Agricultural Development and Advisory Service

Report to: Horticultural Development Council
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No.of copies of report: 4 (2 held by ADAS)
This is copy no. 3: Issued to ADAS

CONTRACT REPORT

No.FV/20/87
Evaluation of calabrese varieties for early production using crop covers undertaken for HDC

COMMERCIAL - IN CONFIDENCE

PRINCIPAL WORKERS

D J Hand Ph.D	Technical Officer (Author of report)
R Goode	Assistant Scientific Officer

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.

.....

Signature

M R Shipway Ph.D
Director Efford EHS
May 1990

Report authorised by: .....

M R Shipway Ph.D
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Lymington Hants

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Date: May 1990

CONTENTS

EVALUATION OF CALABRESE VARIETIES FOR EARLY PRODUCTION USING CROP COVERS

Summary

The suitability of six varieties of calabrese for production under a standard nonwoven crop cover was assessed. The performance of individual varieties was measured as earliness, total marketable yield and the qualitative response of a range of head characteristics. Each variety was also grown at three densities achieved by reducing the within row spacing from 37 cm to 30 cm and 20 cm while retaining a standard 30 cm between rows.

Varieties differed significantly in the number of days needed to achieve the required developmental stage for cover removal, which was a head diameter of 10 mm. The number of days from laying to removal of the covers ranged from 37 to 44 for vars Regilio and Premium Crop respectively.

Rapid development of the variety Regilio resulted in the late removal of covers, the actual date of cover removal should have been nearer 30 days.

Total marketable yield expressed in t/ha did not differ significantly when comparing the six varieties. However, the percentage of marketable heads from the total was highest for var Regilio at 99.5% with Citation the lowest at 84.4%.

Cropping at the closest spacing of 30 x 20 cm resulted in a highly significant increase in yield of 1t/ha; a response common to all varieties. The increased yield was not to the detriment of quality although the diameters of individual heads and butts were reduced at the closest spacing.

Qualitative assessments of bud size, bud colour, head shape, cluster separation and angle of branching showed these to be distinct varietal characteristics.

Introduction

Demand for calabrese has risen steadily over recent years. The natural season for home production is from the middle of June until frost curtails the crop in the autumn. Whilst imports satisfy demand over winter and early spring, quality is often inadequate during early summer, at a time when many other vegetables are in short supply in the gap between overwintered and summer crops. Clearly there is a need to produce high quality early calabrese to extend the English season.

As a general technique previous ADAS trials have indicated that the correct use of low level crop covers could advance the season by up to 14 days so that cropping in the south could begin in early June.

Extensive trials to evaluate the use of crop covers for the production of early calabrese were undertaken during 1987 and 1988 by ADAS on behalf of the HDC. These trials, which were located at Efford EHS, clearly demonstrated the improvement in earliness that could be achieved by the use of crop covers; covered plots cropping 11 and 17 days earlier than bare soil plots in 1987 and 1988 respectively. In both 1987 and 1988 cover type and removal date as a function of the developmental stage of the crop were also investigated as was plant density.

Having established a clear 'blueprint' for the production of early calabrese under crop covers in 1987 and 1988 a further trial was undertaken in 1989 to evaluate the suitability of a number of the more established and newer varieties of calabrese for this production system. A similar, albeit smaller trial of four varieties in 1988 produced inconclusive results due to a high level of bolting in the crop, which, with the exception of the variety Primer 70 resulted in low marketable yields.

In 1989 a total of six varieties were grown under a standard nonwoven crop cover with a single cover removal date coincident with the crop achieving a head diameter of 10 mm. Previous studies (refer to the reports for 1987 and 1988) had shown there to be no further gain in earliness, yield or quality by delaying cover removal beyond this stage of development. The response of individual varieties to crop density was also evaluated.

Materials and Methods

Site: The trial was carried out at Efford Experimental Horticulture Station, Lymington, Hampshire. The soil on which the trial was sited was a well drained very slightly stony sandy silt loam of the Ludford series.

Husbandry: Seed of all six varieties were direct sown into Hassy 308 trays at a rate of one seed per cell on 13 February. Subsequent propagation and growth in the field was as near to standard commercial practice as possible. (For a full crop diary and cultural notes refer to Appendix II page 27).

Treatments:

Varieties: Mercedes
Southern Comet
Citation
Green Duke
Premium Crop
Regilio

Environment (cover type): Nonwoven (Agryl - 16g/$m^{2)}$

Cover removal:

Coincident with plants achieving a head diameter of 10 mm. Each variety was assessed individually. Note: The stage of growth at which covers were removed was consistent with the findings of the two earlier trials.

Spacings:

A standard 5 rows per 1.83m bed was used with 30 cm between rows. Within row spacings were 20 cm, 30 cm and 37 cm.

Experimental design

The trial followed a split plot design with varieties as the main plots and within row spacings as the split plots. All treatments had 3 replicates (for trial plan refer to Appendix III page 29).

Assessments

The following assessments were made for each treatment in the variety trials:-

Total yield (t/ha) and graded yield based on head diameter in the following categories < 50 mm, 50-75 mm, 75-100 mm and > 100 mm. All spears were trimmed to a length of 100 mm prior to recording.

Waste as a % of the total.

Distribution of butt diameters in size grades < 15 mm, 15-30 mm, 45-60 mm and > 60 mm expressed as a % of the total.

Distribution of head diameters in size grades < 50 mm, 50-75 mm, 75-100 mm and 100 mm expressed as a % of the total.

In addition to these quantitative records certain qualitative assessments were made in relation to head characteristics, these were:- bud size, bud colour, head shape, cluster separation and angle of branching (for a key to these characteristics refer to Appendix IV page 32).

