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Bulb Onions: control of
wind erosion on light soils
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ADAS - Food, Farming, Land & Leisure

Report to: Horticultural Development Council
18 Lavant Street
Petersfield
Hants., GU32 3EW

ADAS Contract Manager: C Speller
ADAS Arthur Rickwood
Mepal
Ely
Cambs., CB6 2BA
Tel: 0354 692531

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PRINCIPAL WORKER

Sally R Runham BSc. (author of report).

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.

C Speller .... Date 22.1.93 ....

Colin Speller, Contract Manager

CONTENTS

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Summary

Systems of inter-row barley as a living shelter crop were evaluated for their potential to protect both land prepared for onion crop production and onion plants themselves. Barley cv. Igri was sown (by hand) in October 1991 and in January and March 1992 at 40 and 120 kg/ha with either two or three rows per 1.7 m bed. A further treatment, tractor-drilled in March, comprised wide bands (10 cm) of barley between onion rows. Onions cv. Hysam were drilled on all plots on 20 February.

Fen blows occurred in April and May and commercial crops were lost, including one field of onions c. 1 km from the trial site. However, no soil movement or plant damage occurred on the trial site itself. The systems were evaluated in terms of the length of time that they 'appeared to offer protection' from wind damage.

Both October- and January-sown barley established earlier than the standard system of March-drilled barley, and were at growth stages 5 and 2 (Feeke's scale) respectively, when barley drilled in March was emerging. Barley drilled both in October and January was killed by the standard pre-emergence (of onions) application of paraquat (as Gramoxone 100) in mid-March. Although October-drilled barley, particularly at the higher seed rate, retained some soil stabilising capacity as a dead 'mulch' until mid-May, January-drilled barley rapidly degraded and lost its usefulness.

Barley drilled in March at a higher rate (120 kg/ha) than normally used in commercial crops (40 kg/ha) appeared to give better wind protection from early April, but was probably beginning to compete with onions in mid-May, when selectively controlled using fluazifop-P-butyl (as Fusilade 5). All systems gave similar onion plant populations, yields and quality.

Objective

To identify better systems for wind erosion control, on light soils, which offer earlier and longer term protection to both the land prepared for onions and the crop itself.

Introduction

On light soils there is a risk of minor wind damage to crops in every season. At ADAS Arthur Rickwood, significant onion crop loss can be expected on 14 occasions in 10 years as a result of wind blow (MacLeod and Rickard, 1985). Most crops on fenland soils are protected with some form of shelter system which, in recent years, has been almost exclusively a living crop of barley, selectively suppressed and then killed in May. The limitations of this system are the need to drill barley late to allow an application of paraquat very close to onion emergence for weed control, and also to limit its competition with the onions until it is safe to apply the graminicide (although recent experiences with the highly selective graminicide Fusilade 5 indicate it could be used at earlier onion growth stages than stated on the product label). The period from seed-bed preparation to the first true leaf stage of the onions (February to mid-May) is when the crop is especially vulnerable to blows. Current systems of inter-row barley offer valuable, but often limited protection. At ADAS Arthur Rickwood, one field of onions was lost to fen blows in May 1992 and other fields of onions were damaged in spite of having inter-row shelter systems.

This experiment, in its first year, evaluated modified living shelter techniques including systems used in Canada (Rickard, pers. comm.) which could reduce to a minimum the period during which the soil is susceptible to wind erosion.

Materials and Methods

Site

The experiment was conducted on House Ground field at ADAS Arthur Rickwood. The soil was a loamy peat (90 cm deep) with 35% organic matter content overlaying fen clay (of the Prickwillow series).

