

A REPORT TO THE HORTICULTURAL DEVELOPMENT COUNCIL
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SAVOY CABBAGE: FROST SUSCEPTIBILITY

ANNUAL REPORT

Project Number: FV93

Project Title: Savoy Cabbage: Examination of factors which might affect frost susceptibility

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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

Application

A trial was carried out to assess the effect of nitrogen fertiliser rates and planting date on levels of frost damage in savoy cabbage using four widely grown varieties.

The highest levels of internal frost damage were recorded in Alaska and the lowest in Wirosa and Wivoy. A late June planting date had higher levels of frost damage than the early July planting but yields were reduced. There was no consistent effect from the rate of nitrogen fertiliser.

Summary

Background and Objectives

The incidence of frost damage on savoy cabbage increased in the late 1980's. The reasons for the increase were not known and this project was set up to assess the effect of planting date and rate of nitrogen fertiliser on frost susceptibility using four widely grown varieties.

Savoy cabbage were planted on 25 June and 6 July and given in total 150, 225 or 300 kg/ha of nitrogen fertiliser. The varieties grown were Wintessa, Wirosa, Wivoy and Alaska.

Table 1: Harvest date.

Cultivar	Rate of Fertiliser (kg/ha N)		
	150	225	300
Wintessa	24 Feb [#]	24 Feb	24 Feb
Wirosa	22 Dec	7 Dec	7 Dec
Wivoy	5 Jan	5 Jan	7 Dec
Alaska	5 Jan	5 Jan	5 Jan

[#] Not at maturity but quality starting to deteriorate.

The cultivar Wirosa was the earliest to mature followed by Wivoy and Alaska. Wintessa had matured by late February but the lowest rate of nitrogen did not produce a marketable crop as head weights were low.

The weather before December was cold but it was not until mid December that significant and repeated frost occurred. At the first assessment on 26 January (Figure 1) the levels of internal frost damage were greatest on the Alaska and least on the Wivoy, and levels were lower for the July planted treatments. A similar pattern was also observed on 17 February, but by this date Wirosa had lower levels of damage where the lower rate of nitrogen had been used for the first planting. By 12 March (Figure 2) levels of damage were still lowest for Wivoy but with no consistent effect of the rate of nitrogen.

