

Project Title: Asparagus: Prevention of Decline Problem by use of Salt.

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Project Leader: W J Dyer
ADAS Bury St Edmunds
Southgate Street
Bury St Edmunds
Suffolk IP33 2BD

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Keyworders: W J Dyer, ADAS Bury St Edmunds

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Project Co-ordinator: Mr H V Aveling, Chairman, Asparagus Growers' Association
Badgeney Lodge, 34 Badgeney End
March
Cambs PE15 0DD

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PRACTICAL SECTION FOR GROWERS

Objectives and background

Asparagus crops are very expensive to establish and it is therefore to the grower's advantage to maintain a crop producing at economic levels for as many years as possible. For a number of reasons, cropping performance declines over a period of years, resulting in lower yields of poorer quality spears.

Normally asparagus crops should be highly productive for about 15 years, but it is estimated that 80% of crops are grubbed much earlier than this as a result of the decline problem.

Decline is a complex of disease, physiological and soil related problems. There is research evidence from overseas that indicates the use of soil applied salt will reduce the problem and enhance yields. No work has been carried out on preventing decline of asparagus crops in the UK.

This study was started in the spring of 1993 on a crop that was beginning to show signs of declining. The crop was established in May 1987 with the all male Dutch variety, Limbras 118, and grown in double row beds.

A range of rates of salt (0 to 4.0 t/ha) were applied each year for the period 1993 to 1996 inclusive, with half applied pre harvest (April) and half post harvest (end June).

Yield data and records of fern numbers were recorded in each year.

HDC continued to provide funds for this trial to continue for a further 3 years 1997 - 1999 inclusive.

During each of these years salt was applied at similar rates with half applied pre harvest (April) and half post harvest(end June).

Yield data and fern numbers were collected in 1999. This data was not recorded in 1997 or 1998.

Summary of results

Yields 1999

Although there were no statistically significant differences ($P=0.05$) in any of the categories of yield data collected there was a tendency to produce higher numbers and weights of spears from the 0.5t/ha and the 1.0t/ha rates of salt applied.

Rates of salt applied at 2.0t/ha and 4.0t/ha tended to have a deleterious effect on the number and weight of spears.

Fern numbers 1999

There were no statistically significant differences ($P=0.05$) between treatments for both total numbers and live fern numbers.

Yields 1993-1996 and 1999. Please refer to Tables 10-13.

Total numbers of spears including blown and twisted spears.

Generally salt treatments produced higher total numbers of spears and in 1994 rates of application of 0.5t/ha, 1.0t/ha, and 2.0t/ha were significantly higher ($P=0.05$) than the nil treatment. In 1999 salt treatments at 0.5t/ha and 1.0t/ha produced a higher number of spears than the other treatments but were not significantly higher.

Total weights including blown and twisted spears.

In 1994, 1995 and 1996 all salt treatments produced higher total weights than the nil treatment. Treatments were significantly higher ($P=0.05$) at rates of 0.5t/ha, 1.0t/ha and 4.0t/ha in 1993, 0.5t/ha in 1994, 1.0t/ha in 1995 and 0.5t/ha in 1996. In 1999 salt treatment at 0.5t/ha and 1.0t/ha produced a higher total weight than the other treatments, but differences were not significantly higher.

Number of spears below 10mm diameter.

In 1993 the nil treatment and salt treatment of 1.0t/ha produced significantly higher ($P=0.05$) numbers. In all the other years there were no significant differences.

Number of spears above 10mm diameter.

Generally salt treatments produced higher numbers of spears than the nil treatment and to a significantly higher ($P=0.05$) level in 1993 when all four treatments were higher and 1996 when the 0.5t/ha and 1.0t/ha treatments were significantly higher.

Weights of spears below 10mm diameter.

In 1993 and 1994 significant differences ($P=0.05$) were produced with the nil and 1.0t/ha rate of salt in 1993 and 0.5t/ha and 1.0t/ha rates in 1994. In 1995, 1996 and 1998 there were no significant differences ($P=0.05$) between treatments.

Weights of spears above 10mm diameter.