Treatments

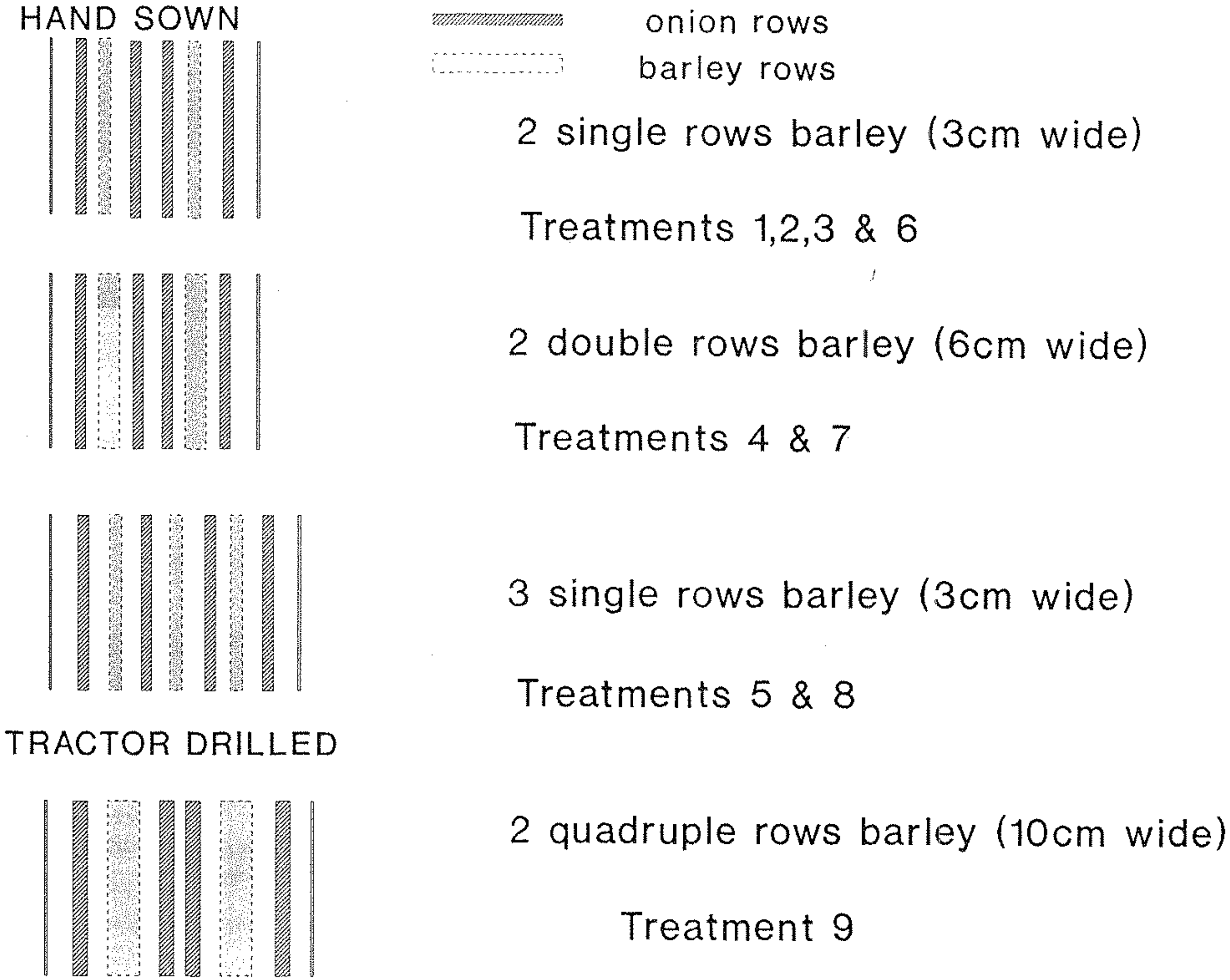
Table 1: Inter-row barley systems.

Treatment No.	Cultivation timing	Sowing (drilling#) timing	Seedrate (kg/ha)	Row No.	Chemical control
1 (control)	February	March	40	2	Fusilade 5
2	October	March	40	2	Fusilade 5
3	October	October	40	2	Gramoxone 100
4	October	October	120	2	Gramoxone 100
5	October	October	120	3	Gramoxone 100
6	January	January	40	2	Gramoxone 100
7	January	January	120	2	Gramoxone 100
8	January	January	120	3	Gramoxone 100
9#	February	March	120	2 (Broad band)	Fusilade 5

Inter-row arrangement of barley on the bed for each system is shown in Figure 1.

The dates of cultivation, barley sowing or drilling, and barley destruction are shown in Appendix I. The distribution of barley seed is shown in Appendix II.

