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Year 1 report

HORTICULTURE RESEARCH INTERNATIONAL
STOCKBRIDGE HOUSE

A REPORT TO THE HORTICULTURAL DEVELOPMENT COUNCIL,
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CROP COVERS: EFFECT OF RATES OF NITROGEN ON YIELD AND QUALITY

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Summary

A range of nitrogen base fertiliser rates, standard, 45% less, 80% less and nil were evaluated for yield and quality on crops of carrots, cabbage and lettuce with and without polyethylene or polypropylene crop covers. Carrots produced similar yields from each of the four nitrogen rates. Lettuce produced similar marketable yields from standard, 45% and 80% less nitrogen with both types of crop cover. Cabbage gave similar yields under the nonwoven crop cover but yield increased in proportion with nitrogen rates under perforated polythene. The perforated polythene (500 holes/m^2) and nonwoven (17 g/m^2) crop covers advanced maturity for all three crops. Overall the nonwoven crop cover gave higher yields for lettuce and cabbage than polyethylene and no crop cover. There was less Nitrate-N remaining under the nonwoven crop cover at harvest.

Introduction

The use of crop covers has become an accepted practice for production of early field vegetables. Experience in their use over the past decade has given individual growers and research workers considerable expertise. However physiological problems still reduce the percentage marketable of most crops so that the full potential of using crop covers is not realised.

The industry has adopted standard fertiliser recommendations when using crop covers but there is increasing evidence that the nutrient balance used on normal outdoor field cropping may not always be appropriate for plants under crop covers. This especially applies to nitrogen. Circumstantial evidence suggests that crop covers allow nitrogen to be used more efficiently and that they may reduce leaching. This may have an influence on some of the physiological problems which limit the quality of some crops. This trial has been designed to evaluate rates of nitrogen applied to a wide range of crops grown under crop covers.

Objective

To evaluate three rates of nitrogen fertiliser compared with no nitrogen fertiliser on carrots, cabbage and lettuce with and without crop covers.

Materials and Methods

Site

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

Soil Type

Sandy loam of the Quorndon Series in an open sunny position.

Design

The experimental design was a randomised block with four replicates for each test crop.

Treatments

Test Crops:

Early carrots, variety Nairobi
Early crisp lettuce, variety Saladin
Early summer cabbage, variety Derby Day

Crop Covers:

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

Rates of Nitrogen Fertiliser (applied according to soil analysis):

None (control)
Standard (ADAS recommendation)
45% less than standard
80% less than standard

Base Fertiliser Applications (NPK):

Carrots	0:100:100	(No N)
	60:100:100	(Standard N)
	33:100:100	(45% less N)
	12:100:100	(80% less N)
Cabbage	0:25:175	(No N)
	300:25:175	(Standard N)
	165:25:175	(45% less N)
	60:25:175	(80% less N)
Lettuce	0:100:100	(No N)
	200:100:100	(Standard N)
	110:100:100	(45% less N)
	40:100:100	(80% less N)

Spacing

Carrots — Four rows per 1.83 m bed, 37.5 cm between rows, drilled at 66 seeds/metre (130 seeds/m^2).

Cabbage — Four rows per 1.83 m bed, 37.5 cm between rows, 30 cm within rows.

Lettuce — Four rows per 1.83 m bed, 37.5 cm between rows, 30 cm within rows.

Recorded Plants per Plot

Carrots	2 m from middle two rows
Cabbage	40 plants from middle two rows
Lettuce	40 plants from middle two rows

Records

Crop diary (see Appendix I)

Growth assessments

Soil analysis before base dressing, 6 weeks after planting/drilling and at harvest

Harvest data for maturity, yield and quality

Results

Table 1: Date of 50% Cut (days from planting)

Treatment	Crop	
	Lettuce	Cabbage
No Crop Cover		
Nil	77	92
Standard	74	81
45% less	73	85
80% less	74	91
Nonwoven Cover		
Nil	66	87
Standard	59	74
45% less	59	74
80% less	61	77
Perforated Polythene Cover		
Nil	66	92
Standard	60	77
45% less	58	80
80% less	62	89
SED	(17 df)	(26 df)
Between covers	0.7	1.8
Within same cover	0.7	1.9

For the lettuce crop, nil nitrogen was later to 50% cut than the other nitrogen rates and no cover delayed maturity compared with nonwoven and perforated polythene.