Generally salt treatments produced higher weights than the nil treatment and to a significantly higher ($P=0.05$) level in 1993 when all treatments were higher and in 1996 when the 0.5t/ha and 1.0 t/ha rates were of statistical significance.

Action points for growers

The trial has been run for seven years during which time detailed harvest data has been collected.

Whilst the results are not always statistically significant ($P=0.05$) within the categories of data there tends to be a consistent trend towards benefits to the asparagus crop when salt is applied at the 0.5t/ha and 1.0t/ha rates (split with half being applied pre harvest in April and half post harvest at the end of June).

A strategy of routinely applying salt at rates of 0.5t/ha or 1.0t/ha split with half being applied pre harvest (April) and half post harvest (end June) should reduce the rate of decline of asparagus crops.

Practical and financial anticipated benefits

As a result of this work yields of asparagus are often significantly improved by adding agricultural salt. This product is not expensive at approximately £50 per tonne (equivalent at 0.5t/ha to 1.0t/ha of £25-50/ha) and is able to provide a financial benefit.

SCIENCE SECTION

Introduction

Decline in the productivity of asparagus crops is a very serious problem resulting in reduction in marketable yield and ultimate death of plants.

Decline is a complex of disease, physiological and soil-related problems. Research evidence from overseas indicates the use of soil applied salt will reduce the problem and enhance yields. It has been recorded that disease levels are sometimes reduced as a result of the treatment.

No work has been carried out in the UK on preventing decline in asparagus crops.

This study was started in the spring of 1993 on a crop that was beginning to show signs of decline.

The crop was established in May 1987 with the all male variety, Limbras 118, planted in double row beds.

A range of rates of salt were applied each year for the period 1993 to 1996 inclusive, with rates being split with half applied pre harvest (April) and half post harvest (end June).

Yields were recorded in each season from 1993 to 1996 inclusive.

HDC continued to provide funds for this trial to continue for a further 3 years, 1997-1999 inclusive.

During each year salt was applied at similar rates being split with half applied pre harvest (April) and half post harvest (end June).

Yield data was collected during 1999. None was collected in 1997 or 1998.

Objective

Asparagus - To measure the effects of using salt applied annually to reduce the rate of decline.

Materials and Methods

Site

The experiment was carried out at Portwood Farm, Gt Ellingham, Nr Attleborough, Norfolk. The soil type is a sandy loam with some stones, of approximately 30cm (12ins) depth, over a sandy clay loam. The site is well drained.

Treatments

Rates of Salt (applied as Agricultural Salt)

- A. Nil
- B. 0.5 tonne/hectare - split, half pre harvest (April) and half post harvest (end June)
- C. 1.0 tonne/hectare - split, half pre harvest (April) and half post harvest (end June)
- D. 2.0 tonne/hectare - split, half pre harvest (April) and half post harvest (end June)
- E. 4.0 tonne/hectare - split, half pre harvest (April) and half post harvest (end June)

Treatments were applied 18 April and 21 June 1993, 29 April and 23 June 1994, 29 April and 20 June 1995, 23 April and 22 June 1996, 18 April and 21 June 1997, 23 April and 25 June 1998 and 26 April and 24 June 1999.

Husbandry

The crop was planted in May 1987 using the all male Dutch variety, Limbras 118. It was established from container raised transplants, planted in double rows at 1.63m (5ft 5ins) centres with an in row spacing in each row of 50cm (20ins), providing a plant population of 24,540 per hectare (9,935 per acre).

Routine levels of phosphate, potash and nitrogen were applied according to current ADAS recommendations.

The crop was very well managed.

Assessments

Records were taken of yield during the cropping period 1 May to 18 June 1993, 3 May to 21 June 1994, 5 May to 20 June 1995, 8 May to 20 June 1996 and 6 May to 21 June 1999 when the crop was assessed for numbers and weights of spears above and below 10mm diameter and spears in the blown and twisted category.

Measurements of plant losses were made in the fern growing period on 6 July 1993 and fern numbers on 15 October 1993 and fern numbers on 23 September 1994, 28 September 1995, 2 October 1996 and 17 September 1999.

Design and Analyses

The trial design consists of a Latin square with 5 replications.

Plot size - 18 m x 6.50 m (4 double row beds) totalling 117 sq. m with the number of plants planted being 576.

