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First year report

HORTICULTURE RESEARCH INTERNATIONAL

STOCKBRIDGE HOUSE

A REPORT TO THE HORTICULTURAL DEVELOPMENT COUNCIL,
18 LAVANT STREET, PETERSFIELD, HANTS, GU32 3EW

Experiment Leader: D N Antill, HRI Stockbridge House, Cawood, Selby, North Yorkshire YO8 OTZ

Project Leader: P Emmett

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CROP COVERS: THE EFFECT OF HERBICIDES AND IRRIGATION ON CROP YIELD AND QUALITY

Cawood · Selby · North Yorkshire YO8 0TZ

Summary

Commercially available herbicides and black polyethylene mulch were evaluated for yield and quality when applied to early summer cauliflower and iceberg lettuce, grown with and without crop covers and irrigation. Trifluralin and chlorpropham + diuron + propham, did not control the problem weeds for lettuce (groundsel and mayweed). Propachlor and chlorthal-dimethyl however gave similar or improved weed control with crop covers. For cauliflower the latter two herbicides gave the highest yields and percentage Class I and deep curds, especially when irrigation was applied in dry weather. For lettuce under crop covers, propachlor at the full rate, although giving good weed control retarded plant growth, and the weed free black mulch gave mis-shapen heads. Crop covers gave 10-14 days earlier maturity on both crops. Delaying covering had a minimal effect.

Introduction

Considerable expertise has been gained using crop covers to achieve earliness for field vegetables. However physiological disorders and lack of weed control continue to cause problems of yield and quality.

Management of the soil, moisture levels, herbicides and timing of laying crop covers may be important factors in minimising physiological disorders and weed problems. The trial was designed to evaluate and assess these factors.

Objective

To evaluate standard herbicides, black polyethylene mulch, irrigation, with and without crop covers on crops of early summer cauliflower and lettuce for maturity, yield and quality.

Materials and Methods

Site

HRI Stockbridge House, Cawood, Selby, North Yorkshire, YO8 0TZ.

The trials were grown on a sandy loam of the Quorndon Series in an open sunny position.

Design

The experimental design was a randomised block with three replicates for each crop. Thirty heads of cauliflower were recorded from the middle row of each plot, and 40 heads of lettuce from the middle two rows of each plot.

Treatments

Test Crops: Early summer cauliflower, Variety; Alpha Jubro
Iceberg lettuce, Variety; Kelvin

Crop Covers: None
Perforated polyethylene (500 x 10 mm holes/m^2)
Nonwoven (17 g/m^2)

Timing of Laying Crop Cover: Immediately after planting
After initial rooting of crop (48 hours)

Herbicides: Cauliflower

Propachlor (Ramrod Flowable at 9 l/ha) plus Chlorthal-dimethyl (Dacthal at 6 kg/ha) post-planting

Trifluralin (Tristar at 2.3 l/ha) pre-planting

Trifluralin (Tristar at 2.3 l/ha) pre-planting plus Propachlor (Ramrod Flowable at 9 l/ha) post-planting

Propachlor (Ramrod Flowable at 9 l/ha) post-planting

Black polyethylene mulch

Lettuce

Chlorpropham + diuron + propham (Atlas Pink C at 22 l/ha) pre-planting

Propachlor (Ramrod Flowable at 6 l/ha) pre-planting
Trifluralin (Tristar at 1.16 l/ha) pre-planting

Black polyethylene mulch

Irrigation: Lettuce

No irrigation

Irrigated 15 mm immediately after planting and before covering

Cauliflower

No irrigation

Irrigated four weeks after covering and then every two weeks for six weeks

Spacing

Each plot was 1.8 m wide with three rows for cauliflower and four rows for lettuce per bed. This gave spacings of:

Cauliflower:	600 mm x 450 mm
Lettuce:	375 mm x 300 mm

Records

Crop Diary (see Appendix I)
Growth Assessments
Weed (% cover) assessment and species
Harvest records for maturity, yield and quality

Results

Section 1: Cauliflower

Table 1: Cauliflower: Effect of herbicides and crop cover on weed control (% ground cover)

