PREDICTION OF NITROGEN REQUIREMENT FOR VEGETABLES

HDC FV17a PART 1

CAULIFLOWERS

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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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SUMMMARY

ADAS nitrogen recommendations for cauliflower crops are currently 250 kg/ha N for crops following cereals (N index 0 soils) and 200 kg/ha following vegetable crops receiving more than 200kg/ha N (N index 1 soils), an allowance of only 50 kg/ha. These recommendations were tested for two cauliflower crops grown in succession for 2 seasons (1988 and 1989) on a silt loam soil in Lincolnshire. Early summer cauliflower crops were planted following low N residue crops (N index 0 soils) in both seasons. They were planted in late March in 1988 and early March in 1989. Maximum marketable produce was given with 300 kg/ha N in 1988 and 240 kg/ha N in 1989, in line with current recommendations. The early summer cauliflower left between 61 and 100 kg/ha N in crop debris and 136-170 kg/ha N in soil mineral N at harvest. Crop debris nitrogen mineralised within the two week period separating the first crop from a following autumn cauliflower crop, which was planted in early July.

Where 300 kg/ha N had been applied to the first crop the maximum number of Class I autumn cauliflower curds were obtained without the addition of any fresh fertiliser nitrogen. This was in contrast to the 200 kg/ha N normally recommended. This suggested that the allowance normally made for N in brassica crop debris has been under-estimated. The contribution of residues from brassica crops to succeeding crops can be assessed by measurements of soil mineral nitrogen.

The autumn cauliflower crop did not respond to fresh fertiliser nitrogen where soil mineral N levels at planting were more than 188 kg/ha in the 0-30 cm soil layer and 253 kg/ha to 90 cm depth. Measurements of soil mineral N at planting of the second crop could be used to make a more accurate allowance for nitrogen in crop and soil residues from early summer cauliflowers. Thus soil mineral nitrogen measurements could form the basis of an improved prediction of fertiliser nitrogen requirements for cauliflowers in brassica rotations.

Further work would be needed to justify this on other soil types or in very different seasons where mineralisation of nitrogen from crop residues may be slower, or in very wet seasons where leaching of N may occur. Investigations also need to be carried out to examine the effect of nitrogen on the production of the highest quality deep Class 1 curds from the autumn cauliflower crop.

A report on work undertaken with 15N labelled fertiliser nitrogen as part of the project was to be included in this report. However due to instrument problems a separate report will be prepared when the results are available.

RECOMMENDATIONS FOR FERTILISING CAULIFLOWER CROPS

The quantity of nitrogen left behind by cauliflower crops can be substantial, up to 270 kg/ha from a well grown crop. This nitrogen is worth £81/ha @ (30 p/kg) to the grower and therefore should be taken into account when fertilising following crops.

The following strategy is suggested:-

1) Where Cauliflowers are grown in essentially arable rotations without additions of animal manures the best estimate of fertiliser requirement will be given by the existing ADAS fertiliser recommendations (MAFF 1981). (See Table i in the introduction)

2) Where cauliflower crops are grown in Brassica rotations or on fields which have received substantial quantities of animal manures in their history, fertiliser recommendations should be based on measurements of soil mineral nitrogen.

Measurements of soil mineral nitrogen should be made to a depth of 60 cm (except between cauliflower crops in the same season where measurements to 30 cm are adequate). Samples should be taken after mineralisation of previously incorporated crop residues.. This could be several months following winter incorporation or 2-3 weeks in the summer. Samples should be kept cool and analysed within 24 hours of sampling or frozen until the analysis can be carried out.

The results from an analysis of soil mineral nitrogen should be interpreted with care taking into account the distribution of soil mineral nitrogen through the soil profile. It should be remembered that poor soil structure could reduce the availability of nitrogen to the growing crop. Interpretation of soil mineral nitrogen results can be provided by the NVRS nitrogen model currently being developed at HRI Wellesbourne, or by the sampling, analysis and interpretation service provided by ADAS as part of the Soil Mineral Nitrogen Service for Vegetables.

PREDICTION OF NITROGEN REQUIREMENT FOR VEGETABLES FV17a PART 1 CAULIFLOWERS

INTRODUCTION

Although nitrogen is the key nutrient for both vegetable yield and quality, there are only crude and often inaccurate methods for estimating nitrogen requirement, mostly based on previous cropping (N Index). N supply from the soil is a major source of nitrogen for the crop, and commonly varies four-fold and occasionally as much as ten-fold between fields. The currently used ADAS nitrogen index (Table i) accounts for only part of the field to field variation in soil nitrogen supply and frequently results in overuse of nitrogen fertiliser and occasionally in underuse. Overuse reduces crop quality, increases nitrate levels in produce and enhances leakage of nitrate into non-agricultural water, whereas under use reduces marketable produce.

Table i

Nitrogen Index - based on last crop grown

Nitrogen Index 0	Nitrogen Index 1	Nitrogen Index 2
Cereals	Peas or beans	Any crop in field receiving large
Sugar beet	Potatoes	frequent dressings
Maize	Oilseed rape	of farmyard manure or slurry
Vegetables receiving less than 200 kg/haN	Vegetables receiving more than 200 kg/haN	Lucerne
Forage crops removed	Forage crops grazed	Long leys, grazed or cut and grazed, high N (b)
Leys (1-2 years), grazed or cut and grazed, low N (a)	Leys (1-2 years) grazed or cut and grazed, high N (b)	Permanent pasture, cut only, grazed or cut and grazed
Leys (1-2 years), cut only	Long leys, cut only	
Permanent pasture, poor quality,matted	Long leys, grazed or cut and grazed, low N (a)	

(a) Low N - less than 250 kg/ha N per year and low clover content

(b) High N - more than 250 kg/ha N per year or high clover content

Source Reference Book 209 (MAFF 1988)

Individual field estimates of nitrogen available to crops can be made from measurements of the amount of mineral nitrogen (NO_3^- and NH_4^+) in soil to the depth of rooting, but additional work is needed to understand how best to use this measure of available nitrogen. To improve prediction by modelling and other means, 5 specific features need to be explored:-

a) The influence of fertiliser nitrogen applied to one crop on the overall soil nitrogen supply to the next crop and on the rate of mineralisation of crop residues.

b) The extent to which different levels of fertiliser nitrogen leave mineral nitrogen in soil at crop harvest.

c) The minimum level to which crop roots can reduce nitrate levels in soil (probably species specific).

d) The apparent disappearance of fertiliser nitrogen into the soil biomass and the extent of its reappearance in the year of application.

e) The extent to which defoliation through the growing season contributes to the apparent reduction in recovery of nitrogen by crops.

OBJECTIVES

1. To evaluate the contribution of residues from brassica crops to the supply of nitrogen to succeeding crops.

2. To develop a more comprehensive basis on which to quantify soil nitrogen supply to brassica crops and thereby improve fertiliser nitrogen prediction.

MATERIALS AND METHODS

DESIGN

Two experiments were carried out at HRI-Kirton during the period 1988-1991: the HDC sponsored work began in 1988 and a MAFF repeat in 1989, The cropping pattern was:-

	Cropping 1987	1988	1989	1990	1991
HDC	Grass	2xCauliflower	Brussel Sprouts	S. Barley	-
MAFF repeat	Brassicas	Barley	2xCauliflower	Brussel sprouts	S. Wheat

Crop husbandry details are shown in Appendix 1.

The crops immediately prior to the early summer cauliflower crops received no fertiliser nitrogen, and they were therefore thought likely to leave residues consistent with N index 0 soils.

The first early summer cauliflower crop was planted in March and was treated with 6 levels of nitrogen in 1988 and 5 levels in 1989. This allowed the response of an early summer cauliflower crop to fertiliser nitrogen to be measured. The plots were split to test the response to fertiliser nitrogen applied to the second crop with different first crop residues. The plots were split into 6 in 1988 and into 3 in 1989. At this stage each treatment was replicated 3 times in fully randomised blocks.

A third crop, Brussels sprouts, was planted in May of the following year. In the HDC experiment the effect of the 2 cauliflower crop residues on the response to 3 levels of fresh fertiliser nitrogen (0, 60, 120 kg/haN) applied to the Brussels sprouts was tested with no replication. In the MAFF repeat, 2 levels (0, 200 kg/ha N) were tested with twofold replication.

A fourth crop, a cereal, receiving no additional fertiliser was grown to assess the maximum usable nitrogen residues from the previous brassica rotation.

TREATMENT AND DIARY OF EVENTS - 1988 HDC Experiment

	Crop	Crop	Crop	Crop
Crop:	Cauliflower	Cauliflower	Brussels	S.Barley
Variety:	"Perfection"	"White Rock"	"Stephen"	"Blenheim"
Planted as:	6cm³ blocks	'308' Module	'308' Module	Seed @ 154kg/ha
Date planted:	30/3/88	8/7/88	19/5/89	21/2/90
Plant spacing:	61cm x 46cm	61cm x 46cm	61cm x 46cm	-
Plot size m:	18.72 x 10.98	3.66 x 7.36	3.66 x 7. 36	3.66 x 7.36
Treatments:	6	36	108	108
Replicates:	3	3	1	1
Nitrogen rates (kg/ha):	0	0	0	0
	60	60	60	-
	120	120	120	-
	180	180	-	-
	240	240	-	-
	300	300	-	-
Dates nitrogen applied:	29/3/88	8/7/88	22/5/89	None
	27/4/88	-	-	-
Method:	Split ½ at each date	Single Dressing at planting	Single Dressing at planting	-
Harvesting	13/6/88	29/9-1/11/88	15/12/89	6/8/90
Residue incorporation	24/6/88	15/12/88	26/1/90	-
Method	Rotavated/ Ploughed	Ploughed	Ploughed	

TREATMENTS AND DIARY OF EVENTS - 1989 MAFF REPEAT

	Crop 1	Crop 2	Crop 3	Crop 4
Crop:	Cauliflower	Cauliflower	Brussels	S.Wheat
Variety:	Perfection	White Rock	Dolmic	Tonic
Planted as:	6cm³ blocks	'308' modules	'308' modules	Seed @ 154 kg/ha
Date planted:	8/3/89	5/7/89	16/5/90	22/2/91
Plant spacing:	61cm x 46cm	61cm x 46cm	61cm x 46cm	-
Plot size m:	10.98 x 7.82	3.66 x 7.82	3.66 x 3.91	3.66 x 3.91
Treatments:	5	15	30	30
Replicates:	3	3	2*	2
Nitrogen rates (kg/ha):	0	0	0	0
	75	75	200	-
	150	150	-	-
	225	-	-	-
	300	-	-	-
Date nitrogen applied:	28/2/89 12/4/89	5/7/89	18/5/90	None
Method:	Split ½ at each date	Single Dressing at planting	Single Dressing at planting	-
Harvesting				
Total yield:	8/6/89	4/10/89	30/10/90	24/8/91
Marketable yield:	22/5-19/6	25/9-19/10	"	"
Residue incorporation				
Date	22/6/89	7/11/89 (1) 16-19/2/90 (2)	6/12/90 21/1/91	-
Method	Disc/plough	Chop (1) Plough (2)	Plough	-

*Block III lost due to top dressing as farm crop in error.

MEASUREMENTS

Soil Mineral N

Measurements of soil mineral N (0-15, 15-30, 30-60, 60-90cm) were made prior to planting and at the harvest of each crop with at least 6 soil cores per plot. Samples were frozen within 24 hours and defrosted at room temperature before extraction with 2M KCl.

Crop yields (Cauliflowers)

Marketable yield

This was determined by HRI (Kirton) staff. An area of 30 plants were harvested as they became of marketable quality. The following assessments were made for each curd using methods described in Holland (1985).

* Harvest date
* Class of curd
* Size of curd
* Texture and density of curd
* Evidence of bracting
* Curd colour
* Curd depth

Fresh and Dry Weight Yields and N offtake

Plants were harvested at ground level in order to assess total fresh weight (FW) and dry weight (DW) yields. Plants were separated into marketable and unmarketable grades. The unmarketable plants were weighed whole, subsamples being taken to allow assessment of dry matter (DM%) and nitrogen (N%) and nitrate (NO3-N) content. Marketable grade plants were trimmed with enough surrounding leaves left to protect the curd, leaving the upper surface of the curd visible. Fresh weights were determined from the curds and trimmings from the marketable plants. Subsamples were taken for dry matter and nitrogen and nitrate content. Plant samples were dried in the oven at 60°C for at least 24 hours until dry. After drying N% and NO3-N were determined on ground material in order to calculate nitrogen offtake.

Harvesting techniques adopted for determining fresh (FW) and dry weight (DW) yields and N offtake

1988 HDC Experiment

	Crop 1	Crop 2
Total no. of plants sampled for total FW and DW:	30	30
Harvesting:	Single harvest When 50% crop of marketable quality	10 harvests Harvested as crop became of marketable quality
Assessments: FW/DW and N offtake		
Curds	√	√
Trimmings)	Calculated by	√
Unmarketable)	difference	√

1989 MAFF Repeat

	Crop 1	Crop 2
Total no. of plants sampled for total FW and DW	30	30*
Harvesting:	Single harvest When 50% crop of marketable quality	Single harvest When 50% crop of marketable quality
Assessments: FW/DW and N offtake		
Curds	√	√
Trimmings)	√	√
Unmarketable)	√	√

*Assessments of average weights of Class 1, Class 2 curds and unmarketable plants were made. These were applied to the numbers per ha to determine total fresh and dry weight yields and N offtake on an area basis.

