CONTRACT REPORT

FV145

Early Production of Carrots using Polythene Covers

Commercial-in-Confidence

Report to: Horticultural Development Council
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Period Covered: 1992/93

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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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RELEVANCE TO GROWERS AND PRACTICAL APPLICATION

Objective of Project

* To establish the benefit of using infrared reflecting polythene, ventilated at 10, 200 or 400 holes per sq m, on early crops of carrots sown in December, January and February.

* To establish the benefits of managed ventilation of solid polythene, ventilated at 10, 200 or 400 holes per sq m on early crops of carrots sown in December, January and February.

Key Results

Infrared reflecting polythene increased soil temperature and encouraged early crop growth. Rate of plant emergence was significantly greater than the control treatment with 200 holes per sq m at three sowing dates (December, January and February).

Infrared reflecting polythene ventilated to 400 holes per sq m increased yield by 12 tonnes per hectare in June 1993 from the February sowing date but not from December or January sowing dates.

Solid polythene also increased soil temperature and early crop growth. Rate of emergence was significantly greater than the commercial control with 200 holes per sq m. Solid polythene progressively ventilated to 400 holes per sq m increased yield by 2 tonnes per hectare and 9 tonnes per hectare when harvested in June from the January and February sowing dates but not from the December sowing.

Opportunity for Application

Infrared reflecting polythene is currently three times more expensive than polythene used commercially but thinner and cheaper IR polythene will be available in future. Polythene manufacturers can apply ventilation holes as with polythene in current use and sufficient for grower trials should be available in 1994.

A system using solid polythene progressively ventilated in the field can be applied commercially. However a more precise system of mechanically ventilating polythene on a field scale is required.

SUMMARY

The current commercial practice of early carrot production using polythene with 200 holes per sq m was compared with IR polythene (infrared reflecting polythene) and solid polythene, both "progressively" ventilated from 10 holes per sq m at drilling, up to 200 holes per sq m in early March and 400 holes in mid April. This was repeated at 3 sowing dates, December, January and February.

Soil temperature and rate of plant emergence was significantly increased by IR polythene and solid polythene with limited ventilation (10 holes per sq m) at all 3 sowing dates.

IR polythene progressively ventilated to 400 holes per sq m increased yield by 12 tons per hectare in June from a February sowing but not from the December or January sowings compared to commercial polythene with 200 holes per sq m. Solid polythene progressively ventilated to 400 holes per sq m increased yield by 2 tons per hectare and 9 tons per hectare when harvested in June from the January and February sowings but not from the December sowing.

INTRODUCTION

The carrot industry currently grows some 800 hectares of early crops under polythene. The technique used is well established and reliable. However, 35,000 tons of carrots are still imported into the UK from Spain and France during April, May and June.

The current commercial technique uses polythene with 200 holes per sq m, sowing in January or February and removing the film in late April or May. Earlier crops can be obtained by sowing in October or December but these are prone to bolt and are more risky to grow. Maintaining a higher temperature under the polythene could reduce this risk of bolting but later in the season more ventilation will be required when temperatures are warmer. Polythene without holes warms the soil more but when and how much ventilation is required is not known.

New types of polythene which trap infrared radiation have been available for walk in poly tunnels for several years and this material may produce earlier carrot crops if a thinner and cheaper polythene became available. British Visqueen currently manufactures an 80 micron infrared or "thermic film" for export to France (for covering strawberries). This is not widely used for early production in the UK but offers the opportunity to test the thermal properties on carrots.

The experimental treatments listed below were designed to measure the benefit of gradually ventilating infrared and normal polythene compared with current commercial practice.

Experimental treatments

1. Polythene type:

a. Solid polythene progressively ventilated.
b. IR polythene progressively ventilated.
c. Current practice - ventilated by 200 holes per sq m.

2. Sowing dates - December, January, February

Covers placed immediately after drilling.

3. Levels of ventilation:

a. Minimum ventilation 10 holes per sq m.
b. Minimum ventilation + ventilation of 200 holes per sq m early March.
c. Minimum ventilation + ventilation of 200 holes per sq m early March and 400 holes mid April.
d. Current practice of 200 holes per sq m throughout.

MATERIALS AND METHOD

Three sites (one per sowing date) were selected in commercial crops, sown for early production (covered with polythene). After drilling and herbicide application, polythene treatments were machine laid within the commercial crop. Apart from ventilation treatments and final removal date of the polythene all other cultural operations were the same as for the commercial crop being grown at each site.

Ventilation treatments were applied manually using 1 cm diameter steel rods pushed through the polythene.