Treatment	Total	AM	AN	C	FH	G	M	SP
No Cover								
Ramrod + Dacthal	27	2	10	23	0	0	41	3
Ramrod	64	0	18	56	0	0	19	1
Tristar	49	0	11	36	1	12	33	8
Tristar + Ramrod	19	0	11	44	0	0	39	3
Black mulch	0							
Perforated Polythene								
Ramrod + Dacthal	8	18	12	5	0	0	47	3
Ramrod	19	13	19	17	5	1	28	3
Tristar	57	1	13	13	2	9	44	18
Tristar + Ramrod	3	0	22	18	3	2	56	8
Black mulch	0							
Nonwoven								
Ramrod + Dacthal	5	14	5	3	0	4	45	0
Ramrod	9	1	15	29	11	0	19	1
Tristar	51	0	10	22	4	14	35	8
Tristar + Ramrod	2	8	8	15	6	0	46	0
Black mulch	0							
SED (64 df)	5.5	8.2	5.3	8.5	5.4	3.6	13.6	5.1

Key:
- AM Annual Meadowgrass
- AN Annual Nettle
- C Chickweed
- FH Fat Hen
- G Groundsel
- M Mayweed
- SP Shepherds Purse

Black polythene mulch controlled all weeds.

For uncovered plots, Ramrod + Dacthal and Tristar + Ramrod gave a lower percentage weed cover than Tristar, which was lower than Ramrod. For covered plots, all herbicides gave good weed control except Tristar.

Covered plots had a lower percentage weed cover for treatments Ramrod + Dacthal, Ramrod and Tristar + Ramrod than uncovered plots. This was mainly due to a reduction in the percentage cover of chickweed.

Table 2: Cauliflower: Effect of herbicides, crop cover and time of laying crop covers on weed control (% ground cover)

Treatment	No Cover	Cover Immediately	Cover After Rooting	SED (64 df)
Ramrod + Dacthal	27	5	8	
Ramrod	64	8	13	
Tristar	49	67	42	4.5
Tristar + Ramrod	14	2	3	
Black mulch	0	0	0	
SED (64 df)		5.5		

Covering reduced the percentage weed cover for all herbicides except Tristar.

Covering immediately after herbicide application increased the percentage weed cover of plots treated with Tristar. All other herbicide treatments were unaffected by time of covering.

Table 3: Cauliflower: Effect of herbicides, crop covers and irrigation on weed control (% ground cover)

Treatment	NO CROP COVER		WITH CROP COVER		SED (64 df)
	No Irrigation	Irrigation	No Irrigation	Irrigation	
Ramrod + Dacthal	41	12	8	5	6.8
Ramrod	72	57	11	10	
Tristar	57	42	65	43	
Tristar + Ramrod	17	20	2	2	
Black mulch	0	0	0	0	
SED (64 df)		6.8			

Irrigated plots gave a lower percentage weed cover than unirrigated for uncovered plots treated with Ramrod + Dacthal, Ramrod and Tristar, and covered plots treated with Tristar.

Table 4: Cauliflower: Effect of herbicide on maturity (days from planting)

Treatment	10%	50%	90%	Mean Date of Cut
Ramrod + Dacthal	70	76	82	76
Ramrod	70	77	82	76
Tristar	70	75	80	75
Tristar + Ramrod	69	75	80	75
Black mulch	69	75	81	75
SED (64 df)	0.7	0.5	0.6	0.5

There was no significant difference in the date of 10% cut between herbicide treatments. Tristar and Tristar + Ramrod were slightly earlier to 50 and 90% cut than Ramrod + Dacthal and Ramrod and black polythene mulch was slightly earlier to 50% cut than Ramrod + Dacthal and Ramrod, but differences were minimal.

Table 5: Cauliflower: Effect of type of cover on maturity (days from planting)

Treatment	10%	50%	90%	Mean Date of Cut
No cover	79	85	89	85
Perforated polythene	67	73	79	73
Nonwoven	67	73	79	73
SED (16 df)	0.7	0.5	0.7	0.5

Perforated polythene and nonwoven crop covers advanced maturity by up to 12 days.

Table 6: Cauliflower: Effect of time of covering on maturity (days from planting)

Treatment	10%	50%	90%	Mean Date of Cut
No Cover	79	85	89	85
Cover immediately after herbicide application	67	73	78	72
Cover after rooting	68	74	80	74
SED (64 df)	0.7	0.5	0.5	0.5

Plots covered immediately after herbicide application were earlier to 50 and 90% cut than plots covered after rooting, which were earlier than uncovered plots.