For cabbage, nil nitrogen was later to 50% cut than standard and 45% less, and the nonwoven cover led to earlier maturity than no cover and perforated polythene.

Table 2: Mean Marketable Yield (t/ha) of Carrots and Cabbage and Total Number of Marketable Lettuce Heads as a percentage of the total number planted (angle transformation)*

Treatment	Mean Marketable Yield (t/ha) Carrots (>15 mm)	Cabbage (Class I)	Total Marketable (%) Lettuce (Class I + II)
No Crop Cover			
Nil	47	18	40
Standard	40	46	59
45% less	50	42	63
80% less	45	29	50
Nonwoven Cover			
Nil	71	30	53
Standard	67	46	87
45% less	67	53	79
80% less	65	45	84
Perforated Polythene Cover			
Nil	67	11	51
Standard	65	50	66
45% less	61	34	66
80% less	67	23	73
SED	(27 df)	(26 df)	(27 df)
Between covers	9.1	5.2	5.7
Within same cover	5.0	3.9	4.6

* See Appendix II, Table 8 for actual percentages

Generally there were no differences in the marketable yield of carrots (>15 mm) between the four rates of nitrogen but the covers produced higher yields than no cover.

For the lettuce crop, nil nitrogen produced a lower percentage marketable than the other nitrogen rates for all three covering treatments, and there were no differences in percentage marketable between standard, 45% less and 80% less for either of the crop covers. The nonwoven cover gave a higher percentage marketable than no cover and perforated polythene.

For cabbage, nil nitrogen produced a lower marketable yield than the other nitrogen rates for all three covering treatments, and there was no difference in yield between standard and 45% less nitrogen with no cover and the nonwoven crop cover. The nonwoven cover gave a larger marketable yield than no crop cover and perforated polythene for 45% less, 80% less and nil nitrogen.

The quality of the lettuce and cabbage was poor for nil nitrogen but there were no consistent differences in quality between the other three nitrogen rates.

Table 3: Mean Marketable Head Weight (g)

Treatment	Crop	
	Lettuce	Cabbage
No Crop Cover		
Nil	389	384
Standard	558	576
45% less	537	558
80% less	496	466
Nonwoven Cover		
Nil	440	452
Standard	611	597
45% less	632	613
80% less	598	575
Perforated Polythene Cover		
Nil	362	349
Standard	521	636
45% less	513	489
80% less	447	447
SED	(27 df)	(26 df)
Between covers	30.8	45.6
Within same cover	22.7	41.8

For both crops, standard and 45% less nitrogen produced a heavier mean head weight than nil nitrogen, while 80% less nitrogen gave an intermediate result. The nonwoven crop cover generally produced a heavier mean head weight than no crop cover and perforated polythene.

Table 4: Effect of Crop Covers on Marketable Yield and the Number of Unmarketable Heads, Heads with Botrytis and Small Heads as a percentage of the number planted (angle transformation)*

Treatment	Lettuce			Cabbage		
	Total Mkt (%)	Unmarketable Total (%)	Botrytis (%)	Total Yield (t/ha)	Unmarketable Total (%)	Small (%)
No crop cover	53	32	26	33	27	20
Nonwoven	76	11	6	44	19	10
Perforated polythene	64	24	12	30	33	23
SED (27 df)	4.1	3.3	3.2	3.9	5.2	4.7

* See Appendix II, Table 9 for actual percentages

Marketable Yield

Nonwoven crop covers gave a significantly higher percentage of marketable lettuce heads than perforated polyethylene and no crop cover, and significantly higher yields for cabbage. The non-woven crop cover also gave lower percentages of unmarketable.