Soil temperature under each type of polythene was recorded at 10 cm depth using a Squirrel data logger.

Plant stand counts were recorded monthly on each site from 1 m of bed (4 rows) until a constant number was reached.

Polythene was removed from all site/treatments when the plant reached 6/7 true leaves.

Experimental treatments were harvested at the same time or within one or two days of the commercial crop on each site. 2 m of bed (4 rows) were lifted and roots graded, - less than 20 mm or greater than 20 mm diameter then counted and weighed. Numbers of fanged roots, bolters and splits were also recorded although levels were low, less than 1% on all sites and treatments.

CROP DIARY

Site	December sown	January sown	February sown
Variety	Primo	Primo	Primo
Final Plant Population	57 per sq m	93 per sq m	123 per sq m
Sowing Date	17/12/92	15/1/93	9/2/93
200 holes per sq m treatment applied	11/3/93	11/3/93	19/3/93
400 holes per sq m treatment applied	14/4/93	14/4/93	14/4/93
Polythene removal date	17/5/93	13/5/93	10/5/93
Irrigation	25 mm applied 7/6/93	25 mm applied 1/6/93	Nil
Harvest date	17/6/93	7/6/93	21/6/93

RESULTS

1. Soil temperature

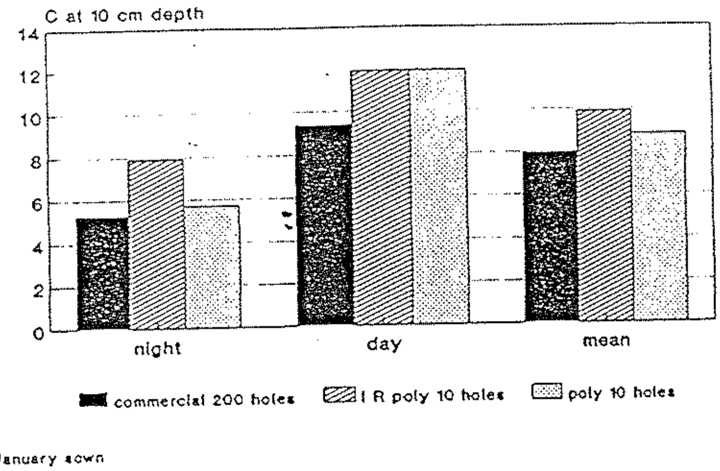
Figure 1 shows the mean soil temperature from sowing until 11 March (taken from the January sown site) which was recorded hourly at 10 cm depth.

The mean soil temperature at night (20.00 hours - 08.00 hours) under the IR polythene was 2°C warmer than either the 200 holes/sq m commercial polythene or solid polythene with only 10 holes per sq m.

The mean soil temperature during the day (08.00 - 20.00 hours) was similar under IR polythene and normal polythene both with 10 holes per sq m, both of these treatments being 3°C warmer than the 200 holes/sq m commercial control.

The mean soil temperature throughout the period was warmest under IR polythene (with 10 holes/sq m), this was 1°C warmer than solid polythene with (10 holes per sq m) and 2°C warmer than the commercial control. Mean temperature under solid polythene (with 10 holes per sq m) was 1°C warmer than the commercial control.

Figure 1 Soil temperature
mean from sowing to 11 March



2. Plant Stand Counts

Plant stand counts were recorded monthly from sowing until May. Figure 2 shows the number per metre of row for each treatment and sowing date.

December Site

There were no significant differences between experimental treatments and the commercial control.

January Site

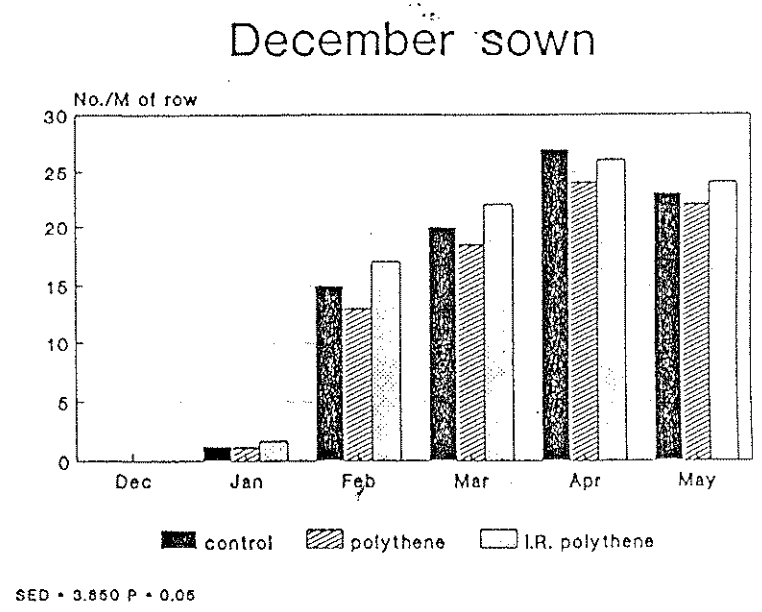
IR polythene (with 10 holes/sq m) gave a more rapid plant emergence. Plant stand counts were significantly greater in February and March, although the final stand count on commercial treatment was greater than the other treatments, possibly due to wind damage by the polythene.

