

**FINAL REPORT
PROJECT FV 152**

**ASPARAGUS:
COMPARISON OF RATES AND TIMINGS
OF NITROGEN APPLICATION ON
CROP PERFORMANCE
(ADAS CONTRACT XHACC)**

FINAL REPORT

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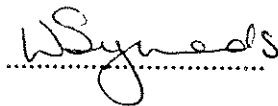
I declare that this work was done under my supervision according to the procedures described herein and that this report represents a true and accurate record of the results obtained.



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Practical section for growers

Introduction

Recommendations on the rates of nitrogen needed for asparagus crops were laid down during the 1960s when poor yielding, open pollinated varieties were grown in the UK and at a time when demands for spear quality were not as strict as they are in the 1990s. No work has been carried out in this country since the 1960s.

It is vital that growers produce satisfactory yields of good quality spears in order to both produce an early break-even point in the crop's life and maximise returns in each of the harvesting seasons. Nitrogen requirements for yield however need to be balanced with the requirement to provide a crop life of 15 years or more.

Good fern growth is a key factor in satisfying these needs. Poor fern growth produces poor quality buds and subsequently inferior spears in the following year.

In discussion with Soil Scientists, it has been concluded that nitrogen levels need to be re-examined on the higher performing varieties being grown in the 1990s.

Treatments

This trial was laid down on a three year old, well managed crop of the all male variety Franklim. A range of rates of nitrogen (from Nil to a total of 450 kg/ha/season) were applied three times per year (pre-harvest - April, post harvest - end June, and in the fern growing period - August) over a four year period. In 1993 the treatments were applied 15 April, 21 June, and 19 August. They were applied 2 May, 24 June and 19 August in 1994, 30 April, 27 June and 22 August in 1995 and 21 April, 22 June and 16 August in 1996. Fern growth was measured in the autumns of 1993 and 1994. Yield data was taken from 1994 to 1996 inclusive and soil samples were taken for mineral nitrogen analysis in 1996.

Summary of Results and Discussion

Fern Growth

Measurements of fern growth taken in October 1993 showed that nitrogen applications tended to reduce the height of fern. There was also an indication that nitrogen treatments increased numbers of ferns per plant, but differences were small. The treatment providing the highest total rate of nitrogen (450 kg/ha during the season) resulted in the least number of ferns per plant in 1993 but the highest number in 1994. In 1994 all treatments produced similar fern height per plant with no significant differences.

Yields - 1996

There were no significant differences between treatments in either total numbers of spears or weight. There were significantly more ($P=0.05$) blown and twisted spears from treatment E (200 kg/ha nitrogen, total applied 50 kg/ha April, 100 kg/ha June and 50 kg/ha August) than from the nil treatment.

Yields - 1994-1996 - Please refer to tables 9 and 10

Total number of spears

Overall there were few differences between treatments but treatment F with a total nitrogen application of 250 kg/ha (50 kg/ha April + 100 kg/ha June + 100 kg/ha August) was significantly better ($P=0.05$) than treatment C (total 300 kg/ha nitrogen) in 1994 and G (total 200 kg/ha nitrogen) in 1995. This suggests that the most beneficial policy is one of a small early application applied before harvesting followed by two larger applications after the harvesting period, during the fern growing period, in order to produce the highest number of spears.

Total Weight

There were no significant differences ($P=0.05$) between treatments in terms of total weight, but treatment F with a total nitrogen application of 250kg/ha (50kg/ha April + 100kg/ha June + 100kg/ha August) always produced the highest yield of all the nitrogen rates tested.

Soil Mineral Nitrogen

Soil samples were taken to a depth of 60cms in July 1996 and analysed for soil mineral nitrogen levels - details provided in tables 11 and 12.

Large quantities of mineral nitrogen are present in all treatments. In treatment D where the highest rates of nitrogen were applied (150 kg/ha April + 150 kg/ha June + 150 kg/ha August) the levels were extremely high.