Fig 1. Number of heads with frost damage (%)
26 January 1993

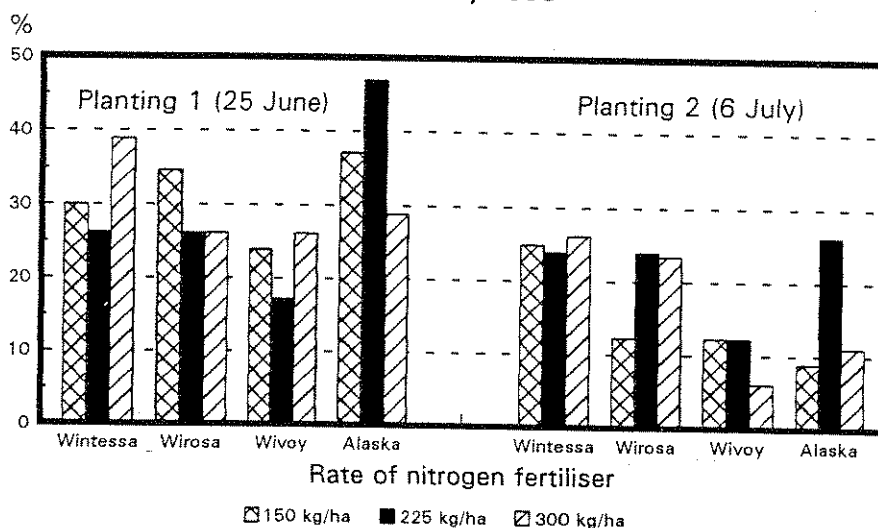
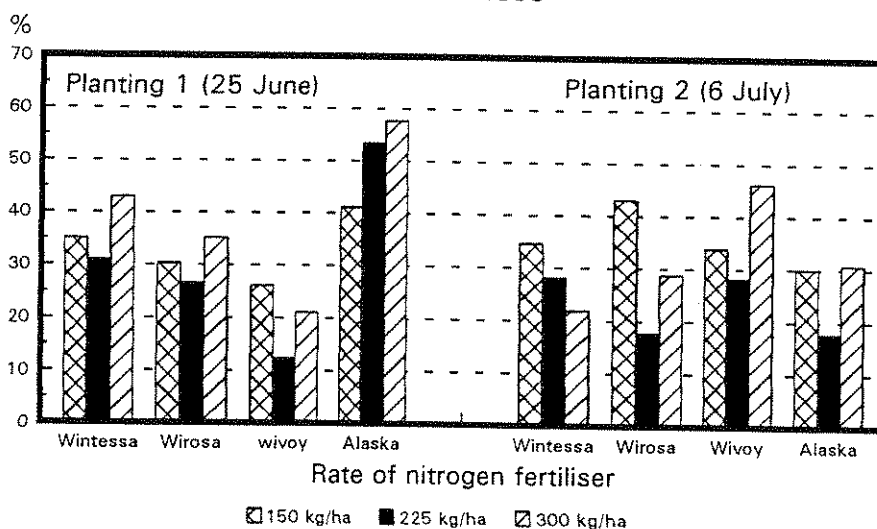
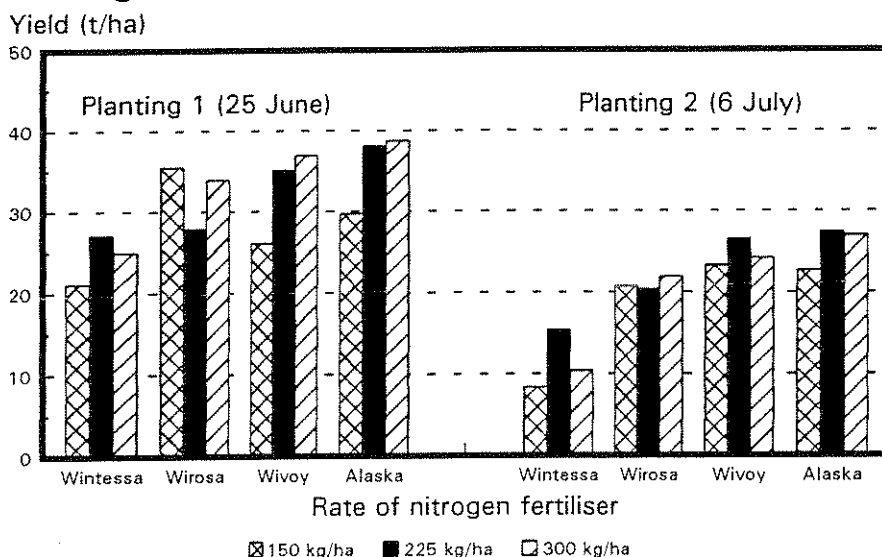


Fig 2. Number of heads with frost damage (%)
12 March 1993



The planting date had a significant effect on marketable yields in a season with a cold wet autumn. The 25 June planting crop produced 31.3 t/ha on average compared to 20.1 t/ha for the 6 July planted crop. The maturity dates were similar for both planting dates but the July planted treatments had a smaller frame and head size. The two highest rates of nitrogen gave similar results but the lowest rate reduced yields.

Fig 3. Marketable yield at harvest (t/ha).



Action Points for Growers

- * The planting date must be carefully selected to avoid crops from being overmature before frosty weather otherwise there is an increased risk of frost damage.
- * Varietal choice for crops grown for harvesting during the winter is very important and Alaska should be avoided. Wivoy and Wirosa appeared suitable for this production period.
- * The plant's susceptibility to frost damage did not appear to be affected by the rate of nitrogen and therefore the rate should be selected to ensure maximum yield and quality.