Fig 1. SPATIAL ARRANGEMENT FOR INTER-ROW BARLEY



Husbandry

On 14 October 1991, appropriate plots were cultivated by one pass of a power harrow, then barley cv. Igri was hand-sown 50 mm deep in rows according to treatment specification for treatments 3, 4 and 5. (Table 1, Figure 1). On 7 January 1992, appropriate plots were cultivated by one pass of a power harrow, and barley was sown for treatments 6, 7 and 8. On 20 February, following cultivation by one pass of the power harrow to all remaining beds, onions cv. Hysam were drilled using a Stanhay Webb Mark II drill to give a target plant population of 45-50 plants/m^2. On 6 March, barley was sown by hand for treatments 1 and 2, and, on 10 March, tractor-drilled (treatment 9) using a Stanhay Webb Mark II drill with four units in tandem to get a broad band of seeds. The onions were grown using standard husbandry inputs for a spring-drilled crop. Pre-emergence herbicides, including paraquat (as Gramoxone 100) were applied to the whole trial on 16 March, which killed established barley on all plots. Barley which subsequently emerged (treatments 1, 2 and 9), was checked and eventually killed by an application of fluazifop-P-butyl (as Fusilade 5) to the whole trial on 12 May (onions at first true leaf stage). The trial received standard inputs other than the wind erosion control system during the season (Appendix I). The trial was harvested on 1 September, soon after reaching maturity (80 % foliar fall-over stage), and onions were dried at 30 °C for 3 days, cured at 28 °C and 65 % R.H for 14 days, then removed from storage on 22 October and assessed for yield and quality.

Assessments

Barley establishment was observed and photocopies of young plants made at certain growth stages. Onion bolting (%) was recorded on 22 June. Plant population (plants/m^2) at harvest, and yield in marketable size grades (40-50 mm, 50-60 mm, 60-80 mm diameter) and quality (EC Marketing standards) were recorded after drying and curing.

Design and statistical analysis

The trial design was a randomised block with three replicates. Each plot was 10 m long by 1.68 m wide (16.8 m^2). Each plot was separated from neighbouring plots by 1 bed width to accommodate a 3.5 m wide power harrow. Barley was drilled (as for treatment 5) on all of these 'discard' beds. The onion drilling arrangement was four rows at 350-250-350 mm spacing. The arrangement of barley rows is shown in Figure 1.

The data were subjected to statistical analyses.

Results

Barley plant establishment

Barley sown on 14 October emerged within 14 days and established quickly and uniformly. The fairly finely tilled seedbed was not disturbed by a fen blow on 22 October. Barley sown on 7 January commenced emergence on 17 February. Barley drilled or sown on 6 March emerged from 17 March. Some growth stages of the barley are shown in Figures 2-4. A visual assessment of the potential shelter benefit from the barley systems is shown in Figure 5.

Bolted onion plants

On 22 June, the number of bolted plants were recorded. There were, on average, 0.13 % of bolted plants, with no significant differences between the treatments.

Onion plant population

At harvest there were, on average, 36 plants/m^2 (lower than the target 45-50 plants/m^2) but with no significant differences between treatments (Table 2). Where the onion seeds had been drilled into an autumn-prepared seedbed there were, on average, 36 plants/m², and where drilled into a spring-cultivated seedbed there were, on average, 35 plants/m².

Onion yield

The mean total yield of onions was 35.8 t/ha, which was about average for most seasons, but slightly low for the relatively warm and very wet year (Appendix III) and soil type; these conditions typically give total onion yields around 50 t/ha. The relatively low yield reflected the lower than target plant populations. There were no significant differences between treatments in either total or marketable yields (Table 2).

Table 2 Plant population (plants/m²) at harvest, total yield (t/ha) and yield (t/ha) of over 50 mm diameter bulbs.

Treatment Number	plants/m²	Yield (t/ha) total	over 50 mm
1	32	32.3	16.4
2	39	38.6	16.8
3	37	37.7	18.2
4	36	36.4	22.7
5	31	31.0	17.8
6	39	38.6	20.5
7	34	34.4	18.4
8	38	38.3	21.8
9	34	34.3	18.5
mean	36	35.8	19.0
S.E.D. (18 d.f.)	3.7	3.68	4.38
L.S.D. (5%)	7.7	7.73	9.20

Defective bulbs

There were very few defective bulbs, which comprised, on average, 0.6 % of thicknecked, 0.5 % of split, 0.3 % of rotten, and 0.2 % of mechanically

FIG. 2
Treatments: 1,2,9
sown: 6 March 1992
photocopied: 6 April 1992
Growth Stage: 1

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FIG. 3

Treatments: 3,4,5
sown: 14 October 1991
photocopied: 15 March 1992
Growth Stage: 23

FIG. 4
Treatments: 6,7,8
sown: 7 January 1992
photocopied: 15 March 1992
Growth Stage: 2