STATISTICAL ANALYSIS

Analysis was carried out using Genstat. Estimates of errors were made by analysis of variance and are quoted as Standard Error of Difference (SED) with their significance given by a probability (p). Where values of p are less than 0.05 the differences are significant at the 95% level, if less than 0.01, at the 99% level. Percentage values were Angle transformed before analysis of variance, (in the Tables, SED and p values are shown in parentheses).

RAINFALL

Monthly rainfall for the cauliflower cropping years are presented in the following table, together with the average annual rainfall given by the 30 year mean values.

Monthly rainfall (mm) at HRI Kirton

	1988	1989	1990	30yr Mean 1960-89
January	89.8	32.5	38.9	47.7
February	27.2	20.4	66.0	34.2
March	65.9	58.1	14.0	45.7
April	29.8	68.1	21.9	44.6
May	61.2	7.2	17.0	47.5
June	33.9	59.7	42.0	52.5
July	78.5	32.1	20.0	45.5
August	48.0	33.1	37.8	53.7
September	28.3	38.9	26.0	45.0
October	39.4	33.5	38.1	41.9
November	47.4	41.7	52.9	55.6
December	16.4	71.3	39.0	48.8
Total	565.8	496.6	413.6	562.7

January 1988 was exceptionally wet; which together with high rainfall in March led to delayed planting. Rainfall throughout the rest of the growing period for crop 1 was average. Rainfall in July was above average. Rainfall for the second crop was a little less than average.

The spring of 1989 was much drier than in 1988 allowing earlier planting of the early summer cauliflower crop. May was exceptionally dry and rainfall after July was somewhat less than average.

RESULTS
EARLY SUMMER CAULIFLOWER CROPS

EARLY SUMMER CAULIFLOWER CROP

Figure 1 shows that in 1988 the marketable number of curds increased steadily from 17,800 (50% of plants) when no fertiliser was given to 33,300 (93% of plants) where 300kg/ha had been applied. (Table 1). In 1989 the number increased from 23,800 (65%) with no nitrogen up to 32,500 (91% of plants) with 300kg/ha nitrogen. Figure 2 gives the plot of soil and fertiliser supply against number of marketable curds. Part of the reason for the lower response to N in 1989 may be the difference in soil mineral N at planting which was 107 kg/ha in 1989 compared with only 73 kg/ha in 1988. In 1988 the number of marketable curds was increased largely through a higher number of class 2 curds. In 1989 the increase was due to a greater number of Class 1 curds.

In 1989 the percentage of marketable and Class 1 curds was higher than in 1988, but year to year variation is normal in early summer cauliflower crops. The performance is consistent with that reported for the variety "Perfection" (NIAB, 1993) ie early but lacking in vigour in difficult growing conditions. "Perfection" has a poorly protected curd and is susceptible to green bracts. The lower number of Class 1 curds in 1988 (Table 2) as a result of more green bracted, loose and pink curds, can be attributed to the delay in planting due to the wet conditions. In 1988 the transplants grown in 6cm peat blocks had grown rather large and up to 20% of plants had initiated or transitional apices. These plants struggled to establish and produced smaller framed plants with loose pink curds especially where little nitrogen had been applied (Table 2). Nitrate levels in the curds were not high, ranging from 212 to a maximum of 965 mg/kg fresh material.

The date when 10% of the crop was harvested for market was delayed by up to 7 days in 1988 where no fertiliser had been applied. However there was no significant effect of nitrogen on the mid-point of harvest (50% harvest date) in either year.

In both years the addition of nitrogen increased fresh and dry matter yields, although the increases were not significant in 1988. Dry matter yields given 300 kg/ha N were higher in 1989 than in 1988.

FIG 1 - Early Summer Cauliflower Crop
MARKETABLE CURDS - CLASS 1 + 2.

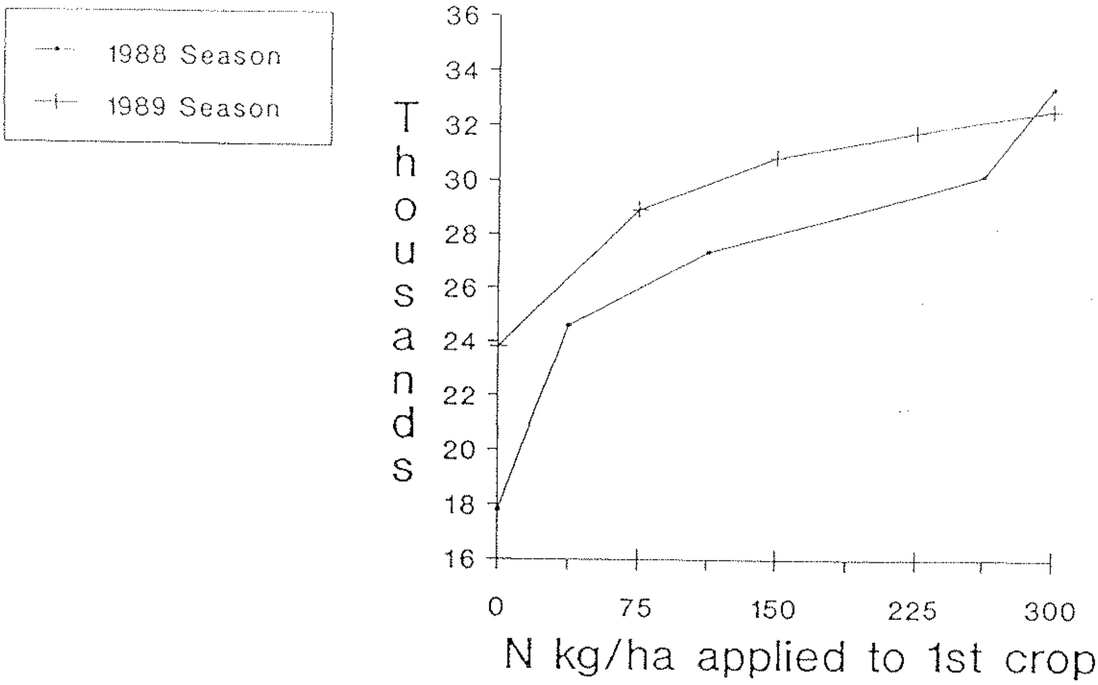

Fig 2 - Early Summer Cauliflower Crop
MARKETABLE CURDS - CLASS 1 + 2.

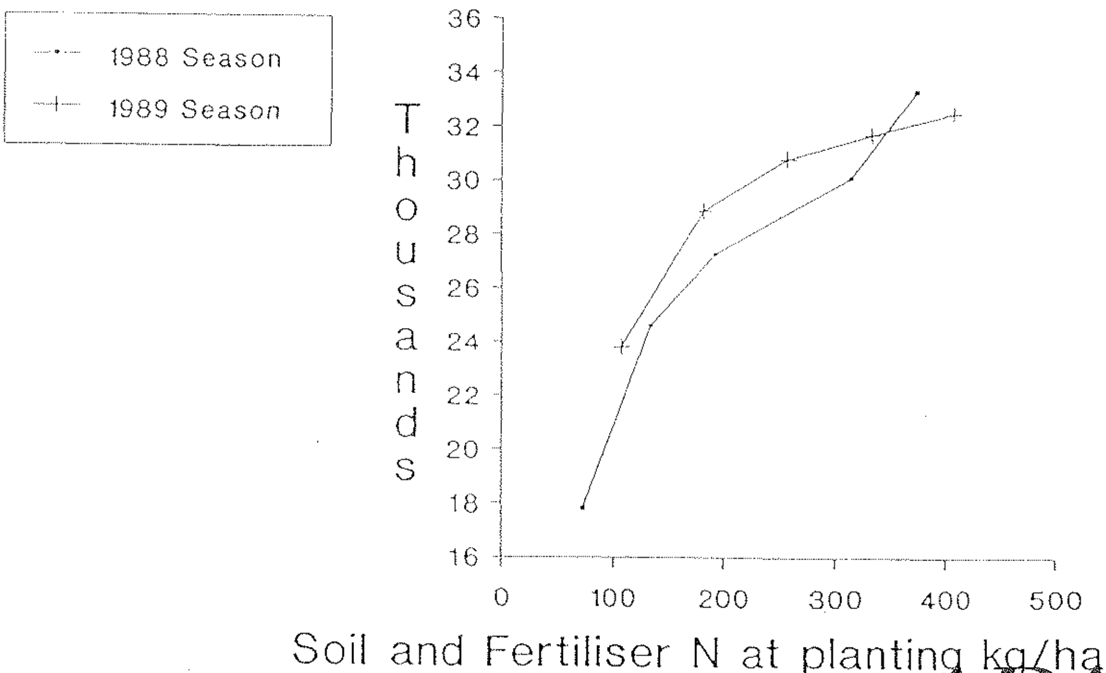

Table 3 shows the amount of nitrogen measured in the crop and soil at harvest. Nitrogen offtake was significantly (p=0.04,0.002) increased by the application of N in both seasons ranging from 68-91 kg/ha with no fertiliser, to 149-176 kg/ha given 300 kg/ha N in 1988 and 1989 seasons respectively. Transfer of N back to the soil as a result of defoliation of leaves during growth was not significant in either season amounting to at most 1.5 kg/ha N.

The proportion of nitrogen taken up by the crop and removed as marketable curds ranged from 30-47%, being larger in 1988.

Nitrogen application increased N in crop residues but this was only significant in 1989. Nitrogen contained in crop debris was 61 and 42 kg/ha where no nitrogen had been applied in 1988 and 1989 seasons respectively. Where 300 kg/ha had been applied 94 and 100 kg/ha N were found in crop debris for 1988 and 1989 seasons respectively. Soil mineral N at harvest ranged from 37 to 169 kg/ha N for nil and 300 kg/ha N treatments respectively. More soil mineral N was measured at low rates of N in 1988 than in 1989.

Table 4 shows the nitrogen balance for the early summer cauliflower crop. Where no fertiliser N had been applied more nitrogen was measured at harvest than at planting suggesting net mineralisation of nitrogen from soil organic matter. Application of fertiliser N decreased net mineralisation and where more than 180 in 1988 or 75 kg/ha N in 1989 had been applied immobilisation took place. Net immobilisation was larger and reached nearly one third of the nitrogen applied in the dryer 1989 season.

Nitrogen Residues from Early Summer Cauliflower Crop

Results are summarised in Table 5. Soil mineral N at harvest and the nitrogen content of trims and unmarketable curds provided an estimate of 'potential' available nitrogen for the second crop. Nitrogen residues were substantial ranging from 100-250 kg/ha N. A large proportion of this was in the mineral form. Figure 3 shows the close agreement in both seasons between this estimate of 'potential' available nitrogen and soil mineral nitrogen at planting of the autumn cauliflower crop. This suggests a rapid turnover of nitrogen from crop residues within 2-3 weeks of incorporation. Figure 4 shows that a large proportion of this released N was measured in the 15-30cm layer, the depth to which the crop debris had been ploughed.

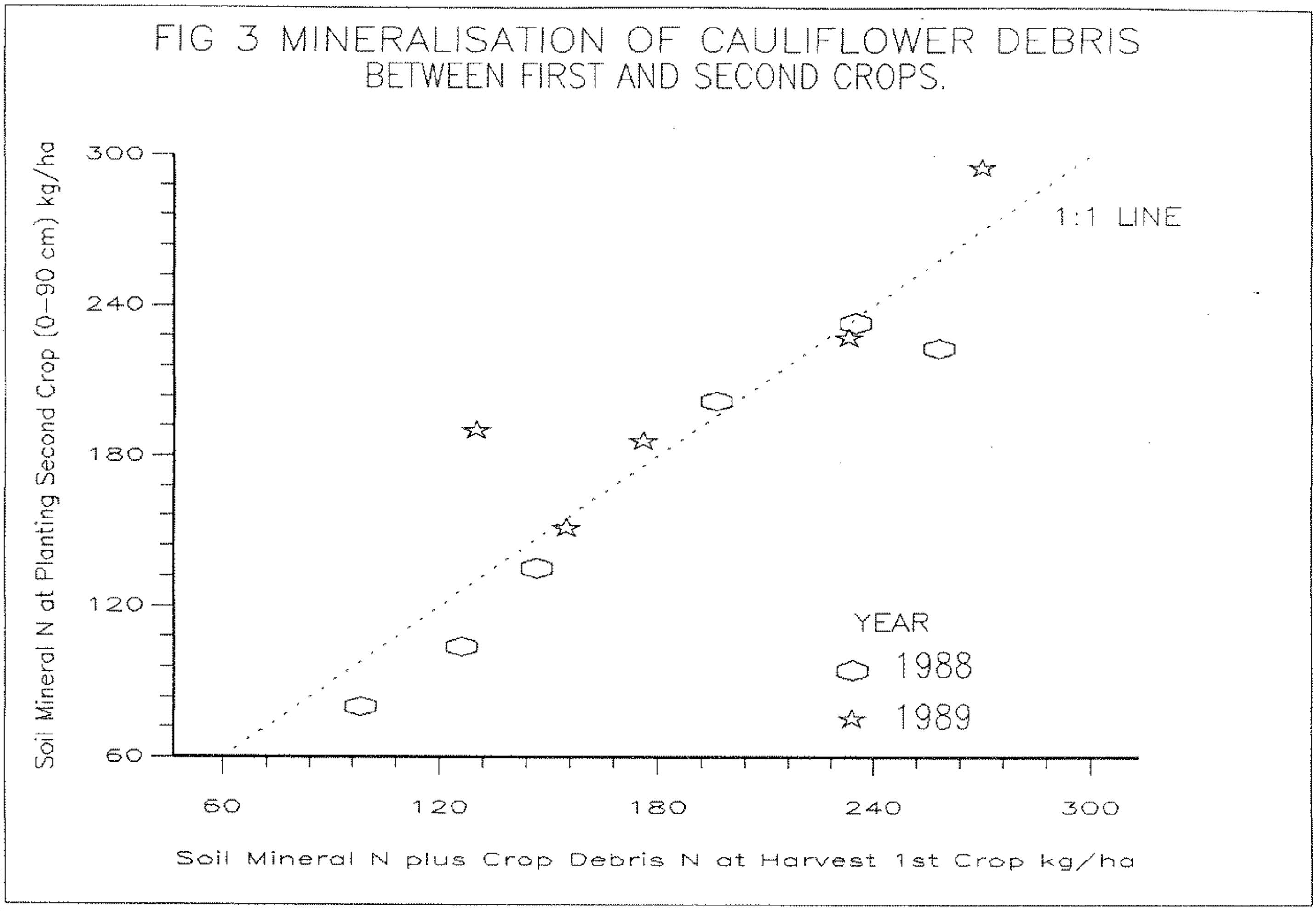

FIG 3 MINERALISATION OF CAULIFLOWER DEBRIS
BETWEEN FIRST AND SECOND CROPS.
Soil Mineral N at Planting Second Crop (0-90 cm) kg/ha
300
240
180
120
60
1:1 LINE
YEAR
1988
1989
60
120
180
240
300
Soil Mineral N plus Crop Debris N at Harvest 1st Crop kg/ha