Introduction

Savoy cabbage has traditionally been regarded as one of the hardiest of the winter vegetable crops. New varieties have been bred which have greater uniformity and better quality. In late autumn of 1988 and 1989 sharp frosts in many areas severely damaged crops making many heads unmarketable. Frost damage can disrupt supplies and reduce the potential for marketing crops between October and April.

A preliminary study was undertaken at Stockbridge House in 1990. The results showed that the planting date had a greater influence on the susceptibility of heads to frosting than did the rate of nitrogen applied as a top dressing. The later planted crop was less susceptible to frost damage but heads were smaller and this reduced the number of marketable heads for certain varieties. In 1991 the results were similar but some treatments matured early and were harvested before severe frosts occurred.

This trial compared two planting dates and evaluated three nitrogen fertiliser regimes. Four varieties were used to assess the interaction between cultivar, planting date and fertiliser rate. Each treatment was harvested as it matured with frost damage assessments taken throughout the late winter.

Objective

To assess the effect of planting date and rate of nitrogen fertiliser on the susceptibility of savoy cabbage to frost damage using four commonly grown cultivars.

Materials and Methods

Site

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

Soil Type

Sandy loam of the Quorndon Series.

Design

The experimental design was a split plot with 3 replicates. Sowing date was at the main plot level, with cultivar and rate of nitrogen fertiliser at the sub-plot level. This design was selected so that each planting date could be managed separately. A total of 112 plants were planted per plot with 30 heads harvested from each plot and a further 10 heads cut and assessed for frost damage in January, February and March.

Treatments

1. Planting Date:
 - A. 25 June 1992
 - B. 6 July 1992

2. Cultivar:
 - A. Wintessa
 - B. Wirosa
 - C. Wivoy
 - D. Alaska

3. Rate of Nitrogen Fertiliser:

- A. 150 kg/ha. 125 kg/ha as a base dressing and 25 kg/ha as a top dressing in late July.
- B. 225 kg/ha. 150 kg/ha as a base dressing and 75 kg/ha as a top dressing in late July.
- C. 300 kg/ha. 150 kg/ha as a base dressing and 150 kg/ha as a top dressing in late July.

Husbandry

Seed of all cultivars was sown on 21 May and 1 June in Hassy 308 module trays and propagated in an unheated glasshouse. Fertiliser was applied on 19 June to the area for the first sowing date prior to planting on 25 June. Fertiliser was applied to the area for the second sowing date prior to planting on 6 July and the whole trial irrigated to aid establishment.

The extra 25, 75 or 150 kg/ha of nitrogen was applied by hand on 24 July according to treatments. The trial received standard commercial inputs for pest and disease control (Appendix I).

Records

- 1. Yield and quality at crop maturity (based on 30 heads/plot).
- 2. Number of frost damaged heads in January, February and March (based on 10 heads/plot).

Statistical Analysis

The yield data at harvest was subjected to an analysis of variance. The number of heads with frost damage on the 3 assessment dates in 1993 were analysed as angular transformations.

Results

Each treatment was harvested as it matured. The crops from both planting dates matured together and so were harvested at the same time.

The harvest dates are given in Table 1.

Table 1: Harvest date.

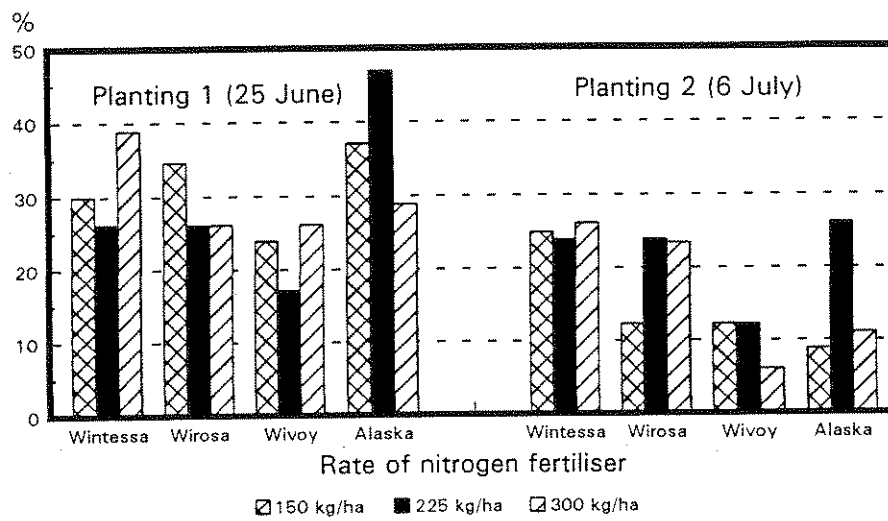
Cultivar	Rate of Fertiliser (kg/ha N)		
	150	225	300
Wintessa	24 Feb [#]	24 Feb	24 Feb
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[#] Not at maturity but quality starting to deteriorate.