Table 7A: Cauliflower: Effect of crop cover and herbicide on marketable yield and Class I heads

Treatment	Marketable Yield (crates/ha)	Class I (% of total marketable yield)
No Cover		
Ramrod + Dacthal	1972	72
Ramrod	1860	76
Tristar	2135	77
Tristar + Ramrod	2169	79
Black mulch	1547	76
Perforated Polythene		
Ramrod + Dacthal	1685	54
Ramrod	1708	65
Tristar	1434	53
Tristar + Ramrod	1651	58
Black mulch	1729	68
Nonwoven		
Ramrod + Dacthal	2085	85
Ramrod	2165	87
Tristar	2007	83
Tristar + Ramrod	2051	80
Black mulch	1881	84
SED (64 df)	147.8	6.5

Marketable Yield

Overall, the no crop cover and nonwoven plots gave similar marketable yields except for Ramrod and black polythene mulch treatments, which were improved by nonwoven covers. Perforated polythene gave lower marketable yields.

No Crop Cover - Black polythene mulch produced a smaller marketable yield than all herbicide treatments, and Tristar + Ramrod produced a higher marketable yield than Ramrod.

Perforated Polyethylene Crop Cover - Black polythene mulch gave a high marketable yield but it was not significant over any of the other herbicides.

Nonwoven Crop Cover - There were no differences in marketable yield between herbicide treatments although black polythene mulch tended to give a poorer result than the herbicides.

Percentage Class I

Nonwoven covers produced a higher % Class I than no crop cover and perforated polythene. The no crop cover plots produced a higher percentage Class I than perforated polythene. This was mainly due to fewer loose heads and fewer buttons.

Table 7B: Cauliflower: Effect of crop cover and herbicide on head characteristics as a percentage of the number planted (angle transformation)*

Treatment	Buttons+	Size+ 4	Size+ 5	Size+ 6/7	Deep Curds	Loose Curds
No Cover						
Ramrod + Dacthal	10	30	38	28	59	29
Ramrod	16	29	34	29	56	29
Tristar	8	25	37	34	59	29
Tristar + Ramrod	8	25	37	35	60	26
Black mulch	21	28	34	23	46	27
Perforated Polythene						
Ramrod + Dacthal	13	40	36	13	36	41
Ramrod	11	45	35	9	38	33
Tristar	15	43	29	5	33	43
Tristar + Ramrod	13	44	33	11	36	39
Black mulch	15	36	40	13	39	30
Nonwoven						
Ramrod + Dacthal	4	35	43	21	58	21
Ramrod	6	32	45	25	62	17
Tristar	5	34	42	21	57	22
Tristar + Ramrod	6	35	43	20	62	20
Black mulch	10	34	42	18	47	22
SED (64 df)	4.2	3.7	4.0	4.0	5.4	4.3

* See Appendix II, Table 12 for actual percentages

+ Buttons (< 5 cm); Size 4 (11-12.9 cm); Size 5 (13-14.9 cm); Size 6/7 (15-17+ cm)

Size Grades

There were no differences in the Size 4, 5 and 6/7 heads between herbicides for each of the crop cover treatments, but the perforated polythene produced more Size 4 and fewer Size 6/7 heads than the uncovered and nonwoven plots. The nonwoven plots produced more Size 5 heads than the no crop cover and perforated polythene plots.

Deep Curds

No crop cover and nonwoven covers gave more deep curds than perforated polythene for all herbicide treatments but not for black polythene mulch.

Loose Curds

Perforated polythene gave a higher percentage of loose curds than either of the other two treatments. Black mulch gave fewer loose curds under perforated polythene than the herbicide treatments. There were no other differences within each crop cover treatment between weed control treatments.

Table 8A: Cauliflower: Effect of irrigation on maturity, marketable yield and Class I heads

Treatment	50% Cut (days from planting)	Marketable Yield (crates/ha)	Class I (% of total marketable yield)
No irrigation	75	1714	65
Irrigation	76	2004	80
SED (64 df)	0.4	34.8	3.8

Table 8B: Cauliflower: Effect of Irrigation on size of head and depth of curd as a percentage of the number planted (angle transformation)*

Treatment	Size 4 (11-12.9 cm)	Size 5 (13-14.9 cm)	Size 6/7 (15-17+ cm)	Deep Curds
No irrigation	39	36	14	44
Irrigation	33	41	23	53
SED (64 df)	0.2	1.4	0.5	1.7

* See Appendix II, Table 13 for actual percentages

Irrigated plots were later to 50% cut than unirrigated. Irrigated plots also produced a larger marketable yield, higher percentage Class I and higher percentage of deep curds than unirrigated. Irrigated plots produced more Size 5 and 6/7 heads than unirrigated.