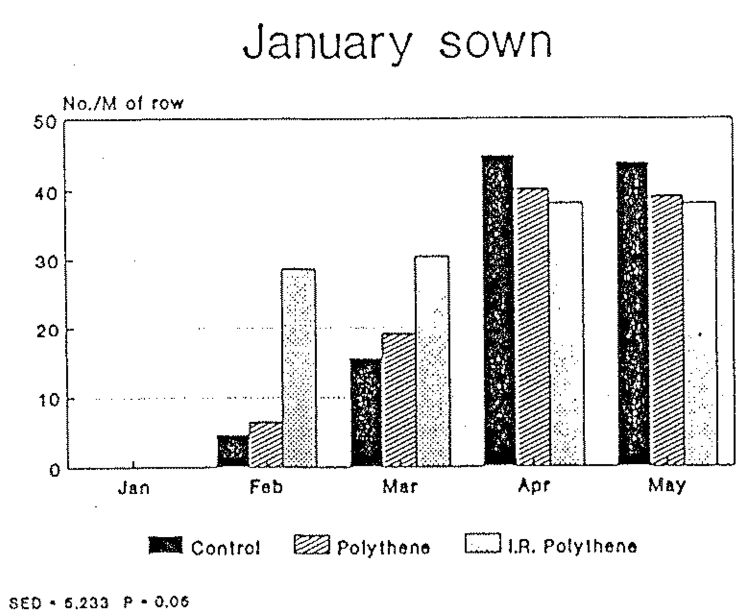
February Site

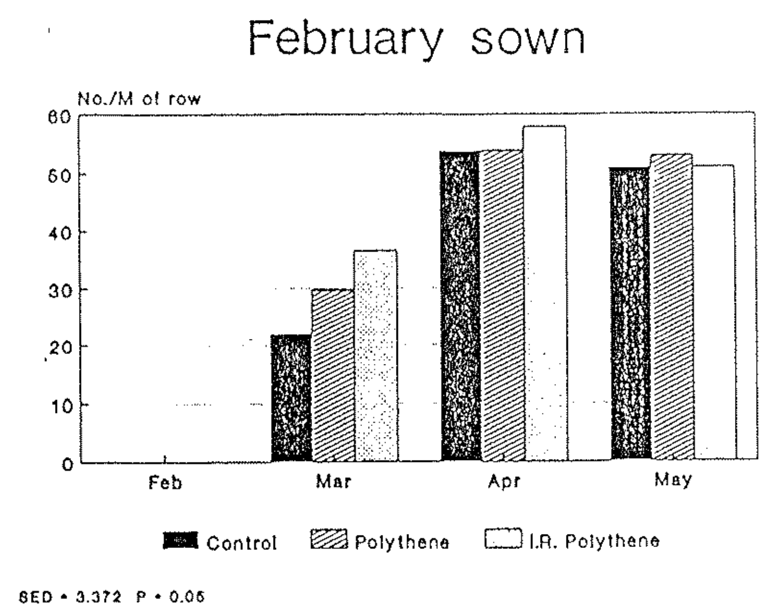
Normal polythene (with 10 holes per sq m) and IR polythene (with 10 holes/sq m) gave significantly more rapid plant emergence than the commercial control. Stand counts on these treatments being significantly greater than the commercial controls in March. The final plant stand was similar for all treatments.

Figure 2

stand counts







3. Yield

Total yield is presented in Figure 3 in t/ha. Tables 1-3 show yield, weight and number of roots, graded < and > 20 mm diameter.

December sowing

The yield from commercial 200 holes/sq m treatment was greater than any of the experimental treatments. Yield from all ventilation treatments in IR polythene was significantly less than the 200 holes sq m commercial control. Other factors adversely affected the trial on this site, eg gale damage, and late application of irrigation.