Quality

All aspects of quality were assessed at harvest and the most prevalent defects for downgrading lettuce and cabbage to unmarketable are shown in the table. For lettuce, crop covers produced fewer heads affected by botrytis. For cabbage, nonwoven crop covers gave fewer small heads.

Some differences were also observed between the nitrogen rates: for lettuce there was more dry tipburn on nil nitrogen plots (data not shown).

Table 5: Soil Analysis for Nitrogen at 0-45 cm depth (Nitrate-N mg/kg). Six weeks after drilling/planting.

Treatment	Crop		
	Carrots	Lettuce	Cabbage
Before base dressing	18	11	10
No Crop Cover			
Nil	59	14	61
Standard	71	117	314
45% less	64	50	195
80% less	56	39	101
Nonwoven Cover			
Nil	47	9	44
Standard	57	74	116
45% less	68	14	126
80% less	56	21	51
Perforated Polythene Cover			
Nil	40	11	36
Standard	71	68	149
45% less	80	27	152
80% less	67	13	90

Table 6: Soil Analysis for Nitrogen at 0-45 cm depth (Nitrate-N mg/kg). At harvest.

Treatment	Crop		
	Carrots	Lettuce	Cabbage
No Crop Cover			
Nil	31	10	10
Standard	54	48	83
45% less	37	25	48
80% less	36	22	14
Nonwoven Cover			
Nil	19	9	7
Standard	20	38	30
45% less	19	16	15
80% less	22	10	13
Perforated Polythene Cover			
Nil	21	11	8
Standard	37	39	121
45% less	45	32	64
80% less	24	35	16

The soil analysis results six weeks after drilling/planting and at final harvest showed a clear decrease in the amount of Nitrate-N with decreasing rate of N fertiliser for cabbage and lettuce. The results for carrots (which received a much smaller range of fertiliser application) showed few differences.

In general, there was less Nitrate-N measured under the nonwoven cover than no cover or perforated polythene.

Table 7: Plant Analysis for Nitrogen (Nitrate-N mg/kg)

Treatment	Crop	
	Carrot	Cabbage
No Crop Cover		
Nil	56	721
Standard	203	2130
45% less	147	1450
80% less	112	91
Nonwoven Cover		
Nil	49	119
Standard	70	1400
45% less	126	308
80% less	42	378
Perforated Polythene Cover		
Nil	105	406
Standard	42	1910
45% less	133	1050
80% less	42	798

There were no consistent differences in the amount of Nitrate-N in the carrot crop at harvest. For the cabbage crop, the highest rate of fertiliser applied led to the highest amount of Nitrate-N at harvest.

Discussion

For the carrot crop there were few differences in yield between fertiliser treatments. Both crop covers significantly increased yield.

For the lettuce crop nil nitrogen tended to delay maturity and reduce yield, but results showed no significant difference in yield between standard, 45% less and 80% less nitrogen, although 80% less nitrogen tended to lower mean head weight. The nonwoven cover gave the highest yields.

Results for cabbage showed a decrease in yield and mean head weight for 80% less nitrogen with no cover and with a perforated polythene cover. The nonwoven cover maintained a high yield for all four rates of fertiliser.

Soil analysis results showed less Nitrate-N remaining under the nonwoven crop cover at harvest for carrots, cabbage and to a lesser extent lettuce. Results of soil temperatures in Appendix III revealed higher accumulated day degrees under the crop covers. Although the polythene cover was perforated, sufficient water may not have reached the soil to utilise all the available nitrogen, in contrast to the nonwoven cover where adequate soil moisture and higher temperatures may have resulted in increased yields.

The quality of cabbage and carrots was excellent. The lettuce grown without nitrogen suffered with botrytis and dry tipburn. The covers caused minimal scorching.

Conclusions

1. The yield of carrots was unaffected by rate of nitrogen fertiliser between 0-60 kg/ha. Crop covers increased yields.

2. For lettuce there was no difference in the percentage marketable or quality between standard and 45% less nitrogen, but a slight decrease in the percentage marketable was recorded for 80% less nitrogen. The nonwoven cover gave the highest yields. Both covers advanced maturity and improved quality.