Table 9: Cauliflower: Effect of irrigation and crop cover on marketable yield and Class I heads

Treatment	Marketable Yield (crates/ha)			% Class I (% of total marketable yield)		
	No Irrigation	Irrigation	SED (16 df)	No Irrigation	Irrigation	SED (16 df)
No cover	1800	2073		73	79	
Perforated polythene	1466	1817	125.1	48	71	4.3
Nonwoven	1919	2157		79	86	
SED (16 df)	112.7			5.0		

Irrigation increased marketable yield for all three covering treatments. Irrigation also increased the percentage of Class I heads under perforated polythene.

Discussion

Covering advanced maturity by 10-14 days compared with no cover. Ramrod + Dacthal and Ramrod delayed maturity by two days as did irrigation. However these small delays were more than compensated for by improved weed control.

The best weed control without crop covers was achieved by Ramrod + Dacthal and Tristar + Ramrod. The two problem weeds were chickweed and mayweed. Ramrod + Dacthal gave better control of chickweed than Tristar + Ramrod whilst control of mayweed was similar. Tristar and Ramrod gave poor weed control without crop covers but covering improved the weed control of all herbicides except Tristar alone. The percentage weed cover of Ramrod was reduced from 64% with no cover, to 19% with a perforated polythene cover and 9% with a nonwoven cover, so that Ramrod gave equally good weed control under covers to Ramrod + Dacthal and Tristar + Ramrod.

The black polythene mulch controlled all weeds. It did however give poorer marketable yields than the herbicide treatments when no cover was used. Covering tended to improve yields. Recent work has shown that insufficient water reaching the roots may be a limiting factor where black polythene mulch is used.

The cool season favoured the use of nonwoven crop covers which gave high percentage of Class I curds and marketable yield.

Irrigation improved marketable yield and percentage Class I for all treatments. It did not however improve weed control when crop covers where used and results were similar to no cover with the exception of Tristar.

The time of covering had minimal affect. Applying crop covers immediately after herbicide application advanced maturity by one day compared with covering after rooting.

Conclusions

1. Nonwoven crop covers improved quality; maturity was advanced by both crop covers.

2. Crop covers reduced the percentage weed cover for Ramrod + Dacthal, Ramrod and Tristar + Ramrod. This was translated into a yield advantage for Ramrod with a nonwoven cover.

3. Tristar did not control the problem weeds in this trial (groundsel and mayweed).

4. Weeds were controlled by black polythene mulch but yields were reduced. This may have been due to lack of water under the mulch.

5. Ramrod + Dacthal and Ramrod marginally delayed maturity, but this was more than compensated for by improved yield and quality especially under nonwoven crop cover.

6. Irrigation increased marketable yield, percentage Class I curds, percentage deep curds and the number of larger size curds. However maturity was slightly delayed.

7. Time of covering did not affect weed control or yield.

Section 2: Lettuce

Table 10: Lettuce: Effect of herbicides and crop cover on weed control (% ground cover)

Treatment	15 May	Total Total	At First Harvest AM	C	G	M	SP
No Cover							
Atlas Pink C	5	38	3	8	38	43	7
Ramrod	1	15	19	37	2	21	13
Tristar	4	43	16	10	21	33	20
Black polythene	0	0	-	-	-	-	-
Perforated Polythene							
Atlas Pink C	22	50	0	2	33	55	4
Ramrod	2	7	17	15	2	35	18
Tristar	15	43	3	12	37	37	10
Black polythene	0	0	-	-	-	-	-
Nonwoven							
Atlas Pink C	47	79	0	0	39	55	0
Ramrod	4	37	19	27	1	24	9
Tristar	41	79	10	13	38	24	14
Black polythene	0	0	-	-	-	-	-
SED	(47 df) 9.3	9.1	(32 df) 12.3	6.2	12.5	12.3	7.1

Key: AM Annual Meadowgrass
C Chickweed
G Groundsel
M Mayweed
SP Shepherds Purse

APPENDIX II:

Table 12: Cauliflower: Effect of crop cover and herbicide on head characteristics as a percentage of the number planted (actual percentages)

Treatment	Buttons	Size 4	Size 5	Size 6/7	Deep Curds	Loose Curds
No Cover						
Ramrod + Dacthal	3	26	38	23	72	24
Ramrod	7	24	31	25	67	23
Tristar	2	19	37	32	72	24
Tristar + Ramrod	1	19	37	33	75	19
Black mulch	10	22	32	16	52	21
Perforated Polythene						
Ramrod + Dacthal	3	42	36	7	35	43
Ramrod	2	51	34	4	39	32
Tristar	5	46	28	5	32	46
Tristar + Ramrod	4	43	31	6	36	41
Black mulch	6	35	41	7	40	25
Nonwoven						
Ramrod + Dacthal	0	33	46	16	70	13
Ramrod	1	28	50	19	78	10
Tristar	1	33	44	15	68	17
Tristar + Ramrod	1	48	48	14	75	13
Black mulch	3	32	46	11	54	14