January sown

In spite of a lower population (Figure 2, January sown) yield over 20 mm from solid polythene progressively ventilated to 400 holes per sq m was significantly greater than the 200 holes/sq m commercial control (2 tons per hectare greater). All ventilation treatments in IR polythene yielded significantly less than the commercial control.

February sown

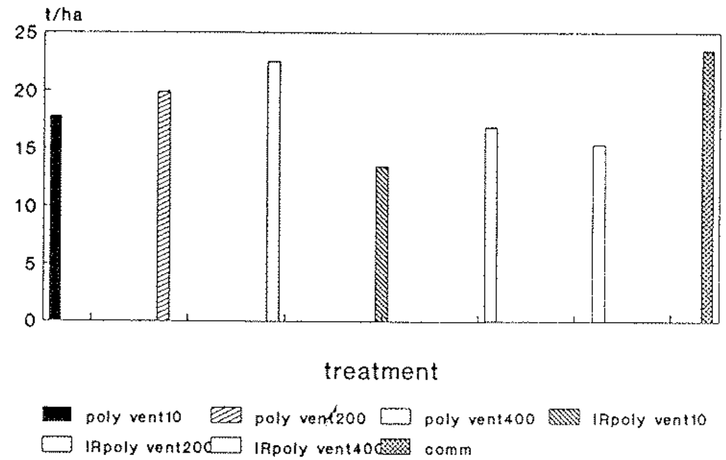
Progressive ventilation to 400 holes per sq m of IR polythene and solid polythene produced a yield significantly greater than the commercial control (12 tons per hectare and 10 tons per hectare respectively).

Figure 3

total yield

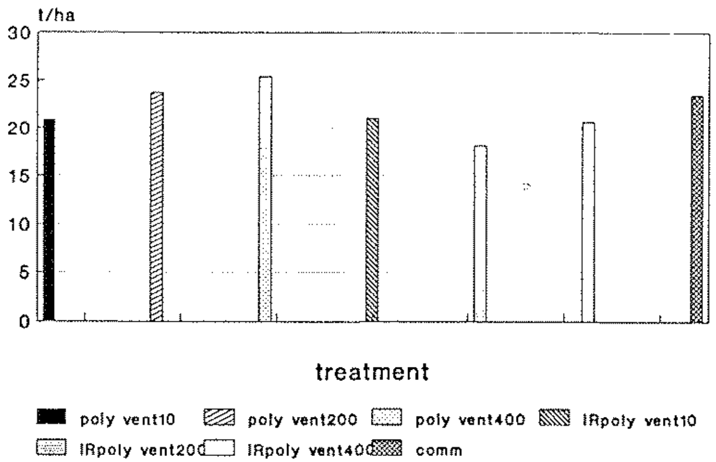
tonnes/hectare of roots

December sown



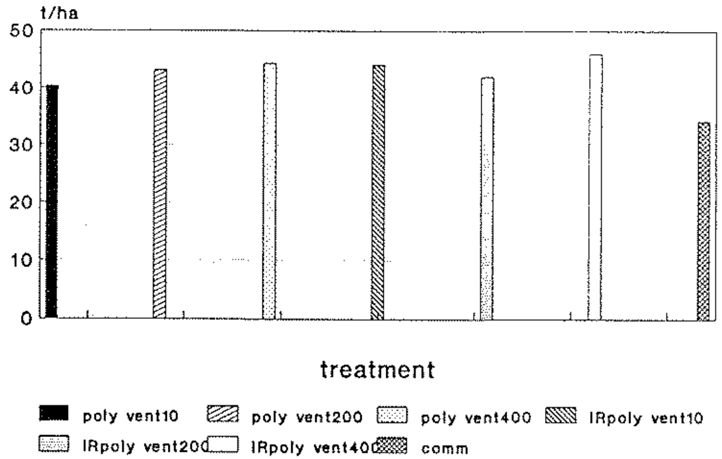
SED = 2.790 P = 0.05

January sown



SED = 1.559 P = 0.05

February sown



SED = 3.89 P = 0.05

TABLE 1 **December sown site**

Mean of 3 replicates

Number and weight/3.6 sq m

Treatment	**< 20 mm**		**> 20 mm**	
	No	**Wt/kg**	**No**	**Wt/Kg**
Polythene with 10 holes/sq m	167.3	1.167	138.7	5.68
Polythene with 200 holes/sq m	167.3	1.333	173.0	4.73
Polythene with 400 holes/sq m	156.7	1.317	138.0	4.20
IR Polythene with 10 holes/sq m	131.3	1.220	180.7	5.18
IR Polythene with 200 holes/sq m	122.0	1.213	171.0	5.95
IR Polythene with 400 holes/sq m	137.3	1.470	182.7	6.65
Control with 200 holes/sq m	131.0	1.653	225.0	6.80
Ground mean	140.8	1.339	172.7	5.31
SED	24.30	0.2279	34.04	0.947