Note: The number of harvests per plot was restricted to three. The first and second harvests were to clear the bulk of the primary heads. The third harvest, if required was designed to take any missed primary heads and any secondary heads exceeding 100 mm in length. Whilst varieties Southern Comet and Regilio produced a few secondary heads they were few in number and not subject to statistical analysis.

Soil and air temperature data were also collected using a Squirrel data logger (Grant Instruments Ltd).

Statistical analysis

All data were subjected to a full analysis of variance.

Results

Cover removal and first harvest:

The date covers were removed and hence the speed with which the crop achieved a head diameter of 10 mm differed considerably when comparing varieties (Table 1). Development of the variety Regilio was rapid with only 37 days elapsing between laying and removal of the covers. Indeed at the time of cover removal, Regilio had developed well beyond a head diameter of 10 mm and was found to be only two days from first harvest. This was in contrast to the other varieties where cover removal was at the correct developmental stage. The variety Premium crop was the slowest to develop with a first harvest almost one month after that for Regilio. The remaining four varieties were intermediate with respect to cover removal and first harvest date (Table 1). Crop density within varieties had no effect on development and hence time to first harvest.

Table 1

Dates of cover removal at a head diameter of 10 mm and first harvest

Variety	Date of Removal	No. of days from laying to Removal	Date of first Harvest
Mercedes	19 May	41	1 June
Southern Comet	17 May	39	30 May
Citation	19 May	41	1 June
Green Duke	17 May	39	1 June
Premium Crop	22 May	44	13 June
Regilio*	15 May	37	17 May

* Due to rapid development of the variety Regilio cover removal was approximately 7 days late.

Table 2 denotes the number of day degrees > 6°C accumulated between the 10 April (5 days after planting; 2 days after covers laid) and cover removal dates for each of the six varieties. These data again clearly demonstrate the significant increase in both air and soil temperature that can be achieved with low level crop covers.

Table 2

Day Degrees > 6°C accumulated between 10 April and each variety dependent cover removal date.

	Date			
	15 May	17 May	19 May	22 May
Cover removed from var:	Regilio	S.Comet Green Duke	Mercedes Citation	Premium Crop
Probe position*				
Crop (75mm)	281	300	320	356
Crop (Surface)	270	289	311	355
Bare soil (75mm)	187	207	232	274
Bare soil (Surface)	182	202	227	268

*Probes were positioned at the air/ground interface or at a soil depth of 75mm both in the crop and on adjacent bare soil.

Marketable and unmarketable yield:

Total marketable yield of primary heads measured as tonnes/ha increased with increasing plant density (Table 3).

Table 3

The effect of plant density on total marketable yield t/ha

	Spacing (cm)		
	30 x 20	30 x 30	30 x 37
Yield t/ha	5.00	4.35	3.98

SED (d.f.=24) = 0.545

However, as the plant density increased the proportion of heads falling within the smaller size grades (< 50mm and 50-75mm) increased. Detailed graded marketable yield data expressed both as t/ha and as a percentage of the total yield are presented in APPENDIX V (Tables A and B; pages 33 and 34).

The yields of the six varieties were shown not to differ significantly when expressed on a t/ha basis. However, when marketable and unmarketable yields were expressed as a percentage of the total, the differences between varieties were significant, $p < 0.01$ (Table 4).

Table 4

The effect of variety on marketable and unmarketable yield expressed as a % of the total harvested

Variety	Yield	
	% marketable	% unmarketable
Mercedes	87.3	12.7
Southern Comet	92.9	7.1
Citation	84.4	15.6
Green Duke	92.3	7.7
Premium Crop	97.7	2.3
Regilio	99.6	0.4
SED (d.f. = 24)	3.23	3.23

The varieties Regilio and Premium Crop produced high quality heads with 99% and 97% marketable respectively. Where the percentage of unmarketable heads was higher; Citation 15.6% and Mercedes 12.7%, this was almost exclusively due to bolting in the crop. Levels of other factors likely to result in downgrading of heads such as spear rot were insignificant.

Full comparisons of total marketable yield t/ha, marketable and unmarketable yield expressed as a percentage of the total weight for all variety x spacing treatments can be found in tables C to E (APPENDIX v page 35 to 37).

Distribution of butt and head diameters within size grades:

Butt diameter: The distribution of butt diameters within the size grades was shown not to differ significantly when comparing the six varieties. Butt diameters in the smallest grade (< 15mm) were however, strongly influenced by plant density; the greater percentage recorded were plants that were grown at the closest spacing of 30 x 20 cm, this effect of spacing was shown to be highly significant ($p < 0.001$). Within the size grade 15-30 mm, which accounted for the bulk of butts, the effect of crop density was less pronounced. With the exception of vars Premium Crop and Regilio grown at the widest spacing few butts exceeded a diameter of 30 mm.

Head diameter: The distribution of heads within the four size grades was, as with butt diameter, largely independant of variety. However, the varieties Regilio, Citation and Green Duke had a significantly greater percentage of their total heads within the size range 50-75mm. This may indicate a higher degree of uniformity within these three varieties. At the extreme ends of the size range, < 50m and 75-100mm (very few heads recorded exceeded 100 mm in diameter), plant density was highly significant ($p < 0.001$) in its effect; independent of variety (Table 5).