Table 13: Cauliflower: Effect of irrigation on size of head and depth of curd as a percentage of the number planted (actual percentages)

Treatment	Size 4	Size 5	Size 6 & 7	Deep Curds
No irrigation	40	36	9	49
Irrigation	30	43	18	62

APPENDIX I: CROP DIARY

CAULIFLOWER

29 March	Applied fertiliser at 250:63:188 kg/ha NPK.
3 April	Planted cauliflower: Hassy 104 modules. First covering treatment.
5 April	Second covering treatment.
3 May 7 May 17 May 30 May	Irrigated appropriate treatments at 15 mm.
29 May	Removed perforated polythene cover.
6 June	Removed nonwoven cover. First harvest.
7 July	Final harvest.

LETTUCE

25 March	Applied fertiliser at 200:50:150 kg/ha NPK.
26 March	Planted lettuce: 38 mm blocks.
27 March	Irrigated at 15 mm. First covering treatment.
29 March	Second covering treatment.
10 May	Removed perforated polythene covers.
11 May	Irrigated all plots at 15 mm.
4 June	First harvest.
5 June	Removed nonwoven covers.
19 June	Final harvest.

Conclusions

1. Ramrod at 6 l/ha gave good weed control but retarded crop growth under crop covers as well as without a crop cover, whether irrigated or not. This herbicide should be tried at a reduced rate.

2. Atlas Pink C and Tristar gave poor weed control which was made worse by irrigation at planting. Results suggest that the nonwoven cover promoted the growth of those weeds not controlled by herbicides, which encouraged botrytis and reduced quality.

3. Planting lettuce through black polythene mulch needs to be carried out with care to ensure heads are not mis-shapen. The system may be improved by profiling beds and laying mulches tightly so that there is no gap between mulch and soil.

Recommendations for the Future

Treatments and husbandry in future must concentrate on controlling weeds especially for lettuce. Until weeds can be successfully controlled the yield and percentage Class I of the first early crop is likely to be lower than the potential offered by crop covers. The experiment should be continued with modifications: less emphasis on covering times at planting, but a wider selection of weed control measures, including a hand weeded control to substantiate the effect of herbicides.

Discussion

Results of marketable yield and quality of lettuce have not been included within this report. This was because the weed control measures used were inadequate and as a consequence it was not possible to determine any potential benefit of crop covers.

The problem weeds during this trial (mayweed and groundsel) were not within the weed control spectrum of Atlas Pink C or Tristar and plots treated with these herbicides became smothered in groundsel and mayweed and crop quality suffered. The nonwoven cover and irrigation promoted weed growth and encouraged botrytis which led to a low percentage of Class I heads.

Ramrod at the full recommended rate of 6 l/ha was selected to assess whether crop covers would off-set the inevitable delay in maturity caused by Ramrod, while achieving good weed control. The plants were earlier than no cover but Ramrod retarded plant growth and the reduction in head weight was not acceptable. A reduced rate may give a more satisfactory result.

The black polythene mulch produced a low percentage Class I due predominantly to mis-shapen heads. There was also a high number of missing heads due to the plants becoming trapped beneath the mulch during the early stages of growth. Experience with other trials with mulches shows that it may be possible to overcome the problem by tighter laying of the mulch and not planting so deep.

Black polythene mulch controlled all weeds. Ramrod gave better overall weed control than Atlas Pink C and Tristar, which did not control groundsel and mayweed. The nonwoven crop covers increased the percentage weed cover for all herbicides.

Table 11: Lettuce: Effect of herbicides, crop cover and irrigation on weed control (% ground cover at first harvest)

	NO CROP COVER		WITH CROP COVER		
Treatment	No Irri-gation	Irri-gation	No Irri-gation	Irri-gation	SED (47 df)
Atlas Pink C	25	52	54	76	
Ramrod	18	13	18	26	
12.1					
Tristar	45	40	55	67	
Black polythene	0	0	0	0	
SED (47 df)			11.7		

Irrigation increased the percentage weed ground cover for Atlas Pink C with and without a crop cover. Irrigation also tended to increase the weed cover for Ramrod and Tristar under covers.

The time of covering had no effect upon weed cover (data not presented).