Recordable area - 12 m x 3.25 m (2 double row beds) totalling 39 sq. m with the number of plants planted being 192.

All data has been statistically analysed.

RESULTS AND DISCUSSION

Harvest Data

Table 1 Total number of spears ('000/ha) and total weight (t/ha) including blown and twisted spears in 1999.

Treatment	Number ('000/ha)	Weight (t/ha)
Nil	119.6	1.84
Salt 0.5 t/ha	147.3	2.49
Salt 1.0 t/ha	123.7	2.05
Salt 2.0 t/ha	107.9	1.63
Salt 4.0 t/ha	113.7	1.78
Mean	122.4	1.96

SED (12df)	13.26	0.284
LSD (P=0.05)	28.89	0.619
CV% Row	11.3	12.3
Column	6.6	11.2
Row.Column	17.1	22.7

Comment

The salt treatments at 0.5t/ha and 1.0t/ha produced a higher number and weight of spears than the other treatments. These differences were not significantly higher than the nil treatment.

Harvest Data

Table 2 Total number of spears ('000/ha) and weight (t/ha) excluding blown and twisted spears in 1999.

Treatment	Number ('000/ha)	Weight (t/ha)
Nil	108.1	1.73
Salt 0.5 t/ha	134.3	2.32
Salt 1.0 t/ha	111.6	1.91
Salt 2.0 t/ha	96.9	1.51
Salt 4.0t/ha	102.7	1.67
Mean	110.7	1.83

SED (12df)	12.10	0.267
LSD (P=0.05)	26.36	0.583
CV% Row	11.0	12.0
Column	7.3	11.6
Row.Column	17.3	23.0

Comment

The salt treatment at 0.5t/ha produced a higher number and weight of spears than the other treatments. The differences were not statistically significant.

Harvest Data

Table 3 Total number of spears ('000/ha) and weight (t/ha) of blown and twisted spears in 1999.

Treatment	Number ('000/ha)	Weight (t/ha)
Nil	11.5	0.11
Salt 0.5 t/ha	13.0	0.17
Salt 1.0 t/ha	12.1	0.14
Salt 2.0 t/ha	11.0	0.12
Salt 4.0 t/ha	11.0	0.11
Mean	11.7	0.13

SED (12df)	1.62	0.025
LSD (P=0.05)	4.80	0.111
CV% Row	18.6	22.9
Column	4.3	6.3
Row.Column	21.7	29.0

Comment

The salt treatments at 0.5t/ha and 1.0t/ha produced a slightly higher number of spears than the other treatments. The salt treatment at 0.5t/ha produced a higher yield of blown and twisted spears than the other treatments. These differences were not statistically significant.

Harvest Data

Table 4 Total number of spears ('000/ha) and weight (t/ha) under and over 10mm spear diameter, excluding blown and twisted spears in 1999.

Treatment	Number('000/ha)		Weight (t/ha)	
	<10mm diameter	>10mm diameter	<10mm diameter	>10mm diameter
Nil	69.1	39.0	0.87	0.86
Salt 0.5 t/ha	77.0	57.3	0.99	1.33
Salt 1.0 t/ha	66.8	44.8	0.84	1.07
Salt 2.0 t/ha	63.4	33.5	0.74	0.77
Salt 4.0 t/ha	63.3	39.4	0.75	0.92
Mean	67.9	42.8	0.84	0.99

SED(12 df) 6.91 8.12 0.090 0.212

LSD (P=0.05) 15.06 17.69 0.197 0.952

CV%

Row 12.0 11.7 12.3 13.1

Column 4.4 16.9 6.2 18.1

Row.Column 16.1 30.0 16.9 33.5

Comment

There were no statistically significant differences between treatments, but the salt treatment at 0.5t/ha gave the highest number and weight of spears in both categories.

Harvest Data

Table 5 Weekly pattern of numbers ('000/ha) of small (<10mm diameter) spears harvested in 1999.