Table 5

Effect of plant spacing on the percentage of heads recorded in size grades 50 mm and 75-100 mm

	Spacing			SED
Size grade (mm)	30 x 20	30 x 30	30 x 37	(d.f.= 24)
< 50	24.3	14.4	10.1	2.46
> 75-100	14.6	26.8	32.3	3.51

(data presented are the means of all six varieties)

Close spacing (30 x 20) produced a larger percentage of heads with a diameer less than 50 mm. Conversely, a larger percentage of heads in the 75-100 mm size grade were produced when plants were grown at the widest spacing of 30 x 37 cm.

The effect of all variety x spacing combinations on the distribution of butt and head diameters within their respective size grades are presented in tables F and G (Appendix V pages 38 and 39).

Qualitative assessments of head characteristics:

All individual characteristics assessed were shown to differ very significantly ($p < 0.001$) when comparing the six varieties (Table 6). There was no effect of plant density on any of the qualitative parameters measured here.

Table 6

Qualitative assessments of head characteristics

Variety	Bud size (1 = smallest)	Bud colour (1 = palest)	Head shape (1 = flatest)	Cluster separation (1 = obvious clusters)	Angle of branching (1 = most pronounced branching)
Mercedes	5.6	6.4	4.8	5.2	5.4
Southern Comet	6.4	5.1	5.4	3.7	6.6
Citation	5.9	7.0	5.5	7.1	6.2
Green Duke	3.5	6.0	4.3	6.0	4.1
Premium Crop	5.3	4.9	3.9	5.5	6.0
Regilio	4.2	4.4	5.1	5.5	6.2
SED (d.f. = 24)	0.34	0.31	0.16	0.44	0.32

Refer to Appendix IV page 32 for a key to the values assigned above

Bud size: When comparing all six varieties the smallest buds were produced by the variety Green Duke; the largest in Southern Comet (Table 6).

Bud colour: Citation produced buds significantly darker than the other varieties under study. Although not significantly different from each other, the buds of Premium Crop and Regilio with scores of 4.9 and 4.4 respectively were considerably paler than those of the other four varieties.

Head shape: The deepest heads were produced by the varieties Southern Comet, Citation and Regilio. With a score of 3.9, the shallowest heads were recorded for Premium Crop.

Cluster separation: None of the varieties studied here possessed obvious bud clusters over the whole surface of the head. However, the poorest quality heads in this respect were recorded in the variety Southern Comet. The variety Citation with a score of 7.1 had only a few clusters confined to the perimeter of the head. The remaining varieties were not significantly different when compared with each other.

Angle of Branching: The angle of branching of Green Duke was the narrowest recorded in the present study and is largely consistent with these varieties tendency to produce shallow or flat heads. None of the varieties showed a very wide angle of branching which is again consistent with the intermediate head shapes (depths) recorded in the present study (refer to Appendix IV).

Discussion and Conclusions

During the three years over which this series of trials has taken place a wide variety of climatic and soil conditions have been encountered. Total rainfall during the first three months of 1989 was low by comparison with the preceding year (Appendix VI page 40) when excessive rainfall in January delayed preparation of the trial area; this was not the case in 1989. Planting of the trial on the 5 April was followed by light persistent rain which facilitated good establishment of the plants which may, in part, have accounted for the low incidence of bolting recorded in the trial when compared with the small variety trial done in 1988 when soil conditions did not favour rapid establishment. (refer to preceding HDC report).

All nitrogen was applied in the base as the presence of covers prevented the application of top dressings. The incidence of hollow stem was negligible and in all other respects the crop showed normal growth.

Growth rate, and hence the time at which plants reached the desired stage for cover removal, namely a head diameter of 10 mm, differed considerably when comparing the six varieties. The rapid growth rate of variety Regilio resulted in the covers being removed only two days before the first harvest. Whilst in this instance there is no evidence to suggest that yield or quality were reduced cover removal this late is not recommended. Earlier studies in this series have clearly demonstrated that there is no benefit in delaying cover removal beyond a head diameter of 10 mm. Indeed under warm humid conditions quality may suffer as a result of increased levels of spear rot and or physiological disorders of the flower head.

The variety Premium Crop produced a much larger frame than the other varieties studied here and the resultant tension in the crop cover gave rise to distortion of the leaves and made inspection of the crop to determine cover removal date difficult. On the basis of this trial the variety Premium Crop would not appear to be well suited to this production technique; although the percentage of heads marketable was very high, second only to Regilio (Table 4).

As with preceeding studies increasing crop density up to a spacing of 30 x 20 cm significantly increased the total marketable yield (Table 3). The increased number of heads falling in the smaller size grades when grown at the higher spacing clearly offers a reliable means of manipulating the crop. This effect has been recorded consistently in all three years.

Qualitative assessments demonstrated that the characteristics of the calabrese heads differed widely when comparing the six varieties under study. Whilst interesting, qualitative scores of this type are, to some degree, subjective and therefore the choice of variety is largely dependant on the perceived preferences of the consumer.

Recommendations for further work

Whilst the current study has been completed under the terms of the original contract it is recommended that new varieties continue to be evaluated for early production under crop covers and that the benefits of new materials are quantified.

Storage of Data

The raw data will be stored at Efford EHS, Lymington, Hants for a period of ten years. HDC will be consulted before disposal.

APPENDICES

APPENDIX I

HORTICULTURAL DEVELOPMENT COUNCIL

APPLICATION FOR A RESEARCH/DEVELOPMENT CONTRACT WITH HDC

PART I

Name of Proposer

DR D J HAND

Name and Address of Institute of Organisation

EFFORD EXPERIMENTAL HORTICULTURE STATION
Lymington
Hampshire
SO41 OLZ

Date of application
November 1988

PART II

PROPOSAL

1. TITLE OF PROJECT

Calabrese: Evaluation of varieties for early production under crop covers.