TABLE 2 **January sown site**

Mean of 3 replicates

Number and weight/3.6 sq m

Treatment	**< 20 mm**		**> 20 mm**	
	No.	**Wt/kg**	**No**	**Wt/Kg**
Polythene with 10 holes/sq m	17.1	0.150	166.3	7.33
Polythene with 200 holes/sq m	17.5	0.150	168.7	8.40
Polythene with 400 holes/sq m	11.0	0.117	169.3	9.03
IR Polythene with 10 holes/sq m	10.5	0.100	185.7	7.45
IR Polythene with 200 holes/sq m	23.1	0.217	161.7	6.32
IR Polythene with 400 holes/sq m	25.2	0.283	192.3	7.13
Control with 200 holes/sq m	18.8	0.167	180.0	8.28
Ground mean	17.6	0.169	174.9	7.71
SED	3.88	0.0388	19.45	0.541

TABLE 3 **February sown site**

Mean of 3 replicates

Number and weight/3.75 sq m

Treatment	< 20 mm		> 20 mm	
	No	Wt/kg	No	Wt/Kg
Polythene with 10 holes/sq m	21.3	0.283	282.0	14.85
Polythene with 200 holes/sq m	10.7	0.1333	299.3	16.03
Polythene with 400 holes/sq m	20.7	0.200	284.3	16.43
IR Polythene with 10 holes/sq m	15.3	0.183	356.0	16.36
IR Polythene with 200 holes/sq m	12.3	0.133	299.0	15.60
IR Polythene with 400 holes/sq m	7.0	0.117	298.7	17.15
Ground mean	17.5	0.217	300.0	15.54
SED	9.41	0.0872	24.48	1.516

4. Field Observations

Normal polythene with only 10 holes per sq m did not "pond" during heavy rainfall which ran off into the wheelings. However, very little rainfall reaches the crop and it is likely that more irrigation will be required when polythene is removed.

Normal polythene with 10 holes per sq m was no more susceptible to wind damage than the polythene used commercially.

IR polythene was strong but "stretchy" and must be laid the right way up. This proved difficult after gale damage (December sown trial) when the polythene was covered in dust.

DISCUSSION

IR Polythene

Soil temperature and plant stand count results show that IR polythene was warmer than polythene with 200 holes per sq m currently used commercially on three sowing dates (December, January and February). However, an increase in yield was only achieved at the February sowing date.

Field observations suggest that a more rapid growth rate is achieved until early or mid April but from this point on crop growth on the IR polythene plots slowed down. This suggests that ventilation was inadequate (even 400 holes per sq m at the December and January sowing dates) or removal date and irrigation should be provided earlier.

Further management information is required to achieve the full potential of this type of polythene.

Solid Polythene

Soil temperature and plant stand count results show that polythene with reduced ventilation was warmer than polythene with 200 holes per sq m currently used commercially on three sowing dates (December, January and February) and an increase in yield was achieved at two sowing dates (January and February).

The December sowing date was affected by gale damage during early January. This site was north facing and exposed to the north east winds which were prevalent during January 1993. All treatments were equally affected, strong wind "worked loose" the polythene and this caused some damage to emerging plants.

CONCLUSIONS

1. IR Polythene

Soil temperature and rate of plant emergence was significantly increased at three sowing dates but a yield or earliness advantage at harvest was achieved only at the February sowing date. Further work is required on the interaction of ventilation with irrigation and removal date before the potential of this type of polythene can be realised.

2. Ventilation and solid polythene

Solid polythene progressively ventilated also increased soil temperature, rate of plant emergence and yield at two sowing dates.

Recommendations

1. IR polythene has potential for producing earlier carrot crops but further development work is required on the interaction of ventilation with removal date and irrigation.

2. IR polythene is more expensive than polythene used commercially, thinner and cheaper IR polythene should be developed.

3. IR polythene is currently designed for two seasons in Mediterranean countries. A system using IR polythene with 200 holes per sq m put in by the factory, and an earlier removal date could reduce the polythene disposal problem depending upon how many seasons this material could be used. This should be investigated.

4. Normal polythene progressively ventilated gave an increase in yield and a system of ventilating polythene on a field scale is required to realise the commercial advantage. This should be further developed.

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