Period No.	Salt Nil	Salt 0.5 t/ha	Salt 1.0 t/ha	Salt 2.0 t/ha	Salt 4.0 t/ha	Mean
1 (6-12 May)	0.1	0.1	0.1	0.1	0.1	0.1
2 (13-19 May)	9.9	10.5	9.7	8.8	8.1	9.4
3 (20-26 May)	8.0	8.8	8.8	9.1	9.7	8.9
4 (27 May-2 June)	24.5	27.8	25.8	24.4	24.4	25.4
5 (3-9 June)	13.6	13.2	11.0	11.4	11.2	12.0
6 (10-16 June)	3.9	4.3	3.4	3.4	3.7	3.7
7 (17-21 June)	9.1	12.3	8.0	6.2	6.1	8.3
Total	69.1	77.0	66.8	63.4	63.3	67.9

Comment

The salt treatment at 0.5t/ha produced a higher number of small spears throughout the season. The salt treatments at 2.0t/ha and 4.0t/ha produced a lower number of small spears than the nil treatment. These differences were not statistically significant.

Harvest Data

Table 6 Weekly pattern of weight (t/ha) of small (<10mm diam.) spears harvested in 1999

Period No.	Salt Nil	Salt 0.5 t/ha	Salt 1.0 t/ha	Salt 2.0 t/ha	Salt 4.0 t/ha	Mean
1 (6-12 May)	0.21	0.21	0.17	0.12	0.14	0.17
2 (13-19 May)	0.09	0.11	0.09	0.08	0.07	0.09
3 (20-26 May)	0.07	0.08	0.09	0.08	0.08	0.08
4 (27 May-2 June)	0.25	0.30	0.27	0.25	0.26	0.26
5 (3-9 June)	0.13	0.13	0.11	0.13	0.11	0.12
6 (10-16 June)	0.03	0.04	0.04	0.03	0.03	0.04
7 (17-21 June)	0.09	0.12	0.07	0.05	0.06	0.08
Total	0.87	0.99	0.84	0.74	0.75	0.84

Comment

The salt treatment at 0.5t/ha produced the highest yield of small spears and the salt treatment at 1.0t/ha, 2.0t/ha and 4.0t/ha produced a lower yield than the nil treatment. These differences were not statistically significant.

Harvest Data

Table 7 Weekly pattern of the number ('000/ha) of large (>10mm diameter) spears harvested in 1999.

Period No.	Salt Nil	Salt 0.5 t/ha	Salt 1.0 t/ha	Salt 2.0 t/ha	Salt 4.0 t/ha	Mean
1 (6-12 May)	15.3	21.7	15.8	12.1	12.8	15.5
2 (13-19 May)	5.4	6.5	6.0	4.0	4.8	5.4
3 (20-26 May)	4.1	7.1	4.3	4.0	6.2	5.1
4 (27 May-2 June)	7.8	13.1	11.5	8.4	10.0	10.2
5 (3-9 June)	5.0	6.2	5.4	4.0	4.4	5.0
6 (10-16 June)	1.0	1.4	0.8	0.4	0.4	0.8
7 (17-21 June)	0.4	1.3	1.0	0.6	0.8	0.8
Total	39.0	57.3	44.8	33.5	39.4	42.8

Comment

The salt treatment at 0.5t/ha produced a higher number of large spears than the other treatments and the salt treatment at 2.0t/ha produced a lower number of spears than the nil treatment. The differences were not statistically significant.

Harvest Data

Table 8 Weekly pattern of weight (t/ha) of large (>10mm diameter) spears harvested in 1999.

Period No.	Salt Nil	Salt 0.5 t/ha	Salt 1.0 t/ha	Salt 2.0 t/ha	Salt 4.0 t/ha	Mean
1 (6-12 May)	0.34	0.52	0.39	0.30	0.30	0.37
2 (13-19 May)	0.11	0.14	0.14	0.08	0.11	0.12
3 (20-26 May)	0.10	0.15	0.09	0.08	0.14	0.12
4 (27 May-2 June)	0.17	0.33	0.27	0.19	0.23	0.24
5 (3-9 June)	0.10	0.13	0.13	0.09	0.11	0.11
6 (10-16 June)	0.02	0.03	0.02	0.02	0.01	0.02
7 (17-21 June)	0.02	0.03	0.03	0.01	0.02	0.02
Total	0.86	1.33	1.07	0.77	0.92	0.99

Comment

The salt treatment at 0.5t/ha produced a higher yield of large spears than the other treatments. The nil treatment produced a lower yield. These differences were not statistically significant.