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FIG 4a SOIL MINERAL N AT PLANTING 2nd CAULIFLOWER CROP - 4/7/88 (kg/ha)

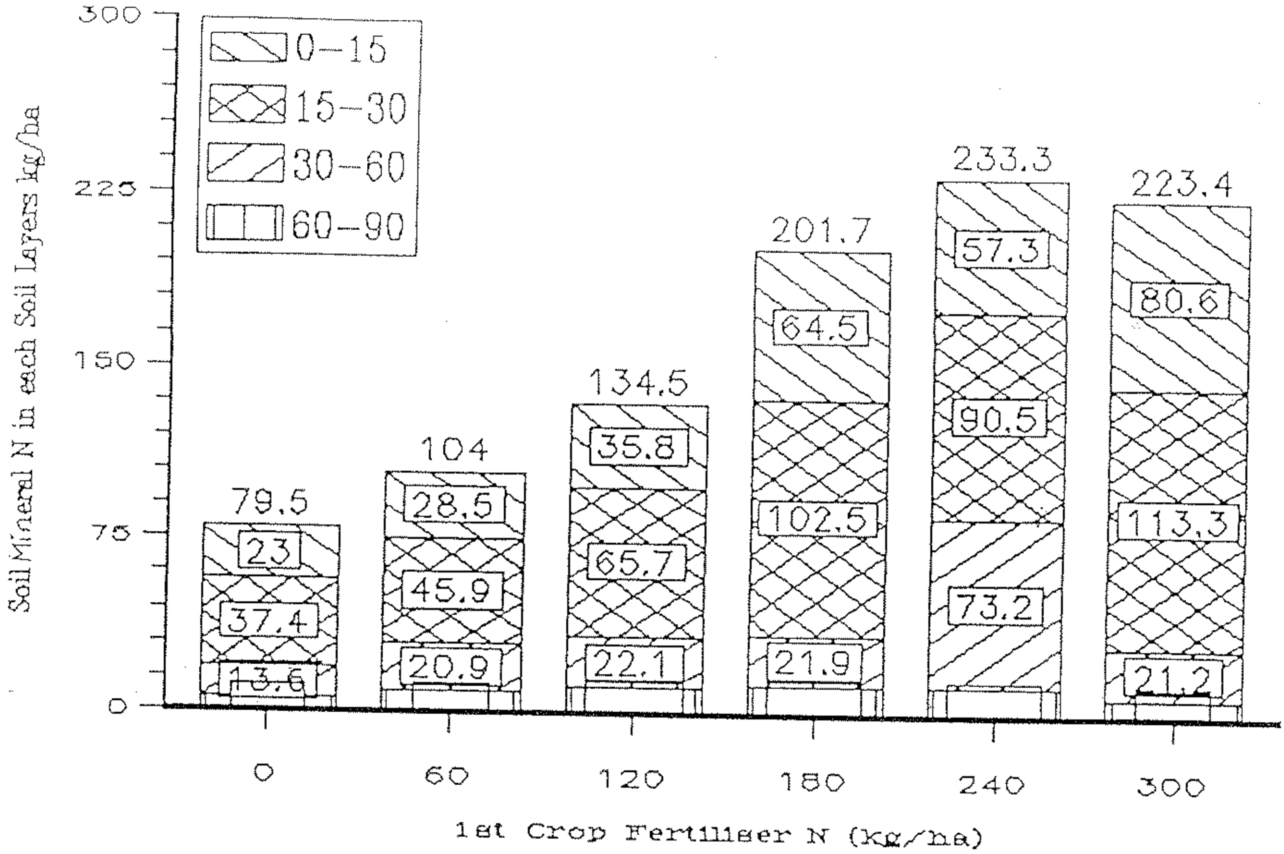

FIG 4b SOIL MINERAL N AT PLANTING 2nd CAULIFLOWER CROP - 4/7/89 (kg/ha)

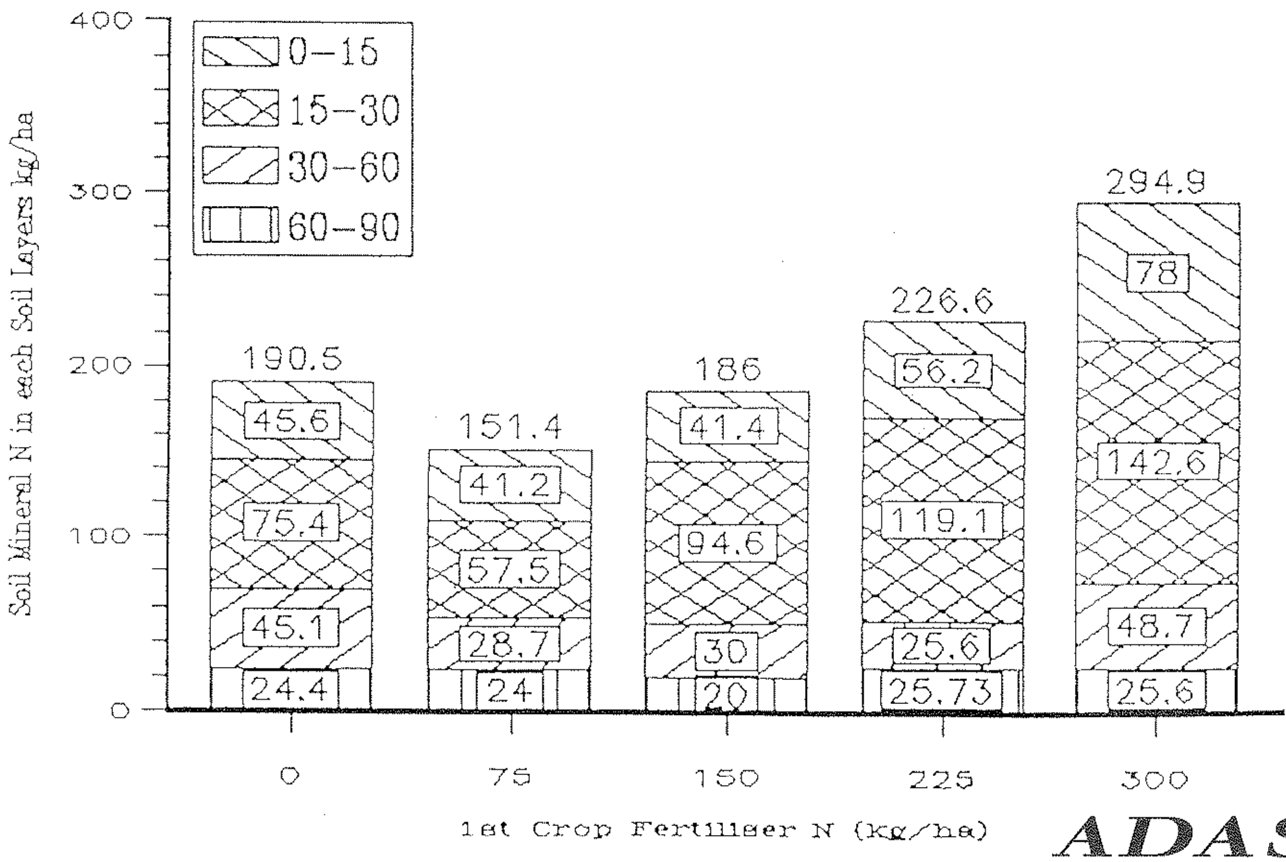

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TABLE 1 Early summer cauliflower - response to fertiliser nitrogen (Percentages analysed as angle transformed data are shown in parentheses)

	No Cls 1 + 2 Mkt curds (1,000/ha)	% Class 1	% Class 2	% unmarketable	Total Fresh (t/ha)	Yield Dry wt (t/ha)	Harvest Index % per plant	Harvest Index % field
HDC EXPT. 1988 planting								
0	17.8	10 (18)	40 (39)	50 (45)	31.6	3.09	50.2	29.4
60	24.6	7 (15)	62 (52)	31 (34)	37.8	3.32	48.8	39.8
120	27.3	13 (21)	63 (53)	24 (29)	40.6	3.53	42.2	40.2
180	24.5	8 (16)	61 (52)	31 (34)	41.2	3.59	44.3	36.9
240	30.1	13 (21)	71 (58)	16 (23)	46.4	3.91	37.7	41.2
300	33.3	19 (26)	74 (60)	7 (15)	45.4	4.13	41.6	42.2
Mean	6.3	12 (19)	62 (52)	6 (30)	40.5	3.60	44.1	38.3
SED	1.4	(3.1)	(3.4)	(2.7)	5.5	0.41	5.38	4.31
Sig p =	0.001	(0.05)	(0.002)	(<0.001)	0.18	0.26	0.27	0.11
MAFF REPEAT 1989 planting								
0	23.8	10 (18)	57 (49)	33 (35)	24.0	2.7	61.2	37.8
75	28.9	22 (28)	59 (50)	19 (26)	38.6	4.5	54.5	31.3
150	30.8	27 (31)	60 (51)	13 (20)	40.9	4.3	53.9	34.5
225	31.7	33 (35)	56 (48)	11 (19)	45.9	4.9	53.9	34.5
300	32.5	31 (34)	60 (51)	9 (16)	48.2	5.2	52.9	32.1
Mean	29.5	25 (29)	58 (50)	17 (23)	39.5	4.3	55.3	34.0
SED	2.8	(5.0)	(5.13)	(6.69)	3.4	0.4	3.09	6.29
Sig p =	0.078	(0.048)	(0.98)	(0.118)	0.001	0.001	0.12	0.71

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TABLE 2 Early summer cauliflowers - Quality aspects (Percentages analysed as angle transformed data as shown in parenthesis)

	Nitrate* content in curds	10% harvest date	50% harvest date	% Plants with (Transformed values) green bracts	loose curds	yellow curds	pink curds	deep curds
		(Days from 1 Jan)						
HDC EXPT 1988								
0	212	159	166	2.2 (5.0)	50.0 (45.0)	41.1 (39.8)	32.2 (34.4)	38.9 (38.5)
60	528	153	164	7.8 (15.8)	44.4 (41.7)	71.1 (57.5)	11.1 (19.4)	48.9 (44.4)
120	676	152	162	4.4 (9.7)	26.7 (31.0)	67.8 (55.4)	4.4 (10.0)	61.1 (51.4)
180	965	154	164	13.3 (21.0)	33.3 (35.2)	63.3 (52.9)	14.4 (21.8)	58.9 (50.2)
240	626	154	165	10.0 (18.3)	21.1 (26.7)	72.2 (58.9)	4.4 (7.1)	75.6 (60.7)
300	956	152	162	11.1 (19.2)	15.6 (22.9)	72.2 (58.5)	2.2 (5.0)	80.0 (63.5)
Mean		154	164	8.1 (14.8)	31.9 (33.8)	64.6 (53.9)	11.5 (16.3)	60.6 (51.5)
SED =		2.2	3.0	nd (4.6)	nd (3.1)	nd (5.7)	nd (6.4)	nd (2.6)
p =		0.096	(NS)	nd (0.04)	nd (<0.001)	nd (0.06)	nd (0.008)	nd (<0.001)
MAFF REPEAT 1989								
0	196	152	159	1.1	36.7 (37.2)	60.0 (50.9)	4.4 (10.0)	26.7 (31.1)
75	134	149	158	1.1	21.1 (26.1)	65.6 (54.2)	3.3 (8.5)	58.9 (50.2)
150	103	149	157	0	20.0 (26.4)	61.1 (51.4)	1.1 (3.5)	66.7 (54.9)
225	484	145	155	2.2	6.7 (15.0)	55.6 (48.2)	0.0 (0.0)	76.7 (61.2)
300	390	145	156	3.3	6.7 (14.6)	60.0 (50.9)	0.0 (0.0)	68.9 (56.7)
Mean		148	157	1.6	18.2 (23.9)	60.4 (51.1)	1.8 (4.4)	59.6 (50.8)
SED =		2.4	1.6	nd	nd (5.7)	nd (5.03)	nd (5.2)	nd (5.1)
p =		(NS)	(NS)	nd	nd (0.02)	nd (0.83)	nd (0.26)	nd (0.003)