The cultivar Wirosa was the earliest to mature followed by Wivoy and Alaska. Wintessa had matured by late February but the lowest rate of nitrogen did not produce a marketable crop as head weights were low.

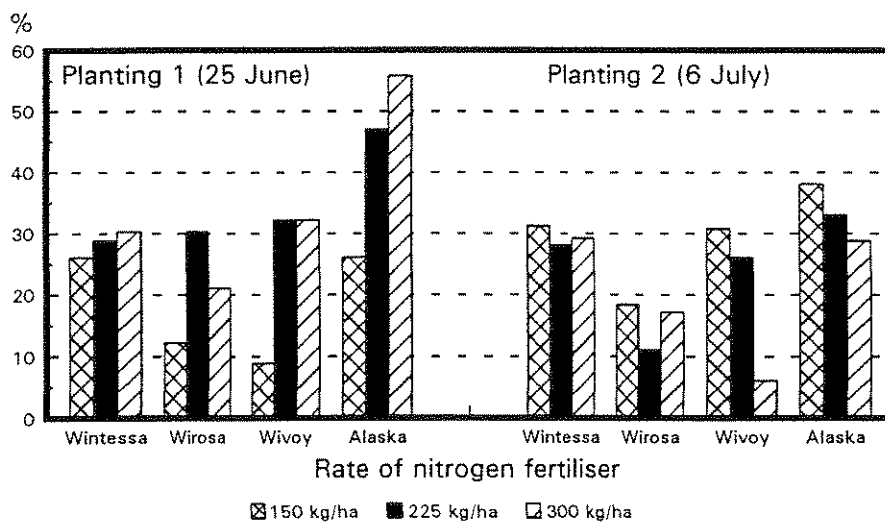
The results for the frost damage assessment are given in Figures 1, 2 and 3.

Fig 1. Number of heads with frost damage (%)
26 January 1993



The first assessment was taken on 26 January. Heads were visually inspected both externally and internally by cutting them in half. There were significant differences between both planting date treatments and cultivars. The first planting date had more internal frost damage than the second. Wivoy was the least susceptible variety to damage. The three nitrogen rates all gave a similar number of frosted heads.

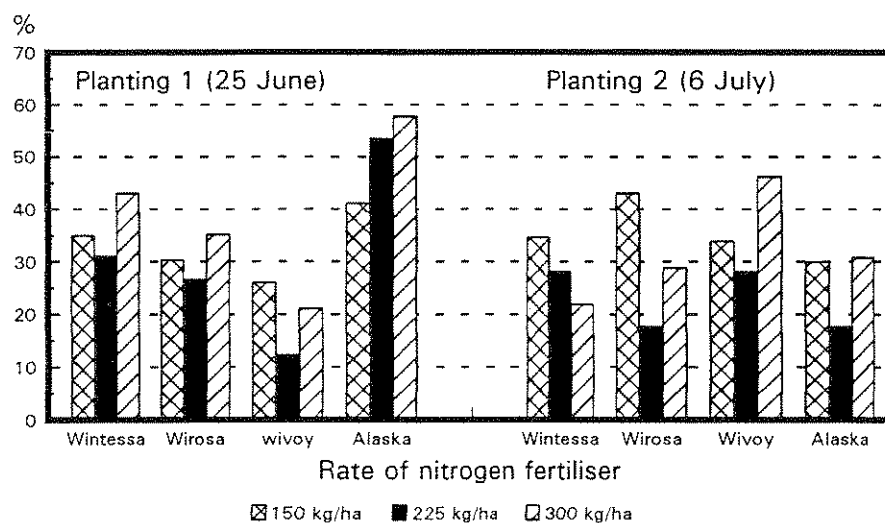
Fig 2. Number of heads with frost damage (%)
17 February 1993