Comparison of Results with Standard Recommendations

When the trial was started in 1993 current nitrogen recommendations on an established crop grown on a sandy loam soil were 125-150kg/ha of nitrogen. Very few significant differences were recorded between the nil and nitrogen treatments during the life of the trial.

However it would be unwise to recommend nil nitrogen and it is concluded that original recommendations will be adequate for most cropping situations. Trial results

indicate that up to 250kg/ha of nitrogen shows benefits in terms of yield and number of spears. This is applied at the rate of 50kg/ha nitrogen pre-harvest in April followed by two applications of up to 100kg/ha each, applied after harvesting at the end of June and during the fern growing period in August (or in a single application at the end of June) at times when the crop is able to utilise the applied fertiliser. This regime also offers the best potential from the point of view of controlled growth and environmental implications.

Even at the highest rates tested (450kg/ha) there were no indications of reduction in yield or crop damage due to excessive nitrogen use.

Harvest data has been collected for three years. Any effects of treatments are likely to require a prolonged period of treatment and recording to evaluate accurately.

INTRODUCTION

Nitrogen is needed to encourage fern growth and subsequent bud formation for the following year's growth of spears for harvest and further fern development.

Levels of nitrogen needed for successful production of asparagus crops have not been evaluated in the UK since the 1960s, when poor yielding open pollinated varieties were grown.

With the development of higher yielding all male varieties, which are being planted in the 1990s, rates of nitrogen and timings of applications needed re-examination.

This study was started in spring 1993.

The crop was established in May 1990 with the all male Dutch variety, Franklim.

A range of rates of nitrogen and timings of application were made in each year for the period 1993 to 1996 inclusive. Soil samples were taken in 1996 for analysis for mineral nitrogen.

Fern growth was measured in the autumns of 1993 and 1994 and crop yield data taken from 1994 to 1996 inclusive.

OBJECTIVE

Asparagus - To measure the effects of a range of rates and timings of nitrogen application over a four year period on crop performance.

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 30 cm (12 ins) depth, over a sandy clay loam (Wick Series). The site is well drained.

Treatments

- (1) Timings of application.
- (2) Rates of nitrogen.

Treatment	Timings and Rates of Nitrogen kg/ha (units/acre)			
	Pre-emergence of spears (April)	After harvesting period (End June)	During fern growing period (August)	Total in Season
A	0	0	0	0
B	50 (40)	50 (40)	50 (40)	150 (120)
C	100 (80)	100 (80)	100 (80)	300 (240)
D	150 (120)	150 (120)	150 (120)	450 (360)
E	50 (40)	100 (80)	50 (40)	200 (160)
F	50 (40)	100 (80)	100 (80)	250 (200)
G	100 (80)	50 (40)	50 (40)	200 (160)
H	100 (80)	100 (80)	50 (40)	250 (200)

Treatments were applied 15 April, 21 June and 19 August 1993, 2 May, 24 June and 19 August 1994, 30 April, 27 June and 22 August 1995, and 21 April, 22 June and 16 August in 1996.

Phosphate and potash were applied to the trial area on 15 April 1993, 28 April 1994, 30 April 1995 and 21 April 1996 according to current ADAS recommendations of 50 kg/ha (40 units/acre) phosphate and 25 kg/ha (20 units/acre) potash.

Husbandry

The crop was planted in May 1990 using the all male Dutch variety, Franklim. It was established from container raised transplants planted in single rows at 1.50 m (5 feet) centres with an in row spacing of 27 cm(11 ins), providing a plant population of 23,750 per hectare (9,500 per acre).

The first harvest was taken in 1992 from 1 to 20 May.

The first full harvest year was 1993 when the crop was harvested for the period 1 May to 18 June.