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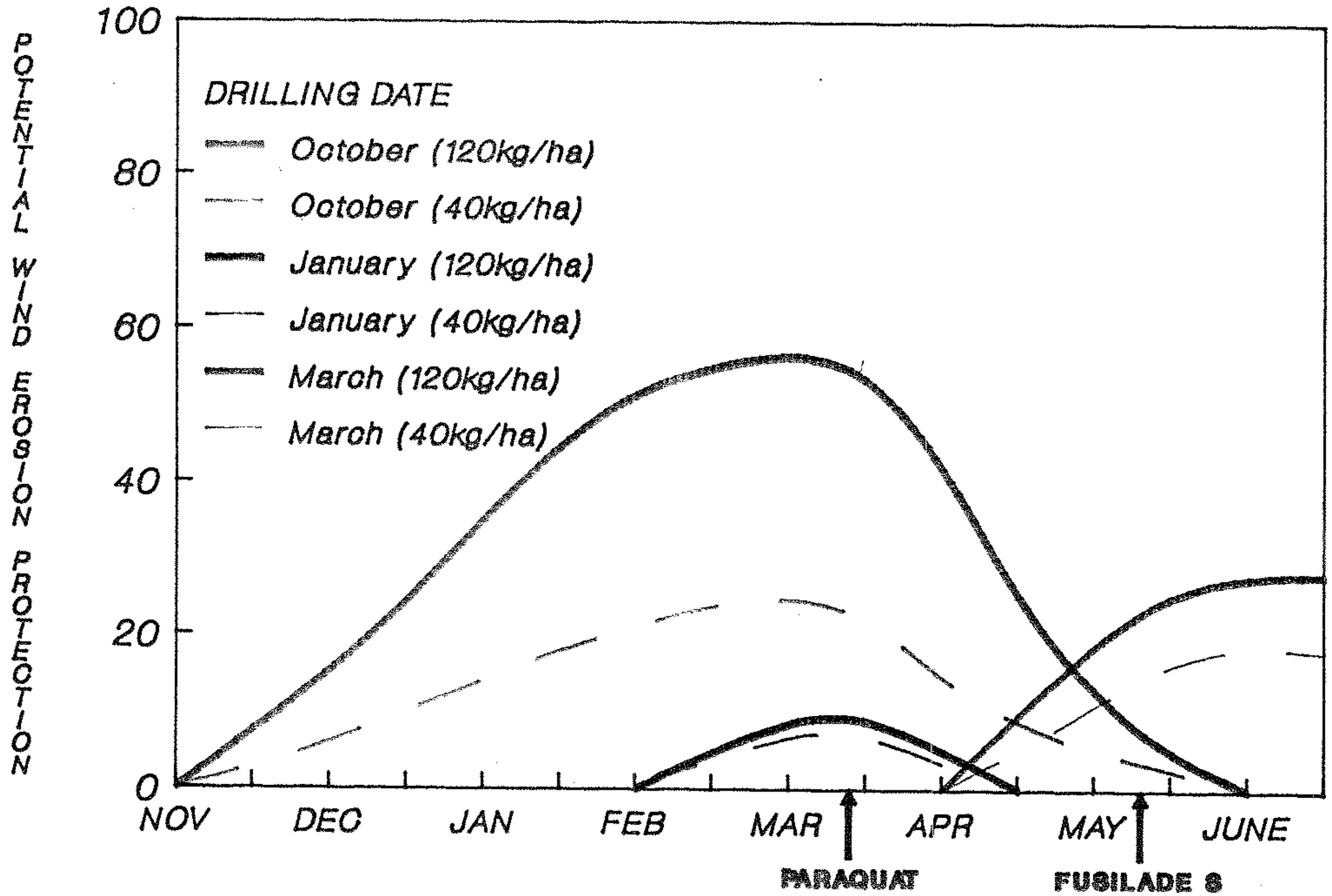
Fig 5. VISUAL ASSESSMENT OF SHELTER BENEFIT FROM INTER-ROW BARLEY SYSTEMS.



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damaged bulbs when removed from storage and graded. There were no significant differences between the treatments.

Bulb quality

The bulbs were very firm (mean score 9.0), and with good skin protection (mean score 7.4). They were fairly dark brown after drying (mean score 7.1), rather flattened in shape (mean score 3.6) with moderate uniformity (mean score 6.4). There were no significant differences between the treatments. The mean scores for both spring- and autumn-cultivated treatments were very similar for all parameters.