The second assessment was taken on 17 February. There were no significant differences between the 2 planting date treatments. There were significant differences between the cultivars. Wirosa was less susceptible to frost damage than Alaska and Wintessa. Overall the three rates of nitrogen gave similar results, however, there was a significant interaction between planting date and nitrogen rate. The two highest rates of nitrogen significantly increasing the levels of frost damage for the June planted crop. The lowest rate appeared to increase the level of damage for the July planted crop.

Fig 3. Number of heads with frost damage (%)

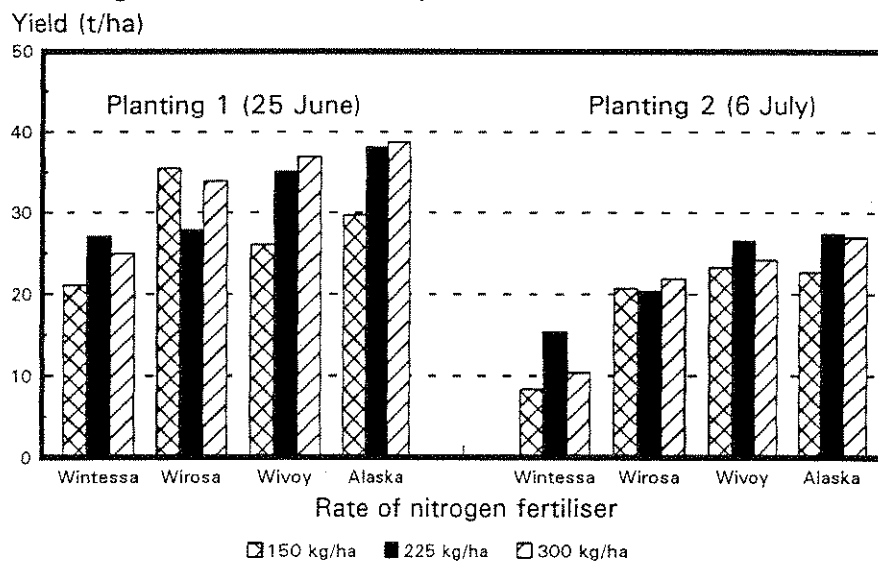
12 March 1993



The results for the third assessment date of 12 March (Figure 3) were that generally the second planting date had lower numbers of frost damaged heads. The cultivar Wivoy had the lowest levels of damage.

The marketable yields for each treatment are given in Figure 4 (see also Appendix IV).

Fig 4. Marketable yield at harvest (t/ha).



The first planting date gave significantly higher marketable yields than the second due mainly to larger heads. The lowest rate of nitrogen generally gave reduced marketable yields although for Wirosa there was no significant affect of rate of nitrogen. The cultivar Alaska gave the highest yields with Wintessa the lowest due to the late maturity of this cultivar.

The results for the number of heads in each size grade are given in Appendix V. The earlier maturing varieties had a higher proportion of heads in the larger size grades.

Discussion

The weather during October and November was wet but generally mild with no significant air frosts until mid December. The choice of planting date affected the number of frosted heads when inspected internally. The earlier planting date had higher levels of frost damage compared to the later planted crop.

The cultivars showed differences in frost susceptibility. Alaska was the most sensitive to frost damage and Wivoy the least affected, particularly for the earlier planting date.

The effect of the rate of nitrogen on frost damage was not consistent and had a greater effect on marketable yield than levels of frost damage. Higher marketable yields were obtained from the 225 and 300 kg/ha rates of nitrogen.