* mg Nitrate in 1kg fresh material

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TABLE 3 Early summer cauliflowers - Crop N content

	Total N offtake (kg/ha)	Curd N offtake (kg/ha)	+Nitrogen Harvest index	*N in lost leaves kg/ha	Trims N (kg/ha)	Unmkt N (kg/ha)	Residue N (kg/ha)	Soil min N (kg/ha) 0-90 cm harvest
HDC EXPT 1988								
0	91.0	29.6	32	0.8	-	-	61.4	36.9
60	121.0	51.8	43	nd	-	-	69.2	57.0
120	135.6	64.2	47	1.1	-	-	71.3	75.3
180	145.2	59.5	41	nd	-	-	85.6	109.9
240	163.6	76.0	46	1.4	-	-	87.6	146.9
300	176.5	82.3	47	nd	-	-	94.2	164.2
Mean	139.0	60.5	44	nd	-	-	78.0	98.4
SED	22.4	6.54		nd	-	-	20.1	24.41
p =	0.04	0.001		nd	-	-	0.56	0.002
MAFF REPEAT 1989								
0	67.9	25.8	35	0.4	15.5	26.6	42.1	87.6
75	103.0	31.8	31	nd	26.5	44.7	71.2	83.7
150	110.4	45.4	41	0.5	34.3	30.7	65.0	110.7
225	136.5	46.6	34	nd	38.3	51.6	89.9	143.2
300	149.6	48.9	33	0.6	38.7	62.0	100.7	169.3
Mean	113.0	39.7	35	nd	30.7	43.1	73.8	118.9
SED	13.1	5.2		nd	4.0	12.4	15.1	52.8
p =	0.002	0.008		nd	0.004	0.10	0.033	0.47

+ proportion of N taken up removed by curds %

*Lost leaves collected from the ground during the growth of the crops.

TABLE 4 Early summer cauliflowers - Nitrogen balance

	Soil mineral N 0-90cm Autumn	Planting (kg/ha)	Post planting (kg/ha)	N in crop planting (kg/ha)	N in Crop + Soil (kg/ha) at planting	Soil N + Crop N (kg/ha) Harvest	Balance (kg/ha)
HDC EXPT.							
Date sampled	6/10/87	27/3/88	27/4/88	27/3/88	27/3/88	20/6/88	
0	107	73	115	2.4	75.4	128	+52.6
60	-	-	-	-	135.4	178	+42.6
120	-	-	-	-	195.4	211	+15.6
180	-	-	-	-	255.4	255	- 0.4
240	-	-	-	-	315.4	311	- 4.4
300	-	-	-	-	375.4	340	-35.4
Mean					225.4	237	
MAFF REPEAT							
Date sampled		28/2/89	-	8/3/89	8/3/89	15/6/89	
0	-	107	-	1.53	108.5	155.5	+ 47.0
75	-	-	-		183.5	186.7	+ 3.2
150	-	-	-		258.5	221.1	-37.4
225	-	-	-		333.5	279.7	-53.8
300	-	-	-		408.5	318.9	-89.6
Mean					258.5	232.0	

TABLE 5 Early summer cauliflower crop - Residues from Crop 1

	Soil mineral N at harvest (kg/ha)	Early crop Residue N (kg/ha)	'Potential' Available N (kg/ha)		Soil mineral N at planting Autumn cauli crop (kg/ha)
HDC EXPT.			20/6/88	14 days	4/7/88
0	36.9	61.4	98.3		80
60	57.0	69.2	126.2		104
120	75.3	71.3	146.6		135
180	109.9	85.6	195.5		202
240	146.9	87.6	234.5		233
300	164.0	94.2	258.2		223
MAFF REPEAT			15/6/89	18 days	4/7/89
0	87.6	42.1	129.7		190
75	83.7	71.2	154.9		151
150	110.7	65.0	175.7		186
225	143.2	89.9	233.1		227
300	169.3	100.7	270.0		295

RESULTS
AUTUMN CAULIFLOWER CROPS

AUTUMN CAULIFLOWER CROP

Marketable yields

The numbers of marketable curds class 1 and 2 are shown in Figure 5 and Table 6 for 1988 and 1989 seasons. The yields ranged from 25.3 to 35.2 and 29.7 to 32.5 thousand marketable curds per ha in 1988 and 1989 respectively. In 1988 there were significant ($p<0.001$) responses to second crop nitrogen, but the effect decreased where first crop N had been applied. Responses to either first or second crop nitrogen were not significant in the 1989 season. In both seasons once sufficient fertiliser N had been applied to the first crop to give the maximum numbers of marketable curds, (300 kg/ha N), no further N was needed for the second crop. The autumn cauliflower crop was far less responsive to nitrogen than the early summer crop.

The proportion of curds in class 1 as shown in Figure 6 and Table 7, were significantly increased by the application of N especially in 1988 ($p<0.001$) where N increased the percentage of class 1 curds whether or not it was applied to the first or second crop. Where less than 120 kg/ha N had been applied to the first crop large increases in Class 1 curds were seen on small applications of N fertiliser to the second crop. Where no nitrogen was applied to the second crop more curds were Class 2, (Table 8). Where 240 or 300 kg/ha of N had been applied to the first crop, no further nitrogen was required to produce the aximum number of class 1 curds for the second crop.

Tables 9 and 10 show the time (expressed as days after the 1st of January) at which 10 and 50% of the crop had been harvested. In 1988 harvesting was delayed where no nitrogen had been applied. Where sufficient nitrogen had been applied for maximum marketable yield, (ie 300 kg/N to the first crop) the start of harvest was brought forward by more than 10 days. Applying nitrogen to the second crop did not significantly advance the start or mid points of the harvest. Nitrogen had little effect on harvesting dates in 1989.

Table 11 shows that in both seasons around 80% of the curds were deep, where curd depth is more than ½ the curd diameter. In 1988 applications of nitrogen significantly ($p=0.004$) increased the proportion of deep curds. The response to second crop nitrogen was largest where no fertiliser nitrogen had been applied to the first crop. Where 300 kg/ha had been applied to the first crop, 120 kg/ha N to the second crop, there was a non significant trend towards increased proportion of deep curds. In 1989 nitrogen did not significantly affect the percentage of crop with deep curds.

The two main defects seen in the trials were loose and yellow curds. Table 12 shows that there were around 10% loose curds in both seasons. There was no significant nitrogen effect on the numbers of loose curds. In 1988 there were around 9% yellow curds, but in 1989 there were nearly four times as many

FIG 5a AUTUMN CAULIFLOWER 1988
Marketable Curds Class 1 + 2

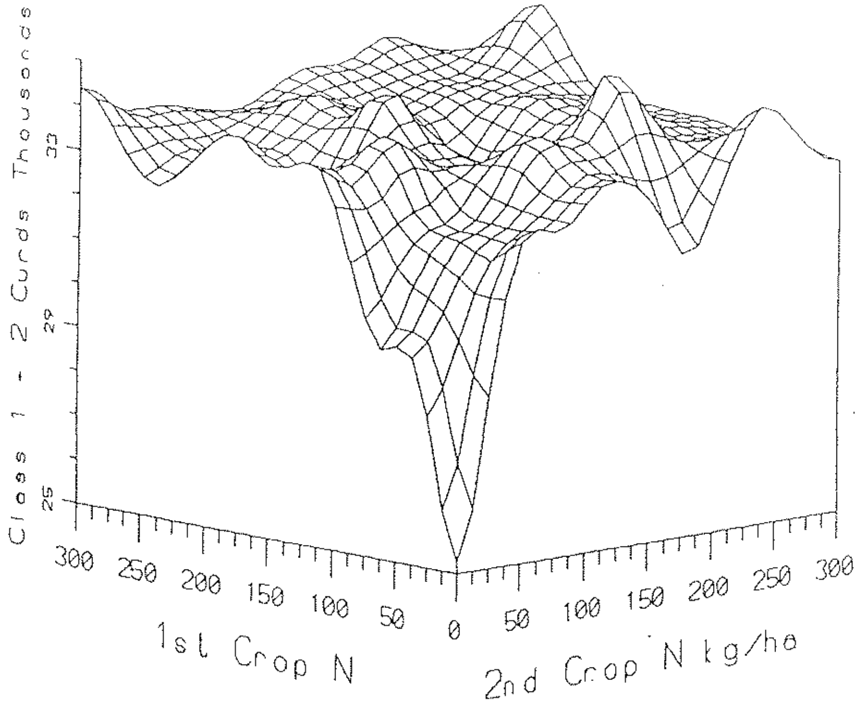

FIG 5b AUTUMN CAULIFLOWER 1989
Marketable Curds Class 1 + 2

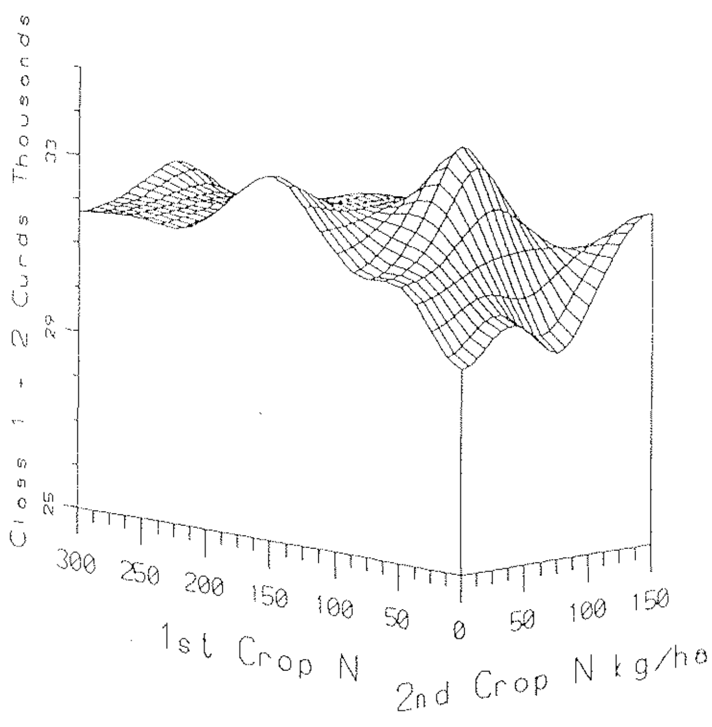

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FIG 6a AUTUMN CAULIFLOWER 1988
Marketable Curds Class 1

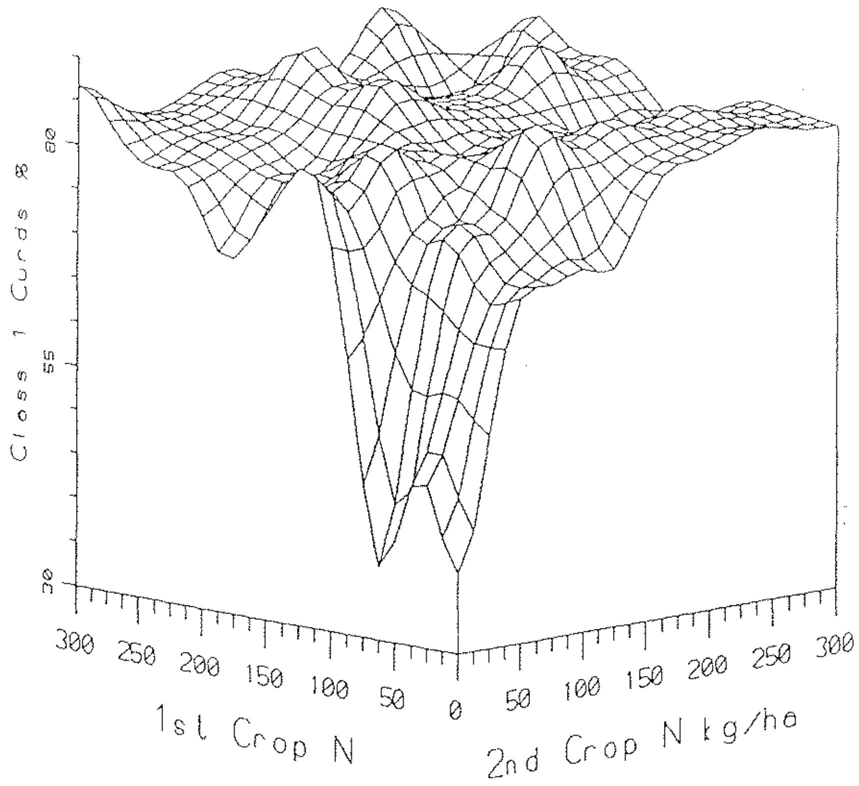
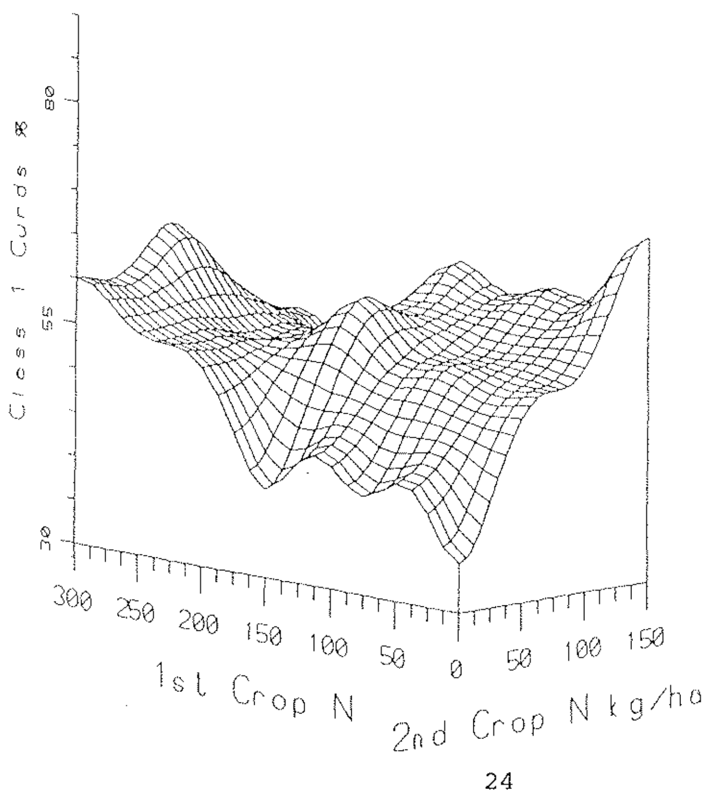


FIG 6b AUTUMN CAULIFLOWER 1989
Marketable Curds Class 1



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reducing the number of Class I curds (Table 13.) Yellowing of the curd occurs when it is exposed to sunlight. In 1989 it was brighter during the harvest period than in 1988 when it was wet and cloudy. In both seasons applications of nitrogen reduced the number of plants with yellow curds. Plants receiving low applications of fertiliser had fewer and smaller leaves to protect the curds from sunlight.

