby achieve the full potential from this treatment.
3. The use of black polythene as a ground mulch to suppress weeds needs further evaluation with the system redesigned to prevent plant loss at establishment.

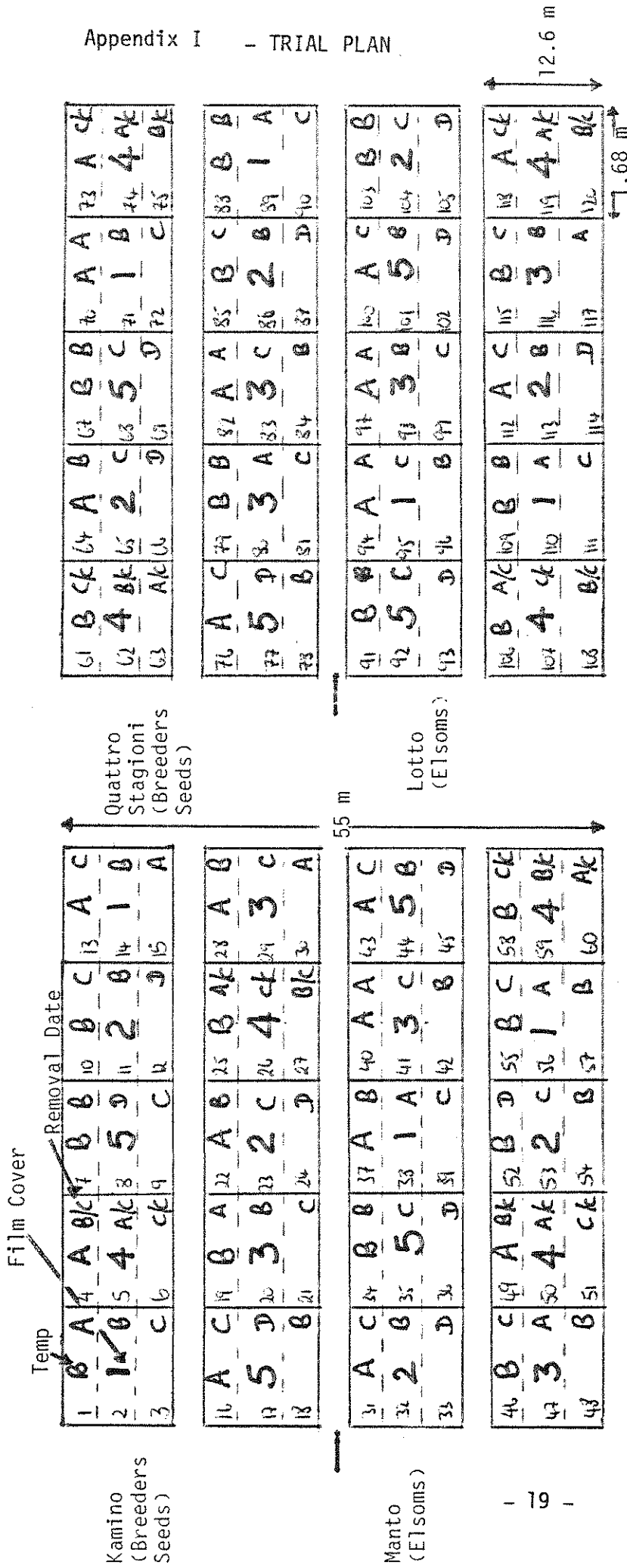
Acknowledgement

The co-operation of Andrew Mead in the Biometrics Department of the Institute of Horticultural Research, Wellesbourne, was much appreciated.

Storage of data

The raw data will be stored by ADAS at Arthur Rickwood EHF, Mepal, Ely, Cambs CB6 2BA for a period of 10 years. The Horticultural Development Council will be consulted before disposal of the data.

Appendix I - TRIAL PLAN



- Temp (post emergence)**
- 12°C
 - 18°C
- Spacing**
300 x 300 mm
- Harvest**
10 plants x 4 rows = 40 plants
- Film cover**
1. Nil
 2. Agryl P17
 3. Polycrop 500
 4. Polycrop 500 + Agryl P17
 5. Agryl P17 + black polythene
- Cover removal date**
- 3 weeks
 - 5 weeks
 - 7 weeks
 - One week before first harvest

APPENDIX II

Crop Diary

Cultivations	4 January	plough and furrow press
	8 March	power harrow
	9 May	hoed nil covered plots only
Propagation	6 February	all seed sown in peat blocks
	7 February	all moved to 18°C
	15 February	plants moved to appropriate propagation temperature
	6 March	all placed at 5°C
Husbandry	20 March	planted
	11 April	first removal date of Polycrop Coverall 500
	21 April	second removal date of Polycrop Coverall 500 and first for Agryl P17
	5 May	final removal date of Polycrop Coverall 500 and second for Agryl P17
	9 May	third removal date for Agryl P17
Herbicides	17 March	1.12 kg/ha ai chlorpropham as 2.8 l/ha cp CIPC + 0.6 kg/ha ai paraquat as 3 l/ha cp Gramoxone in 600 l/ha water, except black polythene ground mulch treatment
Fungicides	10 March + 16 March	0.25 kg/ha ai benomyl as 0.5 kg/ha cp Benlate in 1000 l/ha water (pre-planting drench)
Fertilisers	13 December 15 March	157 kg/ha P ₂ O ₅ + 314 kg/ha K ₂ O 50 kg/ha N or 100 kg/ha N
Irrigation	28 March	20 mm
	20 April	20 mm
	5 May	20 mm
	11 May	20 mm
Harvests	10 May	
	15 May	
	19 May	
	23 May	
	30 May	
	5 June	
	9 June 14 June	

Appendix III

Table A. Weather data recorded during the trial.