Assessments

Measurements were taken of fern numbers and fern height during autumn 1993 and 1994. No harvest records were taken in 1993. The first recorded harvests were taken in 1994 from 3 May to 21 June when the crop was assessed for numbers and weights of spears below and above 10 mm diameter and spears in the blown and twisted category. Similar harvest data was recorded in 1995 during the period 5 May to 21 June and in 1996 from 8 May to 20 June.

Design and Analyses

The trial design consists of randomised blocks with 4 replications.

Plot size - 2 m x 6 m (4 single rows) totalling 72 sq m with the number of plants planted being 178.

Recordable area - 10 m x 3 m (2 single rows) totalling 30 sq m with the number of plants planted being 74.

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 1996.

Treatment	Number ('000/ha)	Weight (t/ha)
A	273.8	6.66
B	260.9	6.26
C	264.5	6.16
D	264.3	6.34
E	273.3	6.21
F	276.7	6.57
G	255.2	5.84
H	268.6	6.11
Mean	267.2	6.27

SED (21 df)	18.54	0.538
LSD (P=0.05)	38.56	1.119
CV%	9.8	12.1

Comment

There were no significant differences (P=0.05) between treatments in either total numbers of spears or weight.

RESULTS AND DISCUSSION

Harvest Data

Table 2: Total number of spears ('000/ha) and total weight (t/ha) excluding blown and twisted spears in 1996.

Treatment	Number ('000/ha)	Weight (t/ha)
A	238.3	5.97
B	223.0	5.56
C	224.1	5.36
D	225.8	5.58
E	229.4	5.42
F	236.2	5.76
G	221.0	5.19
H	230.3	5.41
Mean	228.5	5.53

SED (21 df)	17.14	0.511
LSD (P=0.05)	35.65	1.063
CV%	10.6	13.1

Comment

There were no significant differences ($P=0.05$) between treatments in either total numbers of spears or weight.

RESULTS AND DISCUSSION

Harvest Data

Table 3: Total number of spears ('000/ha) and weight (t/ha) of blown and twisted spears in 1996.

Treatment	Number ('000/ha)	Weight (t/ha)
A	35.5	0.69
B	37.9	0.70
C	40.4	0.80
D	38.6	0.76
E	43.9	0.79
F	40.5	0.80
G	34.2	0.66
H	38.3	0.70
Mean	38.66	0.74

SED (21 df)	2.597	0.048
LSD (P=0.05)	5.402	0.100
CV%	9.5	9.3

Comment

There were significantly more (P=0.05) blown and twisted spears for treatment E (total of 200 kg/ha nitrogen) than for treatment A (nil nitrogen fertiliser) and significantly more weight for treatments C and F (totals of 300kg/ha and 250kg/ha nitrogen respectively) than for treatment A (nil nitrogen fertiliser).

RESULTS AND DISCUSSION

Harvest Data

Table 4: Total number of spears ('000/ha) and weight (t/ha) below and above 10mm spear diameter, excluding blown and twisted spears in 1996.

Treatment	Number ('000/ha)		Weight (t/ha)	
	<10 mm diam.	>10 mm diam.	<10 mm diam.	>10 mm diam.
A	126.1	112.2	2.04	3.93
B	119.4	103.6	1.96	3.60
C	121.5	102.6	1.90	3.46
D	120.4	105.3	1.96	3.63
E	132.7	96.7	2.12	3.30
F	126.7	109.4	2.06	3.71
G	127.0	94.0	2.01	3.18
H	132.0	98.3	2.08	3.33
Mean	125.7	102.8	2.01	3.52

SED (21 df)	11.46	10.64	0.200	0.400
LSD (P=0.05)	23.84	22.13	0.417	0.831
CV%	12.9	14.6	14.1	16.1

Comment

There were no significant differences (P=0.05) between treatments in either total number of spears or weight in the below or above 10 mm spear diameter.

RESULTS AND DISCUSSION

Harvest Data

Table 5: Weekly pattern of numbers ('000/ha) of small (<10 mm diam.) spears harvested in 1996.