Conclusions

1. The choice of cultivar has an important effect on the crop's susceptibility to frost damage. Wivoy and Wirosa were relatively resistant to low temperature damage compared to Alaska.
2. A planting date of early July in 1992 was too late. Although frost damage was less than the earlier planting date the yields were considerably lower.
3. The rate of nitrogen fertiliser had no consistent effect on the level of frost damage but a combination of a high rate of nitrogen and the variety Alaska increased susceptibility to frosting.

Recommendations

Any future trials should include covering treatments applied late in the autumn to protect the heads during frosty weather.

APPENDIX I: TRIAL DIARY

21 May Cultivars sown in Hassy 308 trays for Planting Date 1.

1 June Cultivars sown in Hassy 308 trays for Planting Date 2.

19 June 125 kg/ha N, 120 kg/ha P₂O₅, 200 kg/ha K₂O.
Fertiliser incorporated. Land prepared.

24 June 25 kg/ha N applied to treatments 3B and 3C (Planting 1).

25 June Dursban pre-plant drench @ 100 ml/15 l/10,000 modules. Trial planted (Planting 1). Irrigated 20 mm.

26 June Ramrod @ 9 l/ha + Dacthal @ 6 kg/ha in 600 l/ha water.

1 July Irrigated 20 mm.

6 July 25 kg/ha N applied to treatments 3B and 3C (Planting 2).
Dursban pre-plant drench @ 100 ml/15 l/10,000 modules. Trial planted (Planting 2).

7 July Ramrod @ 9 l/ha + Dacthal @ 6 kg/ha in 600 l/ha water.

13 July Brasoran @ 4 kg/ha in 600 l/ha water (Planting 1).
Metasystox @ 560 ml/ha in 750 l/ha water.

23 July Metasystox @ 560 ml/ha in 750 l/ha water.

24 July Top dressed whole trial according to treatments.

15 August Metasystox @ 560 ml/ha + Ambush @ 250 ml/ha in 750 l/ha water.

4 September Ambush @ 250 ml/ha + Agral in 600 l/ha water.

11 September Metasystox @ 560 ml/ha + Ambush @ 250 ml/ha in
& 12 October 600 l/ha water.

7 December Harvest

22 December "

5 January "

24 February "

(Frost damage assessments taken on 26 January, 17 February,
12 March 1993).

APPENDIX II: MINIMUM TEMPERATURES RECORDED
FOR THE PERIOD NOVEMBER 1992 TO MARCH 1993 (°C)

	November 1992		December 1992		January 1993	
	Grass	Air	Grass	Air	Grass	Air
1	- 0.6	1.2	0.5	4.5	- 7.1	- 3.0
2	3.0	2.0	2.9	5.4	- 3.7	- 3.0
3	1.5	2.8	- 0.7	2.2	- 5.6	- 5.5
4	2.0	6.0	- 5.2	- 0.7	- 5.0	- 5.3
5	5.8	8.5	- 3.0	- 0.3	- 6.2	- 3.8
6	2.0	6.0	- 3.1	0.0	- 1.0	2.6
7	6.9	10.5	- 0.9	1.0	- 4.0	- 0.1
8	- 2.8	0.0	- 1.0	4.5	- 1.0	0.8
9	3.8	2.4	2.5	4.0	0.0	2.8
10	0.3	4.5	- 1.7	2.3	- 0.3	3.5
11	2.5	4.1	- 1.7	2.5	0.4	2.5
12	- 0.5	3.2	- 1.1	2.9	- 2.2	0.4
13	- 2.2	1.0	0.5	3.7	- 1.2	- 3.1
14	- 8.2	- 3.9	5.7	6.8	0.0	2.4
15	- 4.0	- 3.2	6.4	8.8	0.0	2.0
16	1.0	3.0	4.5	7.1	3.7	3.9
17	- 3.5	1.3	- 5.3	- 1.0	5.5	- 0.5
18	- 3.6	1.0	- 2.9	- 1.0	- 3.1	2.1
19	- 0.9	0.9	- 6.0	0.0	- 2.2	2.0
20	- 5.0	1.0	- 8.2	- 3.5	0.6	3.6
21	- 3.6	0.0	- 9.5	- 5.2	2.7	5.9
22	- 0.5	1.6	- 9.0	- 5.5	3.5	4.5
23	8.1	9.5	- 7.5	- 2.2	1.4	3.5
24	0.0	3.4	- 8.0	- 5.0	2.6	5.4
25	2.5	5.0	- 8.9	- 6.1	- 1.9	1.0
26	- 1.8	3.0	- 6.1	- 4.2	- 5.5	- 1.0
27	- 1.3	3.1	- 1.2	- 0.7	- 6.5	- 1.1
28	- 2.6	2.1	- 1.1	1.2	- 2.0	0.0
29	- 6.2	- 1.3	- 1.4	- 2.1	2.1	4.9
30	1.5	2.0	- 2.6	- 3.2	3.0	3.8
31			- 2.9	- 3.2	2.5	4.1