2. BACKGROUND

Extensive trials undertaken at Efford EHS on behalf of HDC have demonstrated the improvement in earliness and yield that can be achieved by using crop covers for the production of early calabrese.

3. OBJECTIVES

To evaluate the suitability of a range of varieties for early production using crop covers.

4. POTENTIAL BENEFIT TO THE INDUSTRY

The proposed investigation will enable the industry to select the most appropriate variety or varieties for use with crop covers and thus produce high quality early calabrese extending the English season. The take-up time of the research findings is likely to be immediate.

5. CLOSELY RELATED WORK IN PROGRESS OR RECENTLY COMPLETED

Early calabrese production using crop covers has been the subject of two trials (1987 and 1988) undertaken by ADAS on behalf of HDC.

6. DESCRIPTION OF THE WORK

The proposed trial will assess the merits of six varieties of calabrese for early production. The varieties Mercedes and Southern Comet will serve as controls having been present in both the proceeding trials; a further four varieties are to be selected.

Transplants are to be raised in Hassy 308 Modules from a mid February sowing. Throughout propagation and following transplanting in early April all cultural operations will, where the trial permits, follow best commercial practice.

All varieties will be covered with a standard crop cover to be removed at a head diameter of 10 mm to be determined for individual varieties. Within variety/cover treatments three crop densities of 30 x 37, 30 x 30 and 30 x 20 cm will be investigated. The trial will be of a split plot design with variety/cover being the main plot and crop density the split plot. All treatments are to be replicated three times. The following records will be taken from 40 plants per split plot: Total and graded marketable yield, % waste, measurements of butt and head diameter and a range of qualitative assessments of head characteristics. In addition a full crop diary and temperature records will be taken.

The number of harvests will be restricted to three. The first two will aim to clear all primary heads while the third any remaining primary heads and marketable secondaries. All records will be based on a spear trimmed to 100 mm in length.

7. STARTING DATE AND DURATION

Start 1.2.89, duration one year

8. STAFF RESPONSIBILITIES

Project leader, Dr D J Hand

Supported by Miss Sarah Stanley, Mr Roger Goode and Farm Staff

9. LOCATION

Efford EHS

10. COSTS

The following schedule of costs has been agreed:

	Man days	£
Technical Officer III	5	1105
SO	2	406
ASO	4	732
Farm Staff	12	612
	£	2855

Inclusive of all materials.

11. PAYMENT

CONTRACT, TERMS AND CONDITIONS AND SCHEDULE

MINISTRY OF AGRICULTURE, FISHERIES AND FOOD

CONTRACT FOR THE SUPPLY OF R & D AND SERVICING WORK

This form sets out the work which it is proposed that the Ministry of Agriculture, Fisheries and Food should do for you. It is subject to the conditions printed in the Terms and Conditions and Schedule attached. If you agree the terms please sign and return both copies of the forms. One set will be returned to you. The offer will remain open for 30 days from its date.

1. Name and address of customer

Horticultural Development Council, 18 Lavant Street,
Petersfield, Hampshire, GU32 3EW

2. Name and address of MAFF/ADAS Unit

Name/Title of Unit .Efford.EHS.....

Address .....Lymington, Hampshire.SO41.OLZ.....

3. Title of work proposed

Evaluation of varieties for early production under crop covers

See attached schedule for full details

4. Price and payment arrangements (including payment dates and VAT payments)

Price: £2,855 (+ VAT)

Payment to be made on completion of report

Proposed completion date July 1989

5. Name or title of person in charge for the customer and MAFF

MAFF Contract Manager Dr M R Shipway

Address if different from 2 above As 2 above

Customer's contact point As 1 above

Address if different from 1 above

6. Miscellaneous

7. Signed by — Agreed by

on behalf of MAFF ..... on behalf of customer .....

Dated ..... Dated .....

ADAS CONTRACT - TERMS AND CONDITIONS

Set out on the attached sheet are the particulars, terms and conditions which, upon acceptance of this offer, will constitute the contract between the Ministry of Agriculture, Fisheries and Food/Secretary of State for Wales and you (the client). Any variation must be agreed in writing and signed by the parties. No term or condition appearing on any order form or other document provided by the client shall be applicable and nothing said prior to the date below shall be deemed to be part of this contract. This offer is open for acceptance for 30 days from the date below.

Client: Horticultural Development Council

Address: 18 Lavant Street, Petersfield, Hampshire, GU32 3EW

Work to be done: Evaluation of varieties for early production under crop covers.

Price: £2,855 (+ VAT)

Payment Arrangements: Payment on completion of report

Miscellaneous:

Invoices will be payable on receipt and will be raised in accordance with the payment schedule set out above. VAT will be added if applicable.

I have read and accept the attached particulars, terms and conditions.

SIGNED BY

ON BEHALF OF THE CLIENT ..... DATE .....

SIGNED BY

ON BEHALF OF ADAS ..... DATE .....

1. If any payment is not made on the due date MAFF reserves the right to cease work and if it thinks fit terminate the contract. The client forfeits all rights to the receipt of the result if payment is not made as agreed. MAFF reserves the right not to provide services under this contract if payment is outstanding under any other contract between the client and MAFF.

2. If there is more than one party providing finance for the work, MAFF's agreement to do the work is conditional upon agreement being reached with all parties.

3. Any notices to be issued shall be in writing to the address given in the job description/quotation document and if sent by prepaid first class post shall be deemed to be served on the second business day after posting.