Treatment									
Week No	A	B	C	D	E	F	G	H	Mean
1	1.83	2.08	1.92	2.08	3.50	2.42	2.33	3.17	2.42
2	7.25	7.42	8.00	8.00	7.25	7.83	8.17	9.00	7.86
3	14.33	15.17	14.83	15.42	12.75	14.00	15.92	14.58	14.62
4	27.58	27.42	29.42	28.33	30.33	28.83	26.83	29.92	28.58
5	32.92	28.00	31.67	30.42	34.58	31.33	33.25	36.08	32.28
6	36.42	33.42	31.00	32.17	38.58	36.42	35.58	34.75	34.79
7	5.75	5.92	4.67	4.00	5.75	5.92	4.92	4.50	5.18
Total	126.08	119.43	121.51	120.42	132.74	126.75	127.00	132.00	125.73

RESULTS AND DISCUSSION

Harvest Data

Table 6: Weekly pattern of weight (t/ha) of small (<10 mm) spears harvested in 1996.

Treatment									
Week No	A	B	C	D	E	F	G	H	Mean
1	0.028	0.035	0.030	0.034	0.057	0.043	0.037	0.047	0.039
2	0.110	0.120	0.117	0.130	0.118	0.127	0.132	0.143	0.125
3	0.230	0.225	0.204	0.233	0.187	0.200	0.219	0.213	0.214
4	0.459	0.468	0.465	0.466	0.497	0.479	0.438	0.467	0.467
5	0.551	0.493	0.535	0.517	0.572	0.538	0.554	0.593	0.544
6	0.581	0.530	0.478	0.517	0.607	0.582	0.555	0.555	0.551
7	0.081	0.085	0.070	0.058	0.081	0.087	0.070	0.064	0.075
Total	2.041	1.956	1.899	1.955	2.119	2.055	2.005	2.083	2.014

RESULTS AND DISCUSSION

Harvest Data

Table 7: Weekly pattern of number ('000/ha) of large (>10 mm diam.) spears harvested in 1996.

Treatment									
Week No	A	B	C	D	E	F	G	H	Mean
1	3.25	2.50	4.00	3.83	3.33	3.83	3.42	3.50	3.46
2	14.25	13.75	14.42	15.08	13.58	14.83	11.33	14.83	14.01
3	37.83	35.42	35.33	35.92	34.75	35.17	30.50	31.33	34.53
4	24.83	23.08	23.25	25.42	20.17	28.42	23.42	23.25	23.98
5	13.42	11.50	10.92	10.67	10.75	11.08	12.25	11.42	11.50
6	16.50	15.08	12.58	12.33	12.58	14.08	11.25	12.33	13.34
7	2.08	2.25	2.08	2.08	1.50	2.00	1.83	1.67	1.94
Mean	112.16	103.58	102.58	105.33	96.66	109.41	94.00	98.33	102.76

RESULTS AND DISCUSSION

Harvest Data

Table 8: Weekly pattern of weight (t/ha) of large (>10 mm diam.) spears harvested in 1996.

Treatment									
Week No	A	B	C	D	E	F	G	H	Mean
1	0.117	0.090	0.140	0.141	0.116	0.748	0.730	0.126	0.126
2	0.528	0.507	0.528	0.543	0.482	0.505	0.416	0.533	0.505
3	1.377	1.262	1.205	1.270	1.230	1.267	1.046	1.084	1.218
4	0.881	0.845	0.803	0.874	0.710	0.946	0.812	0.808	0.835
5	0.444	0.380	0.357	0.363	0.343	0.366	0.377	0.368	0.375
6	0.522	0.455	0.369	0.380	0.374	0.415	0.346	0.367	0.404
7	0.057	0.062	0.057	0.055	0.043	0.062	0.054	0.045	0.054
Total	3.926	3.601	3.458	3.625	3.298	3.708	3.181	3.330	3.516

RESULTS AND DISCUSSION

Harvest Data

Table 9: Total number of spears ('000/ha) including blown and twisted spears 1994-96 inclusive.