Discussion

It is not clear why the mean plant population of 36 plants/m^2 was lower than the target 45-50 plants/m^2. It may have been due to poor seed vigour; the seeds were small but with 90 % germination. All treatments had similar plant stands, even from over-wintered seed-beds without barley shelter protection (treatment 2). Although yield differences were not significant at 5 % level, treatment 9 had slightly lower ($P<0.1$) yields. On this system, barley plants were drilled close to rows of onions and either some disturbance of chitted seed, or subsequent plant competition may have occurred.

The main differences between treatments were in their 'perceived shelter benefit', with a view to developing the more promising of the systems and to assessing the shelter effect on large plots (using low-level anemometers to measure wind speed). In spite of strong winds during May, no soil movement was observed on the trial site and no crop damage occurred even though nearby crops were decimated.

The systems offered potential protection from wind erosion damage (Figure 5). October-drilled systems protected bare ploughed land, tilled land and young crops from November until early April, when the effects of pre-emergence Gramoxone 100 began to show. Even then, the high seed rate of barley at an advanced growth stage (23) offered protection as a dead mulch. It had, however, less apparent value as a shelter crop than March-drilled barley from early April. The October-drilled barley was completely degraded by mid-May.

January-drilled barley was slow to establish and was only at growth stage 2 (Feeke's scale) when Gramoxone 100 was applied. After this, it degraded quickly, offering no perceived shelter protection even as a mulch. It may be possible to modify the management of this system, for example, by using Fusilade 5 throughout rather than use Gramoxone 100 but this could make subsequent broad-leaved weed control more difficult. Alternatively, Gramoxone 100 could, if required, be used immediately prior to barley emergence in early February, for broad-leaved weed control, with subsequent grass weed control using Fusilade 5.

Barley drilled in wide bands at very high seed rate (120 kg/ha) in early March appeared to offer more reliable protection from wind than narrower bands at the lower seed rate (40 kg/ha). The close proximity of barley plants to young onion plants seemed likely to lead to yield reduction due to plant competition: earlier applications of Fusilade 5 to suppress the barley are likely to be required with this system.

Overall, the experiment indicated that earlier established inter-row barley shelter systems could offer longer and, possibly, more reliable wind erosion protection for fenland soils prepared for onion crops. The scope for evaluating October-drilled barley on other types of light soil warrants further study. Modified management of a January-drilled barley system may prove worthwhile where land is not available in October, for example after late-harvested sugar beet.

A combination of both October- and March-drilled barley systems (on alternate beds) could give particularly long-lasting protection from fen blows.

Conclusions

1. Barley drilled in October or January established before March-drilled barley and appeared to offer protection from wind erosion earlier in the season.

2. October-drilled barley established rapidly and was sufficiently well-developed by the time of onion emergence in mid-March that, even after being killed by an application of paraquat (as Gramoxone 100), it offered some protection from wind until it totally degraded by mid-May.

3. The January-drilled barley system gave earlier shelter protection but it was not sufficiently long-lasting given the management described in this trial.

4. All systems evaluated in this trial gave similar yields and quality of bulb onions, indicating that there was no penalty from drilling the crop into an over-wintered seed-bed and that the graminicide Fusilade 5 had been applied sufficiently early to check vigorous barley growth.

References

MACLEOD, J. and RICKARD, P.C. (1985). Effects of cereal cover crop and planted straw on yields of onions and sugar beet. *British Crop Protection Conference - Weeds*, 449-455.

Acknowledgement

The provision of funding through the Horticultural Development Council (UK) is gratefully acknowledged.

Recommendations

1. October- and January-drilled inter-row barley systems should be evaluated on a large plot scale and reductions in wind speed at crop level measured using suitable equipment.

2. Management of both October- and January-drilled inter-row barley systems should be studied to gain long-lasting wind erosion protection.

3. A combination of October- and March-drilled barley systems should be studied to gain maximum wind erosion protection.

4. The use of inter-row barley systems on other types of light soil should be evaluated.

Appendix I

<u>Management of the trial site</u>

Previous cropping 1991 onions
1990 sugar beet
1989 winter wheat

Crop diary

Cultivations

<u>Husbandry</u>

7 October	ploughed
10 October	beds wheeled out
14 October	power harrowed 'autumn-cultivated' beds with Kuhn (one pass)
7 January	hand-sow barley (treatments 3, 4 and 5) power harrowed January-cultivated plots hand-sow barley (treatments 6, 7, 8)
20 February	drill onions cv. Hysam on all plots
10 March	hand-sow barley (treatments 1 and 2).
6 March	drill barley (treatment 9) using Stanhay Webb Mk II (tandem)