February 1993

March 1993

	Grass	Air	Grass	Air
1	- 6.2	- 1.2	- 3.8	- 2.3
2	- 3.5	0.0	- 1.3	0.7
3	- 0.6	4.4	1.0	2.5
4	- 0.8	4.6	- 1.0	0.8
5	- 3.0	2.2	- 3.8	1.8
6	2.0	5.1	- 4.5	0.9
7	0.1	5.6	- 5.1	- 0.1
8	6.4	7.8	3.1	4.0
9	5.1	5.9	- 8.0	- 2.0
10	2.9	3.5	- 7.0	- 2.3
11	2.6	3.5	1.0	0.5
12	1.4	1.9	- 2.9	1.0
13	- 5.1	- 0.5		
14	1.3	1.5		
15	- 2.0	0.4		
16	- 1.0	3.0		
17	1.8	5.7		
18	0.0	5.2		
19	1.4	4.3		
20	- 2.6	1.3		
21	- 0.2	2.8		
22	- 5.8	- 1.0		
23	- 7.2	- 1.8		
24	- 0.6	0.2		
25	- 0.2	2.7		
26	0.0	1.0		
27	- 3.7	- 1.6		
28	- 4.5	- 2.0		

APPENDIX III

Table A: Percentage of heads with frost damage (angle transforms) on 26 January 1993 - actual % in brackets.

Cultivar	Rate of Nitrogen (kg/ha)			Mean
	150	225	300	
<u>Planting 1</u>				
Wintessa	30 (30)	26 (27)	39 (40)	32
Wirosa	35 (33)	26 (20)	26 (20)	29
Wivoy	24 (17)	17 (13)	26 (17)	22
Alaska	37 (37)	47 (53)	29 (29)	38
Mean	31	29	30	30
<u>Planting 2</u>				
Wintessa	25 (19)	24 (17)	26 (20)	25
Wirosa	12 (7)	24 (17)	23 (17)	20
Wivoy	12 (7)	12 (7)	6 (3)	10
Alaska	9 (7)	26 (20)	11 (10)	15
Mean	15	22	17	18
SED (2 df) for comparing planting date means				2.8
LSD (5%)				12.1
SED (44 df) for comparing cultivar means				3.7
LSD (5%)				7.5

Table B: Percentage of heads with frost damage (angle transforms) on 17 February 1993 - actual % in brackets.

Cultivar	Rate of Nitrogen (kg/ha)			Mean
	150	225	300	
<u>Planting 1</u>				
Wintessa	26 (20)	29 (23)	30 (27)	28
Wirosa	12 (7)	30 (27)	21 (13)	21
Wivoy	9 (7)	32 (30)	32 (30)	24
Alaska	34 (33)	47 (53)	56 (67)	46
Mean	20	35	35	30
<u>Planting 2</u>				
Wintessa	31 (30)	28 (23)	29 (27)	30
Wirosa	18 (10)	11 (10)	17 (13)	16
Wivoy	31 (27)	26 (20)	6 (3)	21
Alaska	38 (40)	33 (30)	29 (23)	33
Mean	30	25	20	25
SED (2 df) for comparing planting date means				5.0
LSD (5%)				21.5 (NS)
SED (44 df) for comparing cultivar means				3.8
LSD (5%)				7.7
SED (44 df) for comparing nitrogen means				3.3
LSD (5%)				6.7
SED (44 df) for comparing planting date x nitrogen for same planting date				4.7
LSD (5%)				9.5

Table C: Percentage of heads with frost damage (angle transforms) on 12 March 1993 - actual % in brackets.