Table 14 shows the level of nitrate in the harvested produce, which never exceeded 1542mg/kg. Nitrate contents tended to be largest where second crop nitrogen had been applied especially in combination with first crop N. Nitrate levels would not limit sale where minimum N had been applied to achieve maximum marketable yield. Nitrate contents were slightly larger in 1989.

Table 15 shows the increasing level of nitrate in the trimmed leaves with increasing nitrogen applied to the first and second crops. They were particularly high in 1988 season.

Total fresh and dry matter yields

Fresh weight yields ranged from 47.2 - 81 t/ha in 1988 and 51.3 - 66 t/ha in 1989 (Table 16). Total dry matter yields ranged from 4.5 - 6.9 t/ha in 1988 and 4.5 - 5.9 t/ha in 1989 (Table 17). The difference in yield between seasons may be due to the drier July and August in 1989. Near maximum fresh weight and dry matter yields were achieved by applications of 300kg/ha N to the first crop with no fertiliser to the second. Responses to fertiliser nitrogen were much larger in the wetter 1988 season, where first crop N was as effective as second crop N in increasing yield.

Crop Nitrogen offtake

Nitrogen offtake in the whole crop is shown in Table 18. Nitrogen offtake reached a maximum of about 260 kg/ha in 1988 and 230 kg/ha in 1989. In 1988 nitrogen applied to the first crop increased crop N by approximately the same increments as freshly applied N. In 1989 second crop nitrogen was more effective in increasing crop N uptake. Where 300 kg/ha N had been applied to the first crop near maximum offtakes were achieved in the autumn crop without application of fresh fertiliser. Fresh fertiliser nitrogen given 300 kg/ha N to the first crop did not increase N offtake significantly. Nitrogen removed in the produce ranged from 63 - 141 kg/ha and 70 -109 kg/ha in 1988 and 1989 respectively (Table 19). Considerable quantities of nitrogen remained in the trimmings (Table 20) and was significantly ($p<0.001$) increased by N applied to the first and second crops in 1988 reaching a maximum of 130 kg/ha. In 1989 second crop N significantly ($p<0.001$) increased trimming N offtake, reaching a maximum of 90 kg/ha. N left in the field as unmarketable plants (Table 21) was not significantly affected by nitrogen application and was on average less than 20 kg/ha. Nitrogen lost from the plant due to defoliation of older leaves during crop growth was found to be less than 0.5 kg/ha (Table 22). This suggests a transfer of N from senescing leaves to the rest of the plant.

Total nitrogen content of crop debris ranged from 46-135 and 62-126 kg/ha N in 1988 and 1989 respectively (Table 23). Once sufficient N had been applied to achieve maximum marketable yield there were only small increases in the crop nitrogen debris with increasing N.

Soil mineral nitrogen levels at harvest

Soil mineral N levels at harvest are shown in Figs 7a, b and Table 24. Mineral N levels were typical of index 0, ie around 100 kg/ha N where sub-optimal levels of nitrogen had been applied. Mineral N levels were around 150 kg/ha where optimum N had been applied for marketable yield. Soil mineral N increased substantially where larger quantities of nitrogen had been applied.

Nitrogen balance

Net mineralisation of nitrogen during the growth of the autumn cauliflower crop is shown in Table 26. The calculations are based on measurements of soil mineral N at planting, soil mineral N and crop N offtake at harvest. Each measurement is subject to errors so net mineralisation was very variable. Average net mineralisation was 20 kg/ha in 1988 and 30 kg/ha in 1989.

Turnover of Nitrogen residues from autumn cauliflower

Mineral N at harvest together with the nitrogen in crop debris left a potential N residue of between 81 and 380 kg/ha N for the following crop (Table 25). Fig 8 indicates that there was an efficient turnover of nitrogen between the autumn cauliflowers and the third crop with evidence of net immobilisation at high residue levels in 1988 and some net mineralisation at lower residue levels in 1989.

Although near equivalent levels of N remain in the soil profile at planting of the next crop, Fig 9a and 9b indicate that very little of this nitrogen remained in the 0-30 cm layer in 1988/89 compared to the 89/90 season.

The main difference between seasons was the date of incorporation of crop debris by ploughing. In 1988/89 the debris were ploughed in on 15 December and 89/90 they were ploughed in on 6 February. Immediate incorporation of debris after harvest in 1988 would mean an early start to mineralisation increasing the pool of nitrogen available for leaching.

There may be some loss of nitrogen to the atmosphere where crop debris was left on the surface until February but this was more than counterbalanced by reduced risk of overwinter leaching.

The risk of leaching from N mineralised by the early spring was higher in the 88/89 season due to more rain in March and April than in 89/90.

FIG 7a AUTUMN CAULIFLOWER SOIL MINERAL N AT HARVEST - 8/11/88 (kg/ha)

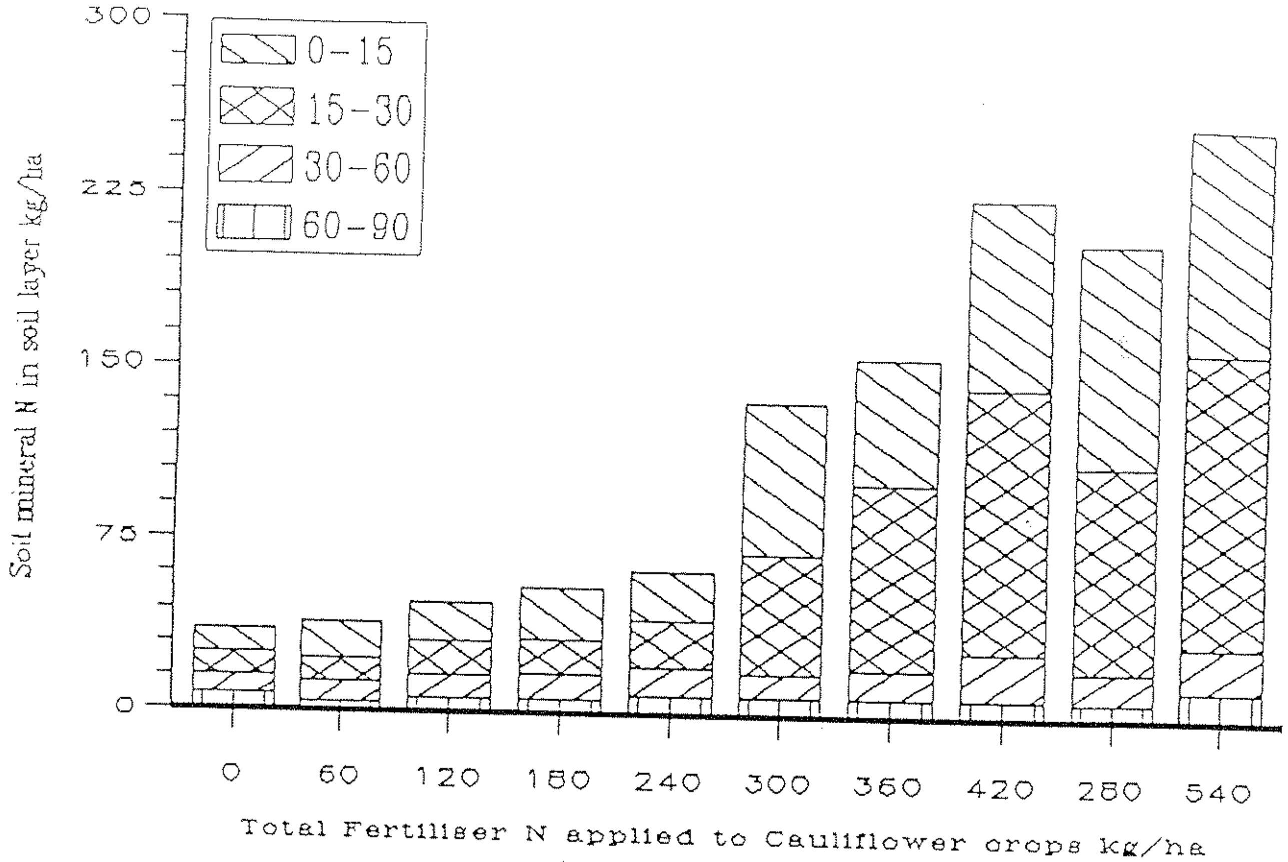

FIG 7b AUTUMN CAULIFLOWER,SOIL MINERAL N AT HARVEST - 25/11/89 (kg/ha)

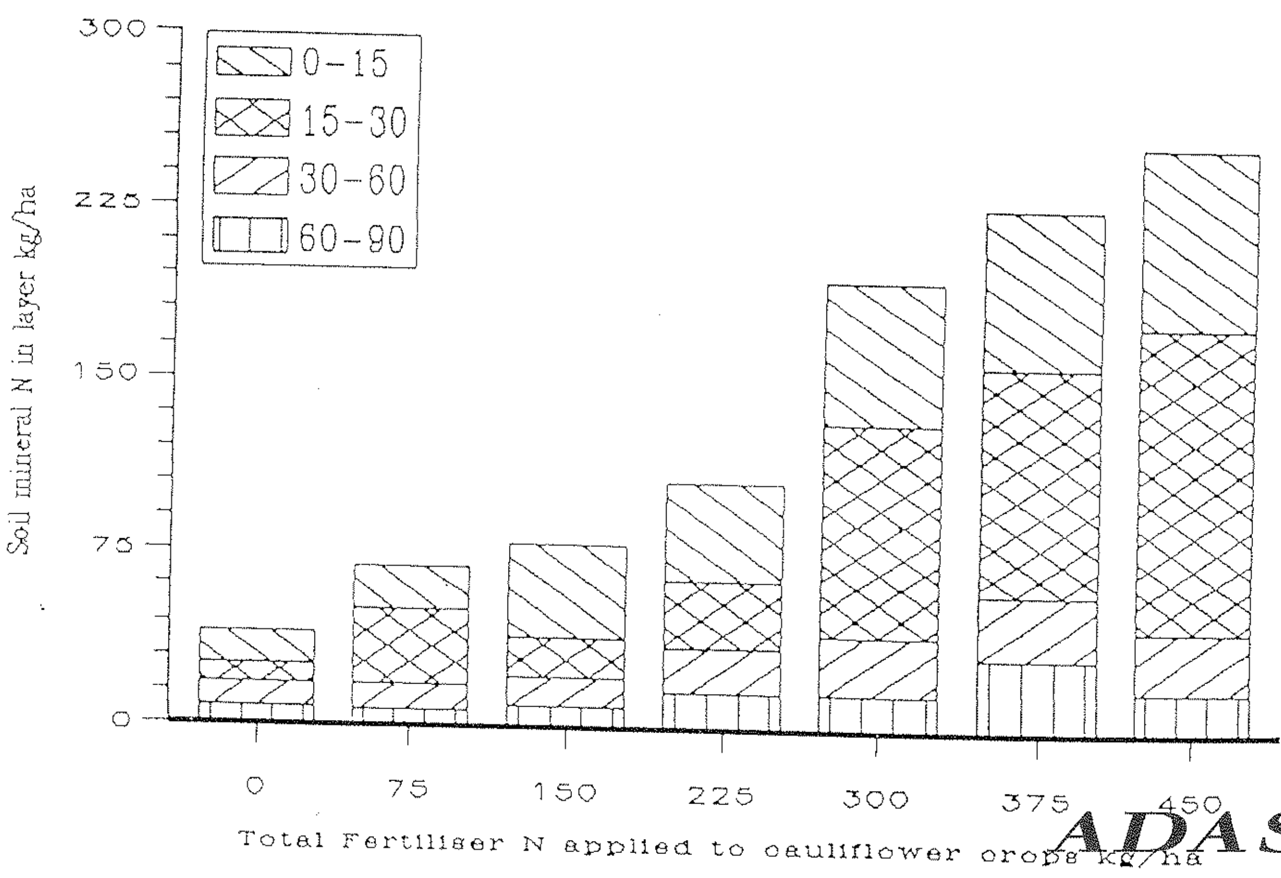

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FIG 8 MINERALISATION OF CAULIFLOWER DEBRIS
BETWEEN SECOND AND THIRD CROPS.