Week commencing	Air temperatures			Soil temps (10 cm)	Accumulated day degrees		Rainfall (mm)
	Max	Min	Mean		Current	1988	
20 March	17.5	0	6.0	5.9	19	22	2.6
27 March	18.6	0.4	6.8	8.5	35	10	18.1
3 April	13.3	-0.4	6.7	5.2	5	9	22.6
10 April	15.7	-0.5	7.9	7.6	20	23	11.3
17 April	12.1	-0.5	9.8	7.2	8	40	23.6
24 April	18.4	-2.3	9.9	6.9	24	13	4.2
1 May	23.0	1.3	11.0	12.1	49	42	0
8 May	18.0	0.4	12.2	11.8	32	46	6.3
15 May	24.7	3.8	12.6	14.1	64	46	0
22 May	28.7	0.9	13.4	16.7	63	47	0.9
Total					319	298	89.6

1. The air temperatures are measured at 09.00 hrs GMT.
2. The accumulated day degrees are based on a temperature of 6°C and give a useful indication of growing conditions for comparison with other years.

The results show that maximum air temperatures were warmer than usual in 1989 particularly in early May and this may have caused the leaf-scorch which occurred beneath the double cover treatments. The accumulated day degrees indicate that immediately after planting in March growing conditions were good but deteriorated somewhat in early-mid April although the rainfall was higher which would have aided those plants still beneath the film covers as more water would have been able to penetrate through the covers over a longer period of time.

Appendix IV

Table B. Dates of 25% harvest all varieties (except Kamino).

Film cover	Cover removal date		
	First	Second	Third
Nil	31 May	31 May	31 May
Agryl P17	24 May	23 May	20 May
Polycrop 500	26 May	23 May	20 May
Polycrop 500 + Agryl P17	19 May	19 May	1 June
Agryl P17 + black polythene	31 May	28 May	26 May

Note: All the Kamino was harvested on 23 May.

Appendix V

Table C. Number of rotten heads (%) all varieties.

Film cover	Cover removal date			Mean
	First	Second	Third	
Nil	4	4	4	4
Agryl P17	2	2	2	2
Polycrop 500	2	3	0	2
Polycrop 500 + Agryl P17	5	2	2	3
Agryl P17 + black polythene	9	5	4	6
Mean	4	3	2	3

CV %	174
SED (44 df) for comparing means of film covers	2.1
SED (44 df) for comparing means of cover removal date	1.9

Note: The results do not include Kamino as there were no rotten heads in this variety.



Appendix VI

Table D. Number of missing plants (%) all varieties (except Kamino).

Film cover	Cover removal date			Mean
	First	Second	Third	
Nil	0	0	0	0
Agryl P17	0	0	0	0
Polycrop 500	0	0	0	0
Polycrop 500 + Agryl P17	0	0	0	0
Agryl P17 + black polythene	22	24	27	24
Mean	4	5	5	5

CV %	63
SED (44 df) for comparing means of film covers	1.7
SED (44 df) for comparing means of cover removal date	1.4

Table E. Number of missing plants (%) for Kamino.

Film cover	Cover removal date			Mean
	First	Second	Third	
Nil	0	0	0	0
Agryl P17	0	0	0	0
Polycrop 500	0	0	0	0
Polycrop 500 + Agryl P17	0	0	0	0
Agryl P17 + black polythene	19	30	35	28
Mean	4	6	7	6

CV %	133
SED (12 df) for comparing means of film covers	3.4
SED (12 df) for comparing means of cover removal date	3.4

Appendix VII

Table F. Mean head weights (g) all varieties (except Kamino).

Film cover	Cover removal date			Mean
	First	Second	Third	
Nil	262	262	262	262
Agryl P17	268	271	261	267
Polycrop 500	262	260	262	262
Polycrop 500 + Agryl P17	252	245	275	257
Agryl P17 + black polythene	258	251	268	259
Mean	260	258	266	261

CV %	6
SED (44 df) for comparing means of film cover	11.0
SED (44 df) for comparing means of cover removal dates	9.1

Table G. Mean head weights (g) for Kamino.

Film cover	Cover removal date			Mean
	First	Second	Third	
Nil	225	225	225	225
Agryl P17	274	258	285	272
Polycrop 500	231	288	288	269
Polycrop 500 + Agryl P17	318	277	236	277
Agryl P17 + black polythene	273	250	266	263
Mean	264	260	260	261

CV %	16
SED (12 df) for comparing means of film covers	11.2
SED (12 df) for comparing means of cover removal dates	15.2