<u>Herbicides</u>

16 March	4.32 kg/ha ai propachlor + 2.24 kg/ha ai chlorpropham + 0.6 kg/ha ai paraquat as 9 l/ha cp Ramrod Flo + 5.6 l/ha CIPC 40 + 3 l/ha cp Gramoxone in 600 l/ha water.
11 April	0.45 kg/ha ai chlorbufam + 0.5 kg/ha ai chloridazon as 2.25 l/ha cp Alicep in 450 l/ha water
22 April	Alicep as above
12 May	0.13 kg/ha ai fluazifop-P-butyl as 1 l/ha cp Fusilade 5 in 250 l/ha water + Agral wetting agent.
3 June	0.16 kg/ha ai ioxynil + 0.35 kg/ha ai cyanazine as 0.7 l/ha cp Totril + 0.7 l/ha cp Fortrol in 400 l/ha water
18 June	0.11 kg/ha ai ioxynil + 0.7 kg/ha ai cyanazine as 0.5 l/ha cp Totril + 1.4 l/ha cp Fortrol in 400 l/ha water.

<u>Insecticides</u>

20 February	2.8 kg/ha ai aldicarb as 28 kg/ha cp Temik (granules)
23 June	0.96 kg/ha ai chlorpyrifos as 2 l/ha cp Dursban 4 in 1000 l/ha water (cutworm control)

Fungicides

20 February	benomyl + thiram seed treatments
23 July	1 kg/ha metalaxyl + 1.5 kg/ha ai chlorothalonil as 2 l/ha cp Folio in 200 l/ha water.
24 July	1.0 kg/ha ai chlorothalonil as 2 l/ha cp Bravo in 300 l/ha water (+ Bond wetting agent).

Fertiliser

5 December	109 kg/ha Triple Superphosphate + 133 kg/ha Muriate of Potash.
25 April	40 kg/ha N
1 June	40 kg/ha N

Trace elements

15 May	9 kg/ha $MnSO_4$ in 280 l/ha water
9 June	8 kg/ha $MnSO_4$ in 250 l/ha water
7 July	8 kg/ha $MnSO_4$ in 250 l/ha water

Irrigation

2 July	25 mm

Sprout suppressant

14 August	3.1 kg/ha ai maleic hydrazide as 17 l/ha 18 % maleic hydrazide in 500 l/ha water.

Harvest

1 September

Store removal

22 October

Appendix II

Barley seed rate and distribution

Treatment	seed rate kg/ha	seeds/m²	seeds/ m row	plants/m² row# on 6 March[1] or 6 April[2]
1	40	84	70	59[2]
2	40	84	70	58[2]
3	40	84	70	64[1]
4	120	252	210	193[1]
5	120	252	140	124[1]
6	40	84	70	65[1]
7	120	252	210	188[1]
8	120	252	140	122[1]
9	120	252	210	193[2]

1 replicate only

Appendix III

Weather records 1991/92

	Temperatures (°C)						Rainfall (mm)	
	Extremes			Accumulated day degrees above 6°C		Mean soil temp at 10 cm		
	Air Max	Min	Grass Min	Current Year	24 yr Mean		Current Year	24 Yr Mean
Oct	21.2	- 2.9	- 7.1	155	164	9.7	21.0	46.7
Nov	15.8	- 2.6	- 6.8	62	62	5.9	41.9	50.3
Dec	14.8	-10.3	-14.5	39	33	4.9	16.9	43.9
Jan	12.4	- 5.6	-10.4	24	24	3.4	48.8	42.1
Feb	15.0	- 3.4	- 5.4	24	20	4.2	9.6	30.4
Mar	16.4	- 0.8	- 4.2	72	77	6.5	9.5	41.1
Apr	17.9	- 0.7	- 5.7	116	129	8.5	39.0	37.6
May	27.7	1.3	- 1.2	262	173	14.8	48.6	48.0
Jun	30.0	5.1	2.0	313	257	18.2	26.2	51.7
Jul	27.7	7.5	2.6	357	329	18.4	87.5	43.5
Aug	25.8	5.6	1.4	333	327	16.9	66.4	49.2

Notes: For the purposes of this table:

1. Reading taken at 0900 hours GMT.
2. A temperature of at least 6°C (42°F) is normally considered necessary for plant growth. Accumulated temperatures (day degrees) above 6°C are a measure of plant growth during the month.

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