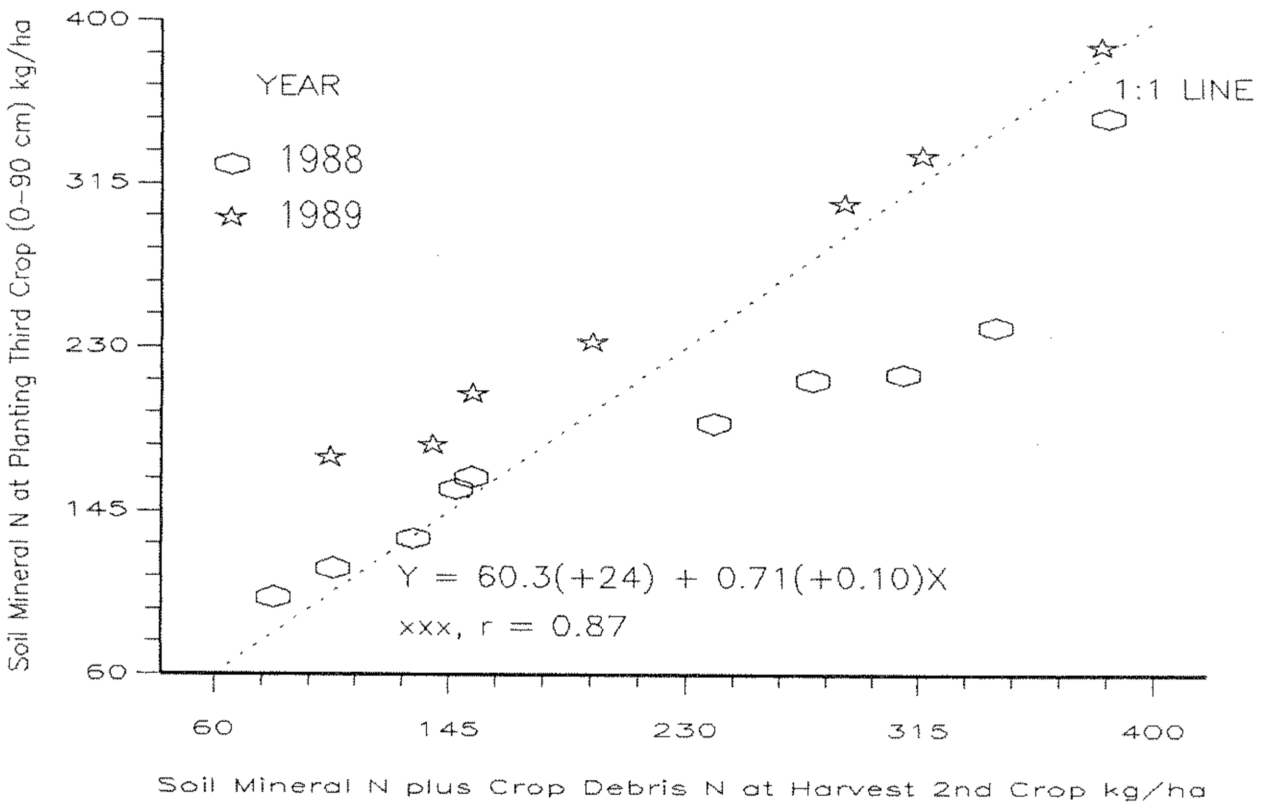

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FIG 9a SOIL MINERAL N AT PLANTING THE 3rd CROP - 2/5/89 (kg/ha)

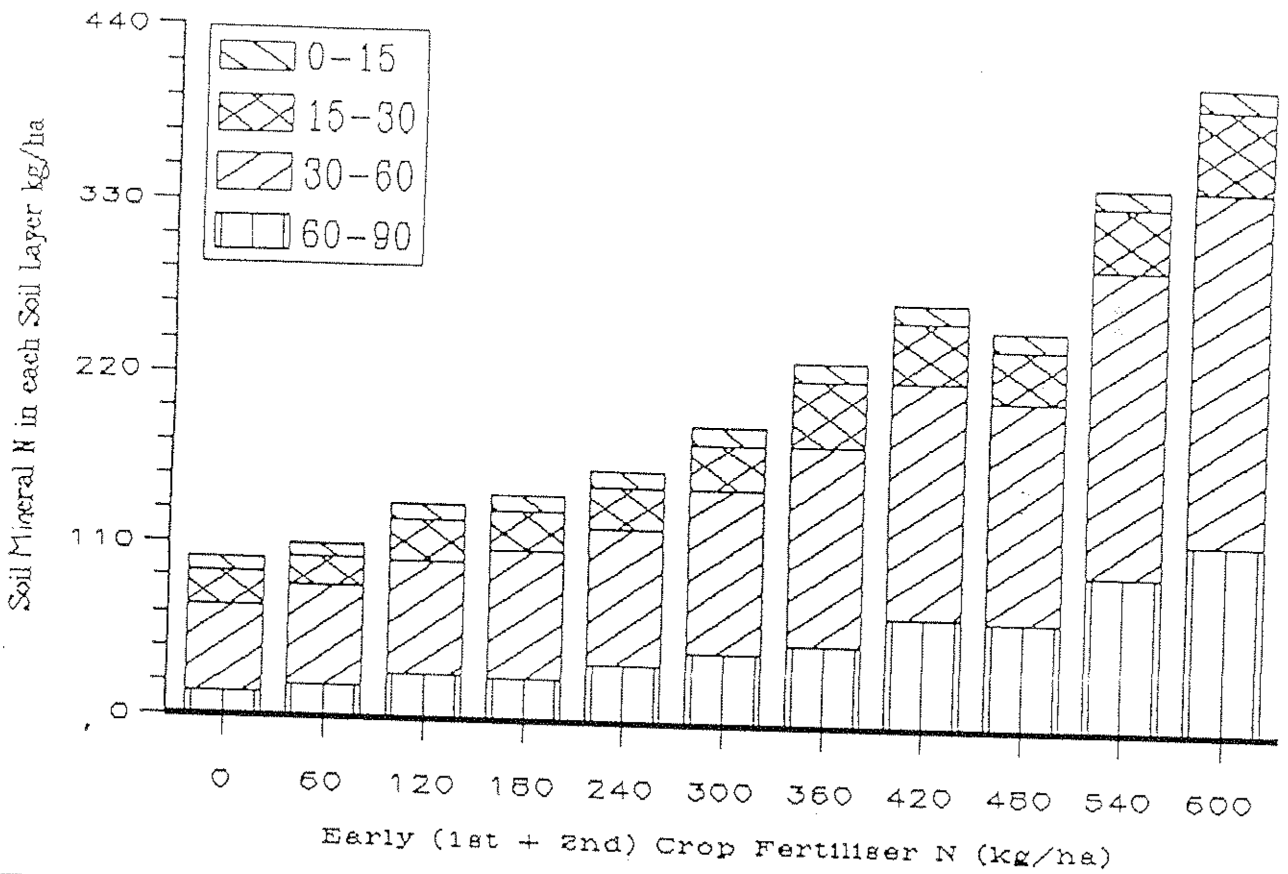

FIG 9b SOIL MINERAL N AT PLANTING 3rd CROP - 15/5/90 (kg/ha)

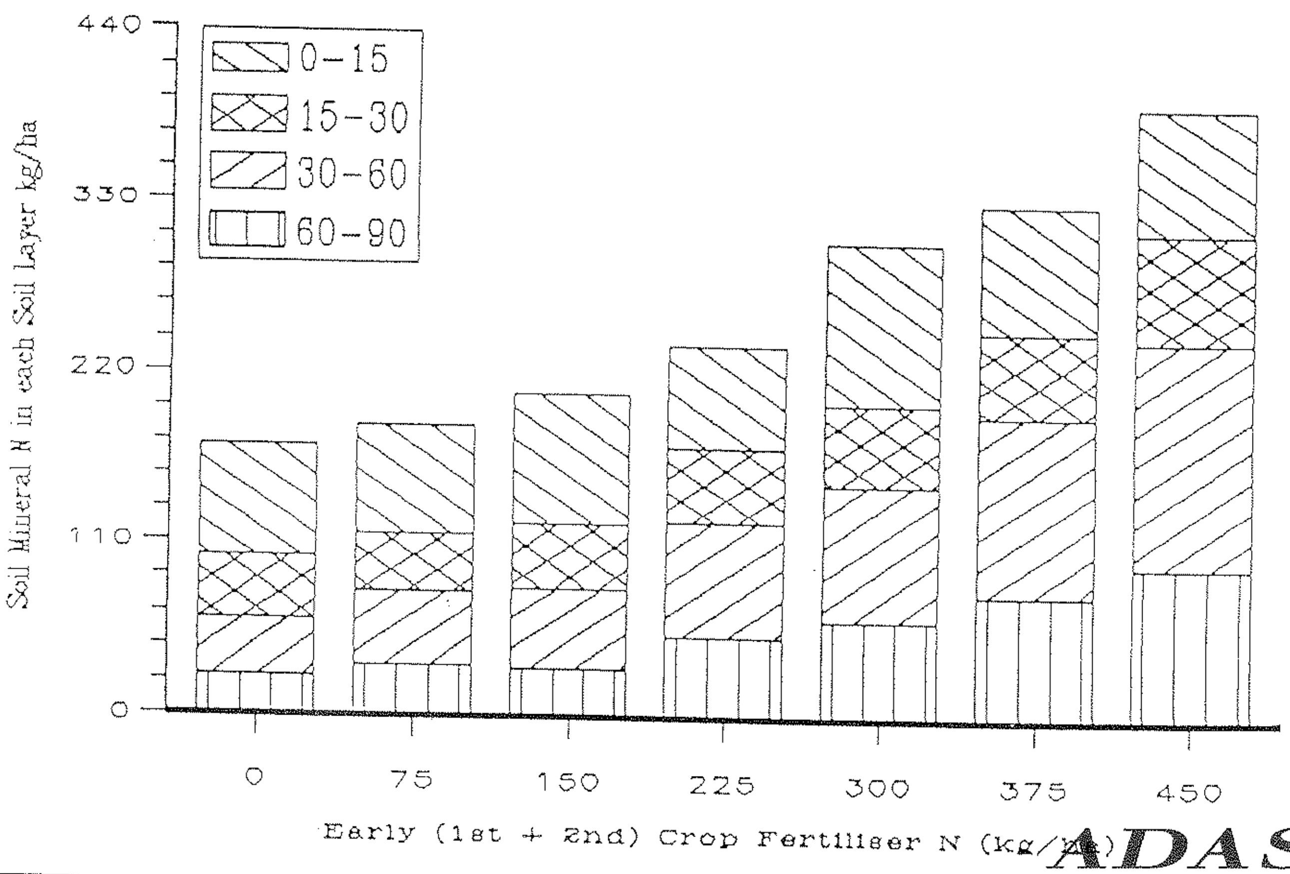

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TABLE 6 - AUTUMN CAULIFLOWER NUMBER OF CLASS 1 + 2 CURDS/ha

HDC EXPT.

FIRST CROP N kg/ha	SECOND CROP N kg/ha 0	60	120 (SED = 1234, p <0.001)	180	240	300	MEAN (SED = 632, p = 0.06)
0	25,300	32,500	33,300	31,300	34,400	32,900	31,600
60	29,700	32,100	34,000	35,200	33,300	32,900	32,900
120	33,700	34,000	32,900	31,700	33,700	33,300	33,200
180	34,000	31,700	34,400	32,100	33,700	33,300	33,200
240	32,500	32,900	34,000	33,300	33,700	35,200	33,600
300	34,400	33,700	33,300	34,000	34,400	33,700	33,900
MEAN	31,600	32,800	33,700	32,900	33,900	33,500	33,100

SED = 474
p <0.001

MAFF REPEAT

FIRST CROP N kg/ha	SECOND CROP N kg/ha 0	75 (SED = 2287, p = 0.44)	150	MEAN (SED = 1623, p = 0.74)
0	29,700	29,700	32,500	30,600
75	31,300	34,000	30,500	31,900
150	33,300	32,500	32,500	32,700
225	31,700	32,100	30,500	31,400
300	31,700	32,500	29,300	31,200
MEAN	31,500	32,200	31,000	31,600

SED = 883
p = 0.47

TABLE 7 - AUTUMN CAULIFLOWER % CLASS 1 (Angle transformed data shown in parenthesis. SED and p values calculated from transformed data)

HDC EXPT.