3. Cabbage yields and quality were similar for both crop covers at the standard nitrogen rate. The nonwoven cover maintained high yields and quality for 45% and 80% less nitrogen, but yields were reduced under perforated polythene.

4. The amount of Nitrate-N measured in the soil at harvest was lower under the nonwoven crop cover due to improved yields. The perforated polythene cover may have suffered from insufficient moisture to utilise all the available nitrogen.

5. Higher levels of Nitrate-N were measured in the cabbage crop for the higher rates of nitrogen fertiliser applied.

Recommendations

In the first year of the project the results suggest there is a potential to reduce nitrogen application under covers. The project needs to continue in order to substantiate the initial results and to collect more detailed data on Nitrate-N in the soil. Crop quality requires special attention with monitoring of levels of diseases and physiological disorders at the different rates of nitrogen to ensure standards are not compromised.

APPENDIX I: CULTURE AND DIARY

CARROTS

26 March	Applied fertiliser. Drilled carrot seed at 130 seeds/m^2.
27 March	Applied herbicide: Linuron (as Liquid Linuron 15) at 3.5 l/ha and paraquat (as Gramoxone 100) at 3.0 l/ha.
28 March	Covered.
31 May	Removed perforated polythene cover.
10 June	Removed nonwoven cover.
12 July) 23 July) 1 August)	First, second and third harvest dates.

LETTUCE

27 March	Applied fertiliser.
28 March	Planted lettuce: 38 mm blocks. Applied herbicide: Propyzamide (as Kerb 50W) at 2.8 kg/ha.
29 March	Covered.
17 May	Removed perforated polythene cover.
23 May	Removed nonwoven cover. First harvest.
19 June	Final harvest.

CABBAGE

9 April	Applied fertiliser. Planted cabbage: Hassy 308 modules.
10 April	Applied herbicide: Propachlor (as Albrass) at 9 l/ha and chlorthal-dimethyl (as Dacthal) at 6 kg/ha. Covered.
17 May	Removed perforated polythene cover.
17 June	Removed nonwoven cover.
19 June	First harvest.
11 July	Final harvest.

APPENDIX II:

Table 8: Lettuce - Total Number of Marketable Heads as a percentage of the number planted - actual percentages

Treatment	Total Marketable (%)
No Cover	
Nil	42
Standard	73
45% less	79
80% less	58
Nonwoven cover	
Nil	64
Standard	99
45% less	96
80% less	98
Perforated Polythene Cover	
Nil	59
Standard	79
45% less	82
80% less	91

Table 9: Effect of Crop Covers on the Number of Unmarketable Heads, Heads with Botrytis and Small Heads as a percentage of the number planted - actual percentages

Treatment	Lettuce			Cabbage	
	Total Mkt (%)	Unmarketable Total (%)	Botrytis (%)	Unmarketable Total (%)	Small (%)
No crop cover	63	29	20	24	23
Nonwoven	89	10	3	12	6
Perforated polythene	78	20	7	32	21

APPENDIX III:

Table 10: Accumulated Day Degrees (above 4 °C) at 50 mm soil depth

A. CARROTS

Cover	30 Apr-31 May*	1 Jun-10 Jun+	Total 30 Apr-10 Jun
No crop cover	289	70	359
Nonwoven	334	69	403
Perforated polythene	355	70	425

B. LETTUCE

Cover	3 Apr-17 May*	18 May-28 May+	Total 3 Apr-28 May
No crop cover	253	115	368
Nonwoven	323	115	438
Perforated polythene	277	122	499

C. CABBAGE

Cover	26 Apr-17 May*	18 May-16 Jun+	Total 26 Apr-16 Jun
No crop cover	146	248	394
Nonwoven	193	271	464
Perforated polythene	208	239	447

* Perforated polythene cover removed

+ Nonwoven cover removed