Harvest Data

Table 9 Fern numbers per square metre and number of dead ferns (%)
17 September 1999

Treatment	Fern numbers per square metre		% dead ferns **
	Total numbers	Live numbers	
Nil	18.51	16.06	21.19 (13.65)
Salt 0.5 t/ha	19.05	17.55	15.85 (7.63)
Salt 1.0 t/ha	19.40	17.05	20.09 (11.91)
Salt 2.0 t/ha	20.70	17.90	21.65 (13.92)
Salt 4.0 t/ha	24.11	20.64	21.90 (14.01)
Mean	20.35	17.84	20.14 (12.22)

SED (12df)	20.068	1.957	2.494
LSD (p=0.05)	4.506	4.264	5.434
CV% Row.Column	16.1	17.3	19.6

** Data shown has been transformed using an angular transformation. Raw data is shown in parenthesis.

Comment

There were no statistically significant differences ($p=0.05$) between treatments for both total numbers and live numbers of ferns.

There were no statistically significant differences between treatments for the % of dead ferns.

Harvest Data

Table 10 Total number of spears ('000/ha) including blown and twisted spears 1993-1996 and 1999.

Treatment	Number ('000/ha)				
	1993	1994	1995	1996	1999
Nil	312.6	201.5	243.5	259.2	119.6
Salt 0.5t/ha	323.0	222.4	264.2	264.9	147.3
Salt 1.0t/ha	325.0	219.7	274.3	270.4	123.7
Salt 2.0t/ha	312.3	216.9	253.2	251.2	107.9
Salt 4.0t/ha	32.02	213.5	255.9	251.5	113.7
Mean	318.7	214.8	258.2	259.5	122.4

SED (12 df)	20.63	6.60	16.72	16.08	13.26
LSD (P=0.05)	13.05	14.38	36.43	35.39	28.89
CV% Row.Column	6.5	4.9	10.2	9.8	17.1

Comment

Generally salt treatments produced higher total numbers of spears and in 1994 rates of application of 0.5t/ha, 1.0t/ha and 2.0t/ha were statistically significantly higher (P=0.05) than the nil treatment. In 1999 salt treatments at 0.5t/ha and 1.0t/ha produced a higher number of spears than the other treatments; but were not statistically significantly higher.

Harvest Data

Table 11 Total weight (t/ha) including blown and twisted spears 1993-1996 and 1999.

Treatment	Weight (t/ha)				
	1993	1994	1995	1996	1999
Nil	8.52	5.00	5.42	5.80	1.84
Salt 0.5t/ha	9.47	5.76	6.29	6.34	2.49
Salt 1.0t/ha	9.11	5.63	6.40	6.29	2.05
Salt 2.0t/ha	8.86	5.45	5.54	5.68	1.63
Salt 4.0t/ha	9.13	5.26	5.43	5.57	1.78
Mean	9.02	5.42	5.82	5.94	1.96

SED (12 df)	0.534	0.309	0.419	0.332	0.284
LSD (P=0.05)	0.338	0.673	0.913	0.730	0.619
CV% Row.Column	5.9	9.0	11.4	8.8	22.7

Comment

In 1994, 95 and 96 all salt treatments produced higher total weights than the nil treatment and were significantly higher ($P=0.05$) at rates of 0.5t/ha, 1.0t/ha and 4.0t/ha in 1993, 0.5t/ha in 1994, 1.0t/ha in 1995 and 0.5t/ha in 1996. In 1999 salt treatments at 0.5t/ha and 1.0t/ha produced a higher total weight than the other treatments, but differences were not statistically significantly higher than the other treatments.

Harvest Data

Table 12 Total numbers of spears ('000/ha) below and above 10mm diameter, excluding blown and twisted spears 1993-1996 and 1999.