4. Contracts for a period of longer than 6 months or for the work of a named adviser shall be terminable by either part on one month's notice and if terminated the fee will be adjusted by MAFF to reflect the work done.

5. MAFF does not undertake to provide services of this type for the client alone.

6. The client warrants that all information provided by him or on his behalf will be full and accurate.

7. ADAS will treat as confidential to MAFF the information obtained by ADAS in the course of the performance of this contract which is specific to the client or the client's business but subject to any legal requirements to the contrary.

8. Any public mention by the client of ADAS or MAFF must be approved in advance in its context by ADAS and the client will not make any reference to ADAS or MAFF without such approval.

9. All materials and items of equipment which are to be supplied by the client for the purposes of the work shall be delivered, assembled, maintained, dismantled and collected at the client's cost and in accordance with the requirements of the MAFF staff responsible for the work. All equipment and other accessories (except those owned and provided by the client) and all materials used shall remain the property of MAFF.

10. MAFF shall not be held responsible for failure or delay in carrying out the work in whole or in part due to any circumstances whatsoever beyond its reasonable control.

11. MAFF shall be entitled to the copyright in respect of any working papers and any report(s) produced. The client will be entitled to publish the report subject to the provisions of condition 8.

12. If any patentable discovery is made in the course of the work MAFF and the client shall attempt to negotiate terms for the exploitation of that discovery, sharing the benefit as may be reasonable in the light of their respective contributions to the making of the discovery and the expected expenses of the exploitation. If agreement cannot be reached the terms shall be determined by a barrister agreed by MAFF and the client or in default of agreement by the President of the Law Society and such barrister shall act as an expert and not an arbitrator.

13. If the work involves the client or the client's employees attending MAFF premises, the client will remain responsible for their salaries and all other associated costs. The client will, and will procure that such employees sign the Official Secrets Acts if required by MAFF. The client will, and will procure that such employees, comply with MAFF security regulations whilst on MAFF premises. The client will hold MAFF indemnified against any claim made against it as a result of any tort committed by the client or any such employee whilst on MAFF premises. MAFF may at any time at its absolute discretion refuse to accept or continue to accept the client or any particular employee on its premises. MAFF is under no obligation to allow the client or the client's employees to witness work being done.

14. This contract will be subject to English law and both MAFF and the client hereby subject to the jurisdiction of the English courts.

15. ADAS is a part of the Ministry of Agriculture, Fisheries and Food. In the case of contracts made with the Secretary of State for Wales references in these terms and conditions to MAFF shall be construed as references to the Secretary of State for Wales.

MINISTRY OF AGRICULTURE, FISHERIES AND FOOD
AGRICULTURAL DEVELOPMENT AND ADVISORY SERVICE

SCHEDULE OF WORK FOR:-

Evaluation of varieties for early production under crop covers.

Name and address of customer

Horticultural Development Council
18 Lavant Street
Petersfield
Hampshire
GU32 3EW

Name and address of MAFF/ADAS Unit

Efford Experimental Horticulture Station
Lymington
Hampshire
SO41 OLZ

OBJECTIVE: To evaluate the suitability of a range of varieties for early production using crop covers.

TREATMENTS: Varieties
Mercedes
Southern Comet
Citation
Green Duke
Premium Crop
Regilio

Covering — Nonwoven (Agryl) 16 g/m_

Cover removal at a head diameter of 10 mm

Spacing (between x within row)
30 x 20 cm
30 x 30 cm
30 x 37 cm

TRIAL DESIGN: The trial is of a split plot design with each treatment replicated three times.

RECORDS:
Full crop diary
Total and graded marketable yield in t/ha; % waste
Distribution of Butt and Head diameters within size grades.
Qualitative assessments of head characteristics.