Cultivar	Rate of Nitrogen (kg/ha)			Mean
	150	225	300	
<u>Planting 1</u>				
Wintessa	35 (33)	31 (27)	43 (47)	36
Wirosa	30 (27)	27 (20)	35 (33)	31
Wivoy	26 (20)	12 (7)	21 (13)	20
Alaska	41 (43)	53 (63)	58 (70)	51
Mean	33	31	39	34
<u>Planting 2</u>				
Wintessa	35 (33)	28 (23)	22 (20)	28
Wirosa	43 (47)	18 (13)	29 (23)	36
Wivoy	34 (40)	28 (30)	46 (53)	30
Alaska	30 (33)	18 (13)	31 (27)	26
Mean	35	23	32	30
SED (2 df) for comparing planting date means				5.1
LSD (5%)				21.9 (NS)
SED (44 df) for comparing cultivar means				4.3
LSD (5%)				8.7
SED (44 df) for comparing nitrogen means				3.7
LSD (5%)				7.5

APPENDIX IV

Table D: Marketable yield at harvest (t/ha).

Cultivar	Rate of Fertiliser (kg/ha N)			Mean
	150	225	300	
<u>Planted on 25 June</u>				
Wintessa	21.1	27.1	25.0	24.4
Wirosa	35.5	27.9	33.9	32.5
Wivoy	26.1	35.1	36.9	32.7
Alaska	29.7	38.1	38.7	35.5
Mean	28.1	32.1	33.6	31.3
<u>Planted on 6 July</u>				
Wintessa	8.4	15.4	10.4	11.4
Wirosa	20.7	20.4	21.9	21.0
Wivoy	23.3	26.5	24.2	24.6
Alaska	22.7	27.4	27.0	25.7
Mean	18.8	22.4	20.9	20.1
Overall Mean	23.4	27.2	27.2	26.0
SED (44 df) for comparing:				
Planting date means	1.34	(5.7)		
Cultivar means	1.43	(2.9)		
Nitrogen means	1.24	(2.5)		
Cultivar x nitrogen	2.47	(5.0)		

LSD's are quoted in brackets.

APPENDIX V

Table E: Percentage of heads in various head weight categories at harvest (angle transformations).

Cultivar & Fertiliser Rate (kg/ha N)	Number of heads (%)					
	>400 g	>500 g	>700 g	>800 g	>1000 g	
<u>Planting 1</u>						
Wintessa	150	59	48	16	8	0
	225	71	61	29	15	0
	300	64	52	25	14	7
Wirosa	150	72	70	48	39	17
	225	63	58	38	29	10
	300	72	63	43	29	20
Wivoy	150	66	55	34	22	7
	225	80	77	46	33	15
	300	83	75	59	45	19
Alaska	150	66	57	41	28	7
	225	73	71	56	46	17
	300	73	71	56	46	18
<u>Planting 2</u>						
Wintessa	150	36	25	7	4	0
	225	50	32	4	0	0
	300	39	23	4	0	0
Wirosa	150	57	44	21	16	0
	225	67	45	21	12	4
	300	59	48	22	12	0
Wivoy	150	67	53	21	7	0
	225	69	60	30	14	0
	300	65	52	29	16	0
Alaska	150	58	50	26	10	0
	225	67	56	35	20	4
	300	64	56	31	25	0
SED (44 df) for comparing all treatments		5.7	6.4	7.5	7.7	5.2
LSD for comparing all treatments (5%)		11.5	13.0	15.2	15.6	1.5