Treatment	Number ('000/ha)		
	1994	1995	1996
A	233.7	256.3	273.8
B	232.2	268.0	260.9
C	218.9	260.8	264.5
D	225.5	266.0	264.3
E	235.9	268.0	273.3
F	249.7	285.2	276.7
G	236.9	250.2	255.2
H	230.2	262.9	268.6
Mean	232.9	264.7	267.2

SED (21 df)	12.63	16.31	18.54
LSD (P=0.05)	26.27	33.92	38.56
CV%	3.8	8.7	9.8

Comment

Overall there were few differences between treatments but treatment F with a total nitrogen application of 250 kg/ha (50 kg/ha April + 100 kg/ha June + 100 kg/ha August) was significantly better ($P=0.05$) than treatment C (total 300 kg/ha of nitrogen) in 1994 and G (total 200 kg/ha of nitrogen) in 1995.

RESULTS AND DISCUSSION

Harvest Data

Table 10: Total weight (t/ha) including blown and twisted spears 1994-96 inclusive.

Treatment	Weight (t/ha)		
	1994	1995	1996
A	5.66	5.54	6.66
B	5.69	5.80	6.26
C	5.21	5.58	6.16
D	5.42	5.69	6.34
E	5.71	5.69	6.21
F	5.80	6.04	6.57
G	5.51	5.12	5.84
H	5.58	5.62	6.11
Mean	5.57	5.64	6.27

SED (21 df)	0.330	0.496	0.538
LSD (P=0.05)	0.686	1.030	1.119
CV%	4.2	12.4	12.1

Comment

There were no significant differences ($P=0.05$) between treatments in terms of total weight, but treatment F with a total nitrogen application of 250kg/ha (50kg/ha April + 100kg/ha June + 100kg/ha August) always produced the highest yield of all the nitrogen rates tested.

Table 11

Soil Samples Mineral Nitrogen Analysis taken 4 July 1996

Results

Treatment	Moisture %	NO ₃ -N mg/kg	NH ₄ -N mg/kg	N %
A 0-30 cms	10.6	14.5	1.5	0.09
A 30-60 cms	11.6	5.6	1.1	0.09
B 0-30 cms	10.8	33.5	3.9	0.08
B 30-60 cms	11.7	8.1	1.7	0.06
C 0-30 cms	10.4	33.3	9.6	0.10
C 30-60 cms	11.5	11.6	2.0	0.03
D 0-30 cms	10.8	70.2	36.0	0.12
D 30-60 cms	11.8	45.8	3.2	0.08
E 0-30 cms	11.1	28.2	12.0	0.09
E 30-60 cms	11.5	9.2	2.1	0.04
F 0-30 cms	10.6	45.0	15.0	0.08
F 30-60 cms	11.2	14.3	3.6	0.05
G 0-30 cms	11.0	37.3	16.0	0.08
G 30-60 cms	11.9	11.0	2.2	0.04
H 0-30 cms	11.0	40.4	16.0	0.10
H 30-60 cms	11.1	9.5	2.4	0.06

Conversions to kg/ha mineral N - on following page.

Table 12

Mineral Nitrogen Analysis

Conversion to kg/ha mineral N (NO₃-N + NH₄-N) in each soil layer.

Treatment	Kg/ha N		
	0-30cms	30-60cms	Total 0-60cms
A	56	23	79
B	130	34	164
C	150	47	197
D	369	169	538
E	139	39	178
F	209	62	271
G	185	45	230
H	196	41	237

Comment

The results show that large quantities of mineral nitrogen are present. In treatment D where the highest rates of nitrogen have been applied (150 kg/ha April + 150 kg/ha June + 150 kg/ha August) the quantities are extremely high.