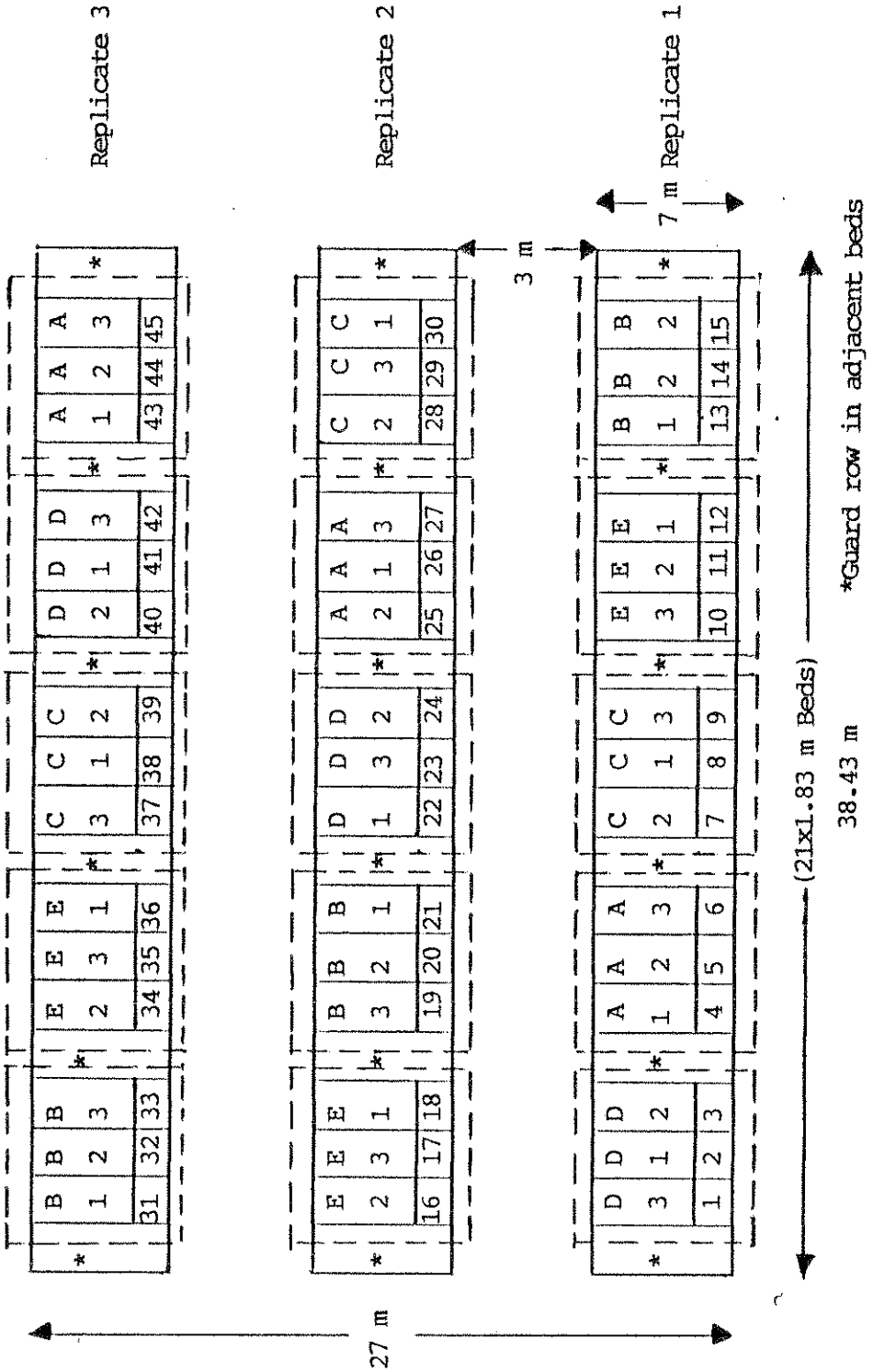
APPENDIX II
Crop diary and cultural notes

13 February	Seeds of all varieties were direct sown into Hassy 308 trays. Temperatures for germination and early growth were 18°C day and night. Over a period of 2 weeks seedlings were weaned to cold glasshouse temperatures.
24 February	Propamocarb hydrochloride (as Filex) drench 25 ml/10l water.
6 March	1st Liquid feed
7 March	Diquat + paraquat (as Cleansweep) applied to trial site 3 l/ha
20 March	Trial site limed 2t/ha
30 March	Iprodione (as Rovral Flo) 2l/ha
31 March	Propamocarb hydrochloride (as Filex) drench 25 ml/10l water
	Base fertilizer applied to field site 260:104:182 kg/ha NPK plus Solubor at 10 kg/ha
5 April	Trial planted. Plants placed in 100 mm deep furrows to prevent bending by crop covers.
7 April	Standard cabbage root fly control applied to all plants (Birlane granules)
8 April	Propachlor (as Ramrod) applied 9 l/ha plus chlorthal-dimethyl (as Dacthal) 6 kg/ha. *chlorthalonil (as Bombardier) 3 l/ha in 1000 l/ha water.
	Agryl covers laid
6 May	Trial irrigated (12 mm)
8 May	Trial irrigated (12 mm)
15 May	Agryl covers removed var. Regilio
17 May	Agryl covers removed vars. Southern Comet and Green Duke
	1st harvest var Regilio
19 May	Agryl covers removed vars Mercedes and Citation
22 May	Agryl covers removed var Premium Crop 2nd Harvest var Regilio
	Trial Irrigated (8 mm)
26 May	Final harvest var Regilio

26-28 May	Trial irrigated (24 mm)
30 May	Trial harvested
1 June	Trial harvested
6 June	Trial harvested
13 June	Trial harvested (1st harvest var. Premium crop)
16 June	Final harvest. Trial completed

APPENDIX III

CALABRESE - EVALUATION OF VARIETIES FOR
EARLY PRODUCTION UNDER CROP COVERS
(HDC TRIAL - 1989)



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KEY TO PLOT CODES

Variety	Spacing	Plot code
Mercedes	30 x 20	A1
"	30 x 30	A2
"	30 x 37	A3
Southern Comet	30 x 20	B1
"	30 x 30	B2
"	30 x 37	B3
Citation	30 x 20	C1
"	30 x 30	C2
"	30 x 37	C3
Green Duke	30 x 20	D1
	30 x 30	D2
	30 x 37	D3
Premium Crop	30 x 20	E1
	30 x 30	E2
	30 x 37	E3
Regilio	30 x 20	G1
	30 x 30	G2
	30 x 37	G3
Single plot area	(1.83 x 7m)	

Spacings:- Plant no/plot

30 x 20 = 5 rows x 35 plants = 175 plants/plot
30 x 30 = 5 rows x 23 plants = 115 plants/plot
30 x 37 = 5 rows x 19 plants = 95 plants/plot

For all plots 14 plants were harvested from each of the three centre rows. The recordable area therefore changed with crop density.