Treatment	Number ('000/ha)									
	<10mm diameter					>10mm diameter				
	1993	1994	1995	1996	1999	1993	1994	1995	1996	1999
Nil	112.3	81.3	104.5	132.3	69.1	146.2	75.3	55.1	96.6	39.0
Salt 0.5t/ha	99.2	89.7	112.7	124.7	77.0	166.5	86.1	66.3	108.1	57.3
Salt 1.0t/ha	111.7	85.8	119.4	133.4	66.8	156.6	85.5	63.0	103.7	44.8
Salt 2.0t/ha	101.5	87.4	115.2	124.7	63.4	154.7	84.3	55.1	95.1	33.5
Salt 4.0t/ha	103.1	85.7	115.8	132.7	63.3	162.2	81.6	55.8	88.9	39.4
Mean	105.5	86.2	113.5	129.6	67.9	157.2	82.5	59.1	98.5	42.8

SED (12df)	13.72	3.97	9.89	9.77	6.91	11.97	5.75	5.16	6.14	8.12
LSD (P=0.05)	8.68	8.65	21.55	21.50	15.06	7.57	12.53	11.24	13.51	17.69
CV% Row.Column	13.0	7.3	13.8	11.9	16.1	7.6	11.0	13.8	9.9	30.0

Comment

Spears below 10mm diameter

In 1993 the nil treatment and salt applied at 1.0t/ha produced statistically significantly higher numbers ($P=0.05$). In all the other years there were no statistically significant differences and numbers were very similar within a year between treatments. In 1999 salt at 0.5t/ha gave the highest numbers of spears below 10mm diameter, but the figures were not statistically significant.

Spears above 10mm diameter

Generally salt treatments produced higher numbers of spears than the nil treatment and to a statistically significantly higher ($P=0.05$) level in 1993 when all four treatments were higher and in 1996 when the 0.5t/ha and 1.0t/ha treatments were statistically significantly higher. In 1999 salt at 0.5t/ha gave the highest number of spears above 10mm diameter but the figures were not statistically significant.

Harvest Data

Table 13 Weight (t/ha) of spears below and above 10mm diameter, excluding blown and twisted spears 1993-1996 and 1999.

Treatment	Weight (t/ha)									
	<10mm diameter					>10mm diameter				
	1993	1994	1995	1996	1999	1993	1994	1995	1996	1999
Nil	1.98	1.37	1.80	2.00	0.87	5.47	2.86	1.92	3.28	0.86
Salt 0.5t/ha	1.77	1.57	2.03	1.93	0.99	6.49	3.31	2.39	3.78	1.33
Salt 1.0t/ha	2.02	1.54	2.27	2.03	0.84	5.97	3.23	2.25	3.68	1.07
Salt 2.0t/ha	1.79	1.50	1.98	1.88	0.74	5.91	3.16	1.87	3.24	0.77
Salt 4.0t/ha	1.85	1.46	1.93	2.01	0.75	6.21	3.01	1.89	3.03	0.92
Mean	1.88	1.49	2.00	1.97	0.84	6.01	3.12	2.06	3.40	0.99

SED (12df)	0.224	0.072	0.227	0.130	0.090	0.469	0.282	0.225	0.253	0.212
LSD (P=0.05)	0.141	0.153	0.495	0.286	0.197	0.297	0.602	0.490	0.556	0.952
CV% Row.Column	11.9	7.6	17.9	10.5	16.9	7.8	14.0	17.2	11.8	33.5

Comment

Weights below 10mm diameter

In 1993 and 1994 statistically significant differences ($P=0.05$) were produced with the nil and 1.0t/ha rate of salt in 1993 and the 0.5t/ha and 1.0t/ha rates of salt in 1994. In 1995 and 1996 there were no statistically significant differences ($P=0.05$) between treatments. In 1999 salt at 0.5t/ha produced the highest weights of spears below 10mm diameter but the figures were not statistically significant.

Weights above 10mm diameter

Generally salt treatments produced higher weights than the nil treatments and to a statistically significantly higher ($P=0.5$) level in 1993 when all treatments were higher, 1995 when the 0.5t/ha rate was higher and in 1996 when the 0.5t/ha and 1.0 t/ha rates were of statistical significance. In 1999 salt at 0.5t/ha gave the highest weight of spears above 10mm diameter, but the figures were not statistically significant.

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