FIRST CROP N kg/ha	SECOND CROP N kg/ha 0	60	120 SED = 4.5 p <0.001	180	240	300	MEAN SED = 1.6 p = .002
0	39 (38)	70 (57)	70 (57)	81 (64)	83 (67)	82 (66)	71 (58)
60	38 (38)	76 (61)	86 (68)	84 (67)	84 (67)	83 (66)	75 (61)
120	82 (65)	83 (66)	80 (64)	80 (64)	77 (62)	79 (63)	80 (64)
180	70 (57)	78 (62)	88 (70)	83 (66)	89 (71)	86 (68)	82 (66)
240	79 (63)	81 (65)	90 (72)	81 (64)	77 (61)	89 (71)	83 (66)
300	87 (70)	82 (65)	86 (68)	81 (64)	90 (72)	81 (65)	84 (67)
MEAN	66 (55)	78 (63)	83 (66)	82 (65)	83 (66)	83 (66)	79 (64)

SED = 1.9
p <0.001

MAFF REPEAT

FIRST CROP N kg/ha	SECOND CROP N kg/ha 0	75 SED = 5.7 p = 0.01	150	MEAN SED = 4.9 p = 0.9
0	36 (36)	53 (47)	69 (56)	53 (47)
75	41 (40)	54 (53)	61 (46)	52 (46)
150	40 (39)	60 (51)	62 (52)	54 (47)
225	54 (48)	53 (47)	49 (44)	52 (46)
300	60 (51)	64 (53)	53 (47)	59 (50)
MEAN	46 (43)	57 (50)	59 (49)	54 (47)

SED = 1.9
p= 0.001

TABLE 8 - AUTUMN CAULIFLOWER % TOTAL PLANTS CLASS 2 (Angle transformed data shown in parenthesis. SED and p values calculated from transformed data)

HDC EXPT.

FIRST CROP N kg/ha	SECOND CROP N kg/ha 0	60	120	180	240	300	MEAN
			SED = 5.3 p <0.009				SED = 1.8 p = 0.035
0	32 (34)	21 (26)	23 (29)	7 (12)	13 (20)	10 (18)	18 (22)
60	46 (42)	14 (22)	10 (18)	14 (22)	9 (17)	9 (16)	17 (23)
120	12 (20)	12 (20)	12 (19)	9 (17)	18 (25)	14 (22)	13 (21)
180	26 (30)	11 (19)	9 (17)	7 (15)	6 (13)	8 (16)	11 (18)
240	12 (20)	11 (19)	6 (11)	12 (20)	18 (25)	10 (18)	12 (19)
300	10 (18)	12 (20)	8 (13)	14 (22)	7 (12)	13 (20)	11 (18)
MEAN	23 (28)	14 (21)	11 (18)	11 (18)	11 (19)	11 (19)	14 (20)

SED = 2.2
p <0.001

MAFF REPEAT

FIRST CROP N kg/ha	SECOND CROP N kg/ha 0	75	150	MEAN
		SED = 5.1 p = 0.113		SED = 3.6 p = 0.521
0	48 (44)	30 (33)	22 (28)	33 (35)
75	47 (43)	41 (34)	24 (35)	37 (38)
150	53 (47)	31 (33)	29 (32)	38 (38)
225	34 (36)	37 (37)	37 (37)	36 (37)
300	29 (32)	27 (31)	29 (32)	28 (32)
MEAN	42 (40)	33 (34)	28 (33)	34 (36)

SED = 1.94
p <0.002

TABLE 9 - AUTUMN CAULIFLOWER DATE 10% CROP HARVESTED (DAYS FROM 1st JAN)

HDC EXPT.

FIRST CROP N kg/ha	SECOND CROP N kg/ha 0	60	120 SED = 3.2 p = 0.14	180	240	300	MEAN SED = 1.98 p = 0.21
0	289	279	274	278	275	279	279
60	280	276	277	276	277	278	277
120	283	274	276	276	278	277	277
180	279	281	272	276	273	272	276
240	278	277	273	277	277	275	276
300	274	275	273	273	272	274	274
MEAN	281	277	274	276	275	276	276

SED = 1.15
p <0.001

MAFF REPEAT

FIRST CROP N kg/ha	SECOND CROP N kg/ha 0	75 SED = 1.66 p = 1.66	150	MEAN SED = 1.69 p = 0.89
0	273	270	269	271
75	269	269	268	269
150	271	268	269	269
225	268	269	269	269
300	270	268	270	270
MEAN	270	269	269	269

SED = 0.78
p = 0.24

TABLE 10 - AUTUMN CAULIFLOWER DATE 50% CROP HARVESTED (DAYS FROM 1st JAN)

HDC EXPT.

FIRST CROP N kg/ha	SECOND CROP N kg/ha 0	60	120	180	240	300	MEAN
			SED = 2.9 p = 0.16				SED = 2.1 p = 0.28
0	296	291	286	290	286	288	289
60	292	289	288	283	286	288	288
120	293	289	289	286	286	288	289
180	289	291	286	286	284	284	287
240	286	286	283	285	287	286	286
300	286	285	284	284	283	285	285
MEAN	290	288	286	286	286	287	287

SED = 0.9
p <0.001

MAFF REPEAT

FIRST CROP N kg/ha	SECOND CROP N kg/ha 0	75	150	MEAN
		SED = 2.06 p = 0.21		SED = 1.7 p = 0.72
0	278	279	275	277
75	276	275	276	276
150	278	274	275	276
225	277	275	276	276
300	276	274	276	275
MEAN	277	275	276	276

SED = 0.6
p = 0.14

TABLE 11 - AUTUMN CAULIFLOWER % CROP WITH DEEP CURDS
(Angle transformed data shown in parenthesis. SED and p values calculated from transformed data)

HDC EXPT.

FIRST CROP N kg/ha	SECOND CROP N kg/ha 0	60	120	180	240	300	MEAN
			SED = 4.8 p = 0.004				SED = 1.5 p <0.001
0	29 (32)	67 (55)	69 (56)	72 (58)	80 (64)	78 (62)	66 (55)
60	43 (41)	63 (53)	81 (64)	86 (69)	82 (66)	83 (66)	73 (55)
120	77 (61)	88 (70)	80 (64)	79 (63)	79 (63)	77 (61)	80 (64)
180	59 (50)	74 (60)	87 (69)	80 (63)	83 (66)	82 (65)	78 (62)
240	77 (61)	83 (67)	88 (70)	84 (68)	82 (65)	89 (72)	84 (67)
300	79 (63)	79 (63)	87 (69)	80 (64)	91 (73)	80 (64)	83 (66)
MEAN	61 (52)	76 (61)	82 (65)	80 (64)	83 (66)	82 (65)	77 (62)

SED = 2.1
p <0.001

MAFF REPEAT

FIRST CROP N kg/ha	SECOND CROP N kg/ha 0	75	150	MEAN
		SED = 6.4 p = 0.099		SED = 4.5 p = 0.637
0	72 (59)	74 (60)	88 (73)	78 (64)
75	80 (64)	88 (70)	73 (59)	87 (64)
150	87 (70)	82 (66)	90 (72)	86 (69)
225	80 (64)	76 (61)	77 (62)	77 (62)
300	80 (64)	87 (69)	74 (60)	80 (64)
MEAN	80 (64)	81 (65)	80 (65)	81 (65)

SED = 2.5
p = 0.89

TABLE 12 - AUTUMN CAULIFLOWER % CROP WITH LOOSE HEADS

(Angle transformed data shown in parenthesis. SED and p values calculated from transformed data)

HDC EXPT.

FIRST CROP N kg/ha	SECOND CROP N kg/ha 0	60	120	180	240	300	MEAN
			SED = 4.9 p = 0.205				SED = 1.8 p = 0.10
0	16 (23)	7 (15)	13 (21)	7 (15)	8 (16)	7 (15)	9 (17)
60	18 (24)	8 (13)	4 (10)	7 (12)	3 (6)	2 (7)	7 (12)
120	9 (17)	9 (17)	9 (16)	9 (17)	7 (15)	12 (20)	9 (17)
180	11 (19)	7 (15)	6 (13)	8 (13)	3 (8)	7 (15)	7 (14)
240	7 (15)	4 (10)	3 (10)	9 (17)	13 (21)	7 (15)	7 (15)
300	9 (17)	7 (15)	3 (8)	11 (19)	7 (15)	11 (19)	8 (16)
MEAN	12 (19)	7 (14)	6 (13)	8 (16)	7 (14)	8 (15)	8 (15)

SED = 2.0
p = 0.046

MAFF REPEAT

FIRST CROP N kg/ha	SECOND CROP N kg/ha 0	75	150	MEAN
		SED = 3.9 p = 0.20		SED = 2.6 p = 0.80
0	12 (20)	11 (19)	9 (17)	11 (19)
75	8 (16)	9 (17)	12 (20)	10 (18)
150	8 (16)	16 (23)	6 (13)	10 (17)
225	10 (18)	10 (18)	12 (20)	11 (19)
300	13 (20)	10 (18)	14 (22)	13 (20)
MEAN	10 (18)	11 (19)	11 (18)	11 (19)

SED = 1.6
p = 0.71

TABLE 13 - AUTUMN CAULIFLOWER % CROP WITH YELLOW CURDS

(Angle transformed data shown in parenthesis. SED and p values calculated from transformed data)

HDC EXPT.

FIRST CROP N kg/ha	SECOND CROP N kg/ha 0	60	120	180	240	300	MEAN
			SED = 6.12 p = 0.003				SED = 2.70 p = 0.37
0	29 (32)	17 (22)	16 (24)	6 (11)	7 (12)	4 (10)	13 (19)
60	40 (39)	11 (19)	6 (14)	7 (15)	4 (10)	4 (7)	12 (17)
120	9 (17)	4 (10)	9 (17)	4 (10)	11 (18)	6 (14)	7 (14)
180	19 (25)	9 (16)	6 (11)	4 (12)	3 (8)	4 (12)	8 (14)
240	6 (14)	8 (13)	7 (15)	11 (19)	9 (17)	3 (8)	7 (14)
300	6 (8)	7 (15)	4 (10)	12 (20)	3 (8)	12 (20)	7 (14)
MEAN	18 (22)	9 (16)	8 (15)	7 (15)	6 (12)	6 (12)	9 (15)

SED = 2.5
p <0.001

MAFF REPEAT

FIRST CROP N kg/ha	SECOND CROP N kg/ha 0	75	150	MEAN
		SED = 4.6 p = 0.018		SED = 3.7 p = 0.75
0	46 (42)	28 (32)	27 (31)	33 (35)
75	47 (43)	30 (33)	28 (32)	35 (36)
150	53 (47)	30 (33)	27 (32)	37 (37)
225	32 (35)	33 (35)	36 (37)	34 (36)
300	28 (32)	27 (31)	32 (34)	29 (32)
MEAN	41 (40)	29 (33)	30 (33)	34 (35)

SED = 1.6
p <0.001

TABLE 14 - AUTUMN CAULIFLOWER NITRATE CONTENT CURDS mg/kg FRESH WEIGHT

HDC EXPT.

FIRST CROP N kg/ha	SECOND CROP N kg/ha 0	60	120	180	240	300	MEAN
			SED = 286 p = 0.47				SED=15 p = 0.23
0	133	366	557	1356	953	1006	728
60	353	429	899	1095	871	919	761
120	587	994	992	1051	1244	1130	1000
180	520	885	1157	1103	1158	1142	994
240	324	902	924	721	908	992	795
300	872	1027	1100	1229	1298	767	1049
MEAN SED = 107 p <0.001	465	767	938	1093	1072	992	888

MAFF REPEAT

FIRST CROP N kg/ha	SECOND CROP N kg/ha 0	75	150	MEAN
		SED = 381 p = 0.91		SED = 239 p = 0.027
0	326	643	915	628
75	243	635	767	548
150	656	1287	1225	1056
225	1311	1559	1546	1472
300	1085	1098	1010	1064
MEAN SED = 163 p = 0.071	724	1044	1093	954

TABLE 15 - AUTUMN CAULIFLOWER NITRATE CONTENT OF TRIMMED LEAVES mg/kg FRESH WEIGHT

HDC EXPT.

FIRST CROP N kg/ha	SECOND CROP N kg/ha						
	0	60	120 SED = 513 p = 0.17	180	240	300	MEAN SED = 252 p <0.001
0	154	426	1049	1144	1846	1739	1059
60	640	674	1700	1575	2430	2514	1589
120	819	1700	1041	2350	2002	1319	1538
180	827	1591	2373	2649	2707	2999	2191
240	1174	1925	1615	3132	3132	2168	2144
300	2177	2550	3035	3282	2945	2836	2804
MEAN SED = 200 p <0.001	965	1478	1802	2355	2350	2376	1888

MAFF REPEAT

FIRST CROP N kg/ha	SECOND CROP N kg/ha			
	0	75 SED = 2.88 p = 0.23	150	MEAN SED = 147 p = 0.10
0	277	105	797	393
75	103	456	833	464
150	339	1023	578	647
225	737	630	834	733
300	498	796	1114	803
MEAN SED = 129 p = 0.01	391	602	831	608

TABLE 16 - AUTUMN CAULIFLOWER TOTAL FRESH WEIGHT t/ha

HDC EXPT.

FIRST CROP N kg/ha	SECOND CROP N kg/ha 0	60	120 SED = 3.5 p <0.001	180	240	300	MEAN SED = 2.0 p = 0.001
0	47.2	57.7	67.9	71.9	72.8	78.9	66.1
60	54.0	64.9	78.2	78.8	76.8	79.2	72.0
120	68.1	73.9	74.2	74.6	75.3	77.3	73.9
180	65.6	73.1	76.0	75.9	77.1	80.1	74.6
240	71.6	72.7	79.6	77.1	75.5	81.6	76.4
300	78.1	80.8	77.2	78.4	81.1	77.9	78.9
MEAN SED = 1.3 p <0.001	64.1	70.5	75.5	76.1	76.4	79.2	73.6

MAFF REPEAT

FIRST CROP N kg/ha	SECOND CROP N kg/ha 0	75 SED = 5.7 p = 0.07	150	MEAN SED = 4.9 p = 0.33
0	51.3	51.6	66.4	56.4
75	50.8	48.9	54.0	51.2
150	50.7	52.7	60.8	54.7
225	53.1	54.2	52.5	53.3
300	62.8	56.8	66.3	61.9
MEAN SED = 1.6 p <0.001	53.8	52.8	60.0	55.5

TABLE 17 - AUTUMN CAULIFLOWER TOTAL DRY WEIGHT YIELD t/ha

HDC EXPT.