Spacing	Recordable area m^2
30 x 20	2.52
30 x 30	3.78
30 x 37	4.66

Bud size

Description	Score
Large	9
Medium	5
Small	1

Bud colour

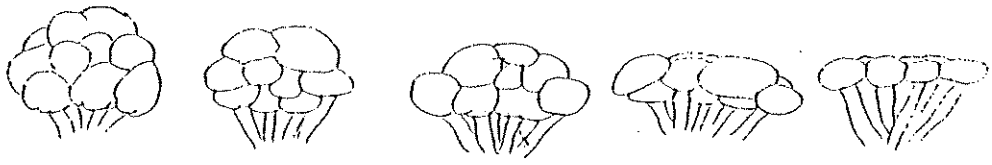
Description	Score
Dark green	9
Medium green	5
Pale green	1

Cluster separation

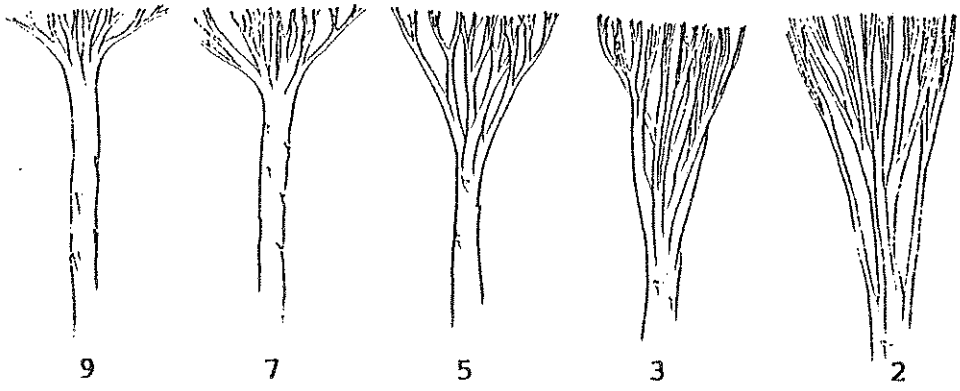
Description	Score
No bud clusters	9
Cluster of buds on perimeter of head	5
Obvious bud clusters over whole surface of head	1

QUALITY CHARACTER SCORING FOR CALABRESE

Head shape



Angle of branching



Top - Diagrammatic representation of primary heads of calabrese showing deep heads (9) and shallow heads (1).

Bottom - Diagrammatic representation of branching within primary heads. Wide angle branching (9), narrow angle branching (2).

Table A.

Graded marketable yield of primary heads t/ha

Variety	Spacing (cm) between x within row	Graded yield/head diameter (mm) <50	50-75	75-100	>100
Mercedes	30 x 20	0.42	2.56	2.14	0.00
	30 x 30	0.25	1.33	2.45	0.37
	30 x 37	0.10	1.75	1.11	0.07
Southern Comet	30 x 20	0.94	3.74	0.45	0.00
	30 x 30	0.14	2.11	1.71	0.00
	30 x 37	0.04	1.65	2.30	0.18
Citation	30 x 20	0.37	3.59	0.06	0.00
	30 x 30	0.22	2.70	1.10	0.00
	30 x 27	0.16	2.39	1.11	0.00
Green Duke	30 x 20	0.23	3.70	0.79	0.00
	30 x 30	0.07	2.81	1.65	0.00
	30 x 37	0.05	1.99	1.90	0.00
Premium	30 x 20	0.51	4.16	0.99	0.00
	30 x 30	0.28	2.85	1.08	0.00
	30 x 70	0.06	2.10	1.96	0.67
Regilio	30 x 20	0.88	4.08	0.35	0.00
	30 x 30	0.09	3.76	1.13	0.00
	30 x 37	0.22	2.78	1.28	0.00
SED (d.f. = 24) comparison of varieties x spacing =		0.217	0.518	0.791	-
Comparison of spacings within variety =		0.191	0.478	0.726	-

Table B.

Graded marketable yield of primary heads t/ha

Variety	Spacing (cm) between x within row	Graded yield/head diameter (mm) <50	50-75	75-100	>100
Mercedes	30 x 20	8.4	47.3	33.6	0.0
	30 x 30	11.7	31.9	37.3	5.5
	30 x 37	4.2	54.1	26.4	1.5
Southern Comet	30 x 20	19.0	71.5	9.1	0.0
	30 x 30	3.0	46.0	36.2	0.0
	30 x 37	0.9	39.5	50.2	3.2
Citation	30 x 20	7.6	68.1	0.9	0.0
	30 x 30	6.7	62.9	20.4	0.0
	30 x 27	4.9	57.5	24.2	0.0
Green Duke	30 x 20	4.6	74.5	15.5	0.0
	30 x 30	1.6	61.1	31.9	0.0
	30 x 37	1.4	47.1	39.2	0.0
Premium	30 x 20	9.8	72.5	15.3	0.0
	30 x 30	6.6	65.8	25.1	0.0
	30 x 37	1.4	46.4	37.1	13.0
Regilio	30 x 20	17.9	75.3	6.8	0.0
	30 x 30	2.3	76.9	20.8	0.0
	30 x 37	5.0	64.2	29.5	0.0
SED (d.f. = 24) comparison of varieties x spacing =		6.34	11.33	12.94	-
comparison of spacings within variety =		5.33	11.34	11.69	-

Table C

Total marketable yield (primary heads) t/ha

	Spacing (cm)		
Variety	30 x 20	30 x 30	30 x 37
Mercedes	5.14	4.40	3.03
Southern Comet	5.13	3.96	4.16
Citation	4.02	4.01	3.65
Green Duke	4.72	4.53	3.95
Premium Crop	5.67	4.22	4.79
Regilio	5.30	4.98	4.28
SED (d.f. = 24) Comparison of spacings within a variety =	0.638	0.638	0.638
SED (d.f. = 24) Comparison of varieties x spacings =	0.754	0.754	0.754

Table D

Marketable yield expressed as a percentage of the total weight

	Spacing (cm)		
Variety	30 x 20	30 x 30	30 x 37
Mercedes	89.3	86.4	86.3
Southern Comet	99.6	85.3	93.9
Citation	76.5	89.9	86.6
Green Duke	94.6	94.6	87.7
Premium Crop	97.6	97.6	97.9
Regilio	100.0	100.0	98.7
SED (d.f. = 24)			
Comparison of spacings within a variety =	5.48	5.48	5.48
Comparison of varieties x spacings =	5.52	5.52	5.52

Table E

Unmarketable yield expressed as a percentage of the total weight

	Spacing (cm)		
Variety	30 x 20	30 x 30	30 x 37
Mercedes	10.7	13.6	13.7
Southern Comet	0.4	14.7	6.1
Citation	23.5	10.0	13.4
Green Duke	5.4	5.4	12.3
Premium Crop	2.4	2.4	2.1
Regilio	0.0	0.0	1.3
SED (d.f. = 24) comparison of varieties x spacing =	5.52	5.52	5.52
Comparison of spacings within variety =	5.48	5.48	5.48

Table F

Distribution of butt diameters within the size grades expressed as a % of the total number

Variety	Spacing (cm) between x within row	Butt diameter (mm) <15	15-30	30-45	45-60	>60
Mercedes	30 x 20	22.9	59.3	0.0	0.0	0.0
	30 x 30	13.6	63.6	0.0	0.0	0.0
	30 x 37	22.3	61.6	0.0	0.0	0.0
Southern Comet	30 x 20	33.3	56.3	0.0	0.0	0.0
	30 x 20	16.2	68.0	0.0	0.0	0.0
	30 x 37	9.4	74.6	2.9	0.0	0.0
Citation	30 x 20	23.4	56.6	0.0	0.0	0.0
	30 x 30	9.0	73.2	0.0	0.0	0.0
	30 x 37	3.0	74.5	0.0	0.0	0.0
Green Duke	30 x 20	15.7	71.8	0.0	0.0	0.0
	30 x 30	3.0	79.9	0.0	0.0	0.0
	30 x 37	0.0	76.7	2.9	0.0	0.0
Premium Crop	30 x 20	13.4	66.0	2.9	0.0	0.0
	30 x 30	0.0	76.7	0.0	0.0	0.0
	30 x 37	0.0	63.5	18.8	0.0	0.0
Regilio	30 x 37	14.6	75.4	0.0	0.0	0.0
	30 x 30	6.0	72.4	11.4	0.0	0.0
	30 x 37	6.7	68.7	14.8	0.0	0.0
SED (d.f. = 24)						
Comparison of varieties x spacings =		9.79	9.61	4.58	-	-
Comparison of spacings within variety =		6.65	6.95	4.35	-	-

Table G

Number of marketable heads within size grades expressed as a % of the total

Variety	Spacing (cm) between x within row	Head diameter (mm) <50	50-75	75-100	100
Mercedes	30 x 20	19.9	46.8	29.1	0.0
	30 x 30	14.5	36.6	30.9	6.7
	30 x 37	14.5	52.3	25.5	2.9
Southern Comet	30 x 20	34.4	50.6	11.0	0.0
	30 x 30	15.7	48.2	32.9	0.0
	30 x 37	7.2	44.0	41.8	5.2
Citation	30 x 20	21.1	58.5	3.0	0.0
	30 x 30	18.7	54.8	19.8	0.0
	30 x 37	12.2	53.8	25.5	0.0
Green Duke	30 x 20	18.6	60.4	19.0	0.9
	30 x 30	10.1	56.0	29.6	0.0
	30 x 37	7.2	48.9	36.7	0.0
Premium Crop	30 x 20	21.3	55.7	15.8	0.0
	30 x 30	19.4	54.8	23.3	0.0
	30 x 37	7.2	45.9	34.9	14.1
Regilio	30 x 20	30.7	56.3	9.7	0.0
	30 x 30	8.1	62.7	24.2	0.0
	30 x 37	12.2	54.3	29.7	0.0
SED (d.f. = 24) (Comparison of varieties x spacings) =		7.62	5.60	9.71	-
(Comparison of spacings within variety) =		6.03	5.97	8.61	-

APPENDIX VI

Comparison of climatic conditions in 1987, 88 and 89

	Total Rainfall (mm)	Total sunshine (hrs)	Air frost (days)	Ground frost (days)	Temp (°C) min	max	Light Integral (daily mean) g/cal/cm^2
Jan 1987	15.8	66.1	19	20	- 9.2	10.3	68
1988	170.9	61.2	3	9	- 1.0	11.5	66
1989	30.6	68.4	4	10	- 2.3	11.8	68
Feb 1987	60.4	83.0	10	15	- 3.5	13.0	131
1988	47.3	132.8	4	18	- 2.1	12.0	162
1989	20.1	46.0	2	15	- 1.7	13.5	144
Mar 1987	95.7	122.2	11	17	- 4.8	11.9	210
1988	82.0	105.1	4	10	- 3.2	12.6	202
1989	20.7	103.8	2	10	- 2.6	17.6	193
Apr 1987	69.1	200.4	0	8	0.2	19.7	356
1988	39.5	194.6	2	9	- 1.1	15.8	379
1989	71.7	169.4	1	11	- 0.4	13.6	315
May 1987	19.3	240.8	0	9	1.8	22.4	448
1988	27.9	248.5	0	2	3.1	23.7	482
1989	13.7	327.6	0	1	4.4	26.6	542
Jun 1987	54.4	173.7	0	1	2.7	24.3	419
1988	34.3	183.1	0	0	6.0	26.2	410
1989	34.6	277.5	0	1	4.5	27.4	530