FIRST CROP N kg/ha	SECOND CROP N kg/ha 0	60	120	180	240	300	MEAN
			SED = 0.33 p <0.001				SED = 0.22 p = 0.05
0	4.46	5.11	5.99	6.09	6.03	6.75	5.75
60	5.06	5.85	6.78	6.77	6.11	6.60	6.20
120	5.96	6.30	6.20	6.07	6.44	5.93	6.15
180	5.80	6.11	6.44	6.34	6.50	6.77	6.33
240	6.39	6.11	6.79	6.46	6.06	6.88	6.45
300	6.34	6.77	6.57	6.43	6.86	6.33	6.55
MEAN SED = 0.11 p <0.001	5.67	6.04	6.46	6.36	6.33	6.55	6.24

MAFF REPEAT

FIRST CROP N kg/ha	SECOND CROP N kg/ha 0	75	150	MEAN
		SED = 0.4 p = 0.045		SED = 0.3 p = 0.4
0	4.64	4.81	5.88	5.11
75	4.98	4.50	5.09	4.86
150	4.83	5.14	5.34	5.07
225	5.02	5.23	4.84	5.03
300	5.52	5.09	5.94	5.52
MEAN SED = 0.14 p = 0.007	5.0	4.96	5.42	5.12

TABLE 18 - AUTUMN CAULIFLOWER NITROGEN OFFTAKE - WHOLE CROP (ABOVE GROUND) kg/ha

HDC EXPT.

FIRST CROP N kg/ha	SECOND CROP N kg/ha						
	0	60	120	180	240	300	MEAN
			SED = 14.1 p <0.001				SED = 8.6 p <0.001
0	109	134	191	211	204	251	183
60	127	166	227	238	223	242	204
120	197	216	229	229	243	224	223
180	185	221	229	239	248	257	230
240	217	205	252	234	224	258	232
300	237	260	250	240	267	246	250
MEAN SED = 5.0 p = <0.001	179	201	230	232	235	246	220

MAFF REPEAT

FIRST CROP N kg/ha	SECOND CROP N kg/ha			
	0	75	150	MEAN
		SED = 14.9 p = 0.007		SED = 10.6 p = 0.02
0	132	153	206	164
75	148	147	191	162
150	156	188	194	180
225	180	199	180	186
300	200	190	231	207
MEAN SED = 5.8 p <0.001	164	176	200	180

TABLE 19 - AUTUMN CAULIFLOWERS NITROGEN OFFTAKE - CURDS kg/ha

HDC EXPT.

FIRST CROP N kg/ha	SECOND CROP N kg/ha						
	0	60	120 SED = 9.4 p <0.001	180	240	300	MEAN SED = 4.1 p <0.001
0	63	71	104	118	115	135	101
60	71	96	123	127	119	130	111
120	116	123	118	119	130	116	120
80	110	119	124	122	129	141	124
240	125	113	131	117	121	132	123
300	120	136	129	129	132	128	129
MEAN SED = 3.8 p <0.001	101	110	122	122	125	131	118

MAFF REPEAT

FIRST CROP N kg/ha	SECOND CROP N kg/ha			
	0	75	150	MEAN
		SED = 9.1 p = 0.04		SED = 6.8 p = 0.19
0	70	84	109	88
75	78	86	96	87
150	89	99	107	98
225	94	100	96	97
300	106	96	105	102
MEAN SED = 3.3 p <0.001	87	93	103	94

TABLE 20 - NITROGEN OFFTAKE - TRIMS kg/ha

HDC EXPT.

FIRST CROP N kg/ha	SECOND CROP N kg/ha						
	0	60	120 SED = 9.0 p <0.001	180	240	300	MEAN SED = 4.9 p <0.001
0	29	55	83	83	88	105	74
60	42	63	101	108	98	106	86
120	75	91	100	95	108	101	95
180	72	90	101	109	117	108	100
240	81	90	116	112	99	126	104
300	114	121	115	108	132	114	117
MEAN SED = 3.4 p <0.001	69	85	103	102	107	110	96

MAFF REPEAT

FIRST CROP N kg/ha	SECOND CROP N kg/ha			
	0	75 SED = 12.7 p = 0.30	150	MEAN SED = 9.8 p = 0.14
0	43	51	73	56
75	57	55	71	61
150	60	80	72	71
225	71	81	71	74
300	75	81	91	82
MEAN SED = 4.5 p = 0.01	61	70	76	69

TABLE 21 - AUTUMN CAULIFLOWER - NITROGEN OFFTAKE IN UNMARKETABLE PLANTS kg/ha

HDC EXPT.

FIRST CROP N kg/ha	SECOND CROP N kg/ha 0	60	120	180	240	300	MEAN
			SED = 4.9 p = 0.20				SED = 1.8 p = 0.26
0	16	9	4	11	1	10	8
60	14	7	3	3	6	5	6
120	5	2	11	15	5	7	8
180	3	12	3	8	2	7	6
240	11	3	5	6	5	0	5
300	3	4	6	4	4	4	4
MEAN SED = 2.0 p = 0.18	9	6	5	8	4	6	6

MAFF REPEAT

FIRST CROP N kg/ha	SECOND CROP N kg/ha 0	75	150	MEAN
		SED = 9.6 p = 0.57		SED = 6.6 p = 0.44
0	18	19	24	20
75	13	5	23	14
150	8	9	15	11
225	16	17	12	15
300	19	14	35	23
MEAN SED = 3.8 p = 0.07	15	13	22	16

TABLE 22 - AUTUMN CAULIFLOWER - N IN LEAVES LOST DURING CROP GROWTH KG/HA

HDC EXPT.

FIRST CROP N kg/ha	SECOND CROP N kg/ha						
	0	60	120	180	240	300	MEAN
0							
60							
120	- assessment not made -						
180							
240							
300							
MEAN							

MAFF REPEAT

FIRST CROP N kg/ha	SECOND CROP N kg/ha			
	0	75	150	MEAN
0	0.4	nd	0.4	0.4
75	nd	nd	nd	nd
150	0.3	nd	0.3	0.3
225	nd	nd	nd	nd
300	0.4	nd	0.4	0.4
MEAN	0.4	nd	0.4	0.4

SED = nd
p = nd

TABLE 23 - AUTUMN CAULIFLOWER NITROGEN DEBRIS (TRIMS + UNMARKETABLE) N kg/ha

HDC EXPT.

FIRST CROP N kg/ha	SECOND CROP N kg/ha 0	60	120	180	240	300	MEAN
			SED = 9.6 p = <0.001				SED = 6.1 p <0.001
0	46	64	87	93	89	116	82
60	56	70	104	111	104	111	93
120	80	93	111	111	113	108	103
180	76	102	104	117	119	116	106
240	92	93	121	118	103	126	109
300	117	125	120	112	135	118	121
MEAN SED = 3.3 p <0.001	78	91	108	110	111	116	102

MAFF REPEAT

FIRST CROP N kg/ha	SECOND CROP N kg/ha 0	75	150	MEAN
		SED = 11.4 p = 0.06		SED = 7.0 p = 0.01
0	62	70	97	76
75	70	60	94	75
150	68	90	87	82
225	86	98	83	90
300	94	95	126	105
MEAN SED = 5.0 p = 0.001	76	83	98	85

TABLE 24 - SOIL MINERAL N AT HARVEST 0-90 cm kg/ha

HDC EXPT. (measured 8/11/88)

FIRST CROP N kg/ha	SECOND CROP N kg/ha 0	60	120 SED = 51 p = 0.21	180	240	300	MEAN SED = 27 p = 0.08
0	35	39	53	50	84	185	74
60	-	-	-	-	-	-	-
120	44	59	-	-	-	-	-
180	-	-	-	-	-	-	-
240	41	87	155	225	206	257	162
300	-	-	-	-	-	-	-
MEAN SED = 33 p <0.001	40	62	104	137	145	221	109

MAFF REPEAT (measured 25-26/10/89)

FIRST CROP N kg/ha	SECOND CROP N kg/ha 0	75 SED = 40.6 p = 0.199	150	MEAN SED = 23.3 p = 0.001
0	40	60	88	63
75	78	99	115	97
150	49	98	217	121
225	106	236	230	191
300	130	225	255	203
MEAN SED = 18.15 p <0.001	81	143	181	135

TABLE 25 - POTENTIAL NITROGEN RESIDUES END OF SECOND CAULIFLOWER CROP

HDC EXPT.

FIRST CROP N kg/ha	SECOND CROP N kg/ha						
	0	60	120	180	240	300	MEAN
			SED = 54 p = 0.36				SED = 29 p = 0.059
0	81	103	140	143	173	300	157
60	-	-	-	-	-	-	-
120	124	152	-	-	-	-	-
180	-	-	-	-	-	-	-
240	133	180	276	343	309	383	271
300	-	-	-	-	-	-	-
MEAN (exc 120) SED = 35 p <0.001	107	141	208	243	241	342	214

MAFF REPEAT

FIRST CROP N kg/ha	SECOND CROP N kg/ha			
	0	75	150	MEAN
		SED = 42 p = 0.24		SED = 23 p <0.001
0	102	130	185	139
75	148	159	210	172
150	117	188	304	203
225	192	334	313	280
300	225	319	381	308
MEAN SED = 19 p <0.001	157	226	279	220

TABLE 26 - MINERALISATION OF NITROGEN DURING GROWTH OF CROP 2

HDC EXPT.

FIRST CROP N kg/ha	SECOND CROP N kg/ha 0	60	120 SED = 61 p = 0.68	180	240	300	MEAN SED = 39 p = 0.69
0	65	34	44	1	-31	56	28
60	-	-	-	-	-	-	-
120	105	80	-	-	-	-	93
180	-	-	-	-	-	-	-
240	25	0	54	46	-43	-17	11
300	-	-	-	-	-	-	-
MEAN (exc 120) SED = 37 p = 0.27	45	17	49	24	-37	19	20

MAFF REPEAT

FIRST CROP N kg/ha	SECOND CROP N kg/ha 0	75 SED = 61 p = 0.29	150	MEAN SED = 49 p = 0.30
0*	*-18	*-52	*-47	*-39
75	+74	+19	+ 4	+32
150	+19	+25	+75	+40
225	+60	+133	+33	+75
300	+36	+45	+41	+40
MEAN SED = 19.6 p = 0.76	+34	+34	+21	+30

* Large error on value of mineral N at planting of second crop for this N level so estimate of mineralisation could be unreliable.

DISCUSSION

SOIL MINERAL NITROGEN AND THE PREDICTION OF N REQUIREMENT FOR CAULIFLOWERS

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SOIL MINERAL N AND THE PREDICTION OF N REQUIREMENT FOR CAULIFLOWERS

Early summer cauliflowers

There was a large response to fertiliser nitrogen in both seasons. Soil mineral N levels were only 73 kg/ha in 1988 and 107 kg/ha N in 1989 to 90 cm depth. These levels were typical of an N index 0 soil so the large responses to fertiliser N were not unexpected. The response to nitrogen in 1989 was a little less than that in 1988 and may be explained by the difference in mineral N levels at planting Fig. 2. However, other seasonal factors may also have affected response. Therefore there is no evidence that the current recommendations for early cauliflowers could be improved by measuring soil mineral N in these low residue situations. The production of quality curds for early planted crops is very dependent on a large nitrogen supply.
Further work needs to be carried out to estimate their N requirements when they follow high residue crops such as other brassica crops.

Autumn summer cauliflowers

From the foregoing data considerable nitrogen residues were left by early summer cauliflower crops. The subsequent autumn cauliflower crop did not respond to fresh fertilisr nitrogen once sufficient had been applied to the previous crop. Existing fertiliser recommendations grossly underestimated the effect of crop and soil residues, actual measurements of N in crop and soil should be able to explain the variations in yield response.

Table 5 shows the levels of soil mineral N measured in the soil at harvest of crop 1 and planting of crop 2. Figure 4 shows how soil mineral N was distributed through the soil profile to 90 cm depth. The table below shows how these measurements of mineral N relate to the increase (above the unfertilised control) in numbers of Class 1 curds as a result of adding 150 kg/ha fertiliser. This is an actual value for 1989 and averaged over plots receiving 120 and 180 kg/ha N for 1988.

Measurement of soil Mineral N (X)	Regression Equation (Y) = Yield response (Thousands of Class 1 curds) to fertiliser nitrogen	% variance accounted for (r^2)	Mineral N for Nil response kg/ha N
Harvest Crop 1			
Depth cm			
0-15	Y = 14.1-0.162 X	53.1	87
0-30	Y = 15.6-0.136 X	58.4	115
0-60	Y = 17.3-0.129 X	59.6	134
0-90	Y = 18.2-0.119 X	57.7	153
Planting Crop 2			
Depth cm			
0-15	Y = 18.1-0.255 X	47.1	71
0-30	Y = 19.2-0.102 X	54.6	188
0-60	Y = 19.2-0.0830 X	48.1	231
0-90	Y = 19.4-0.0767 X	46.2	253

See Figure 10, 11.

Half or more of the variation in response to fertiliser N has been accounted for by variation in soil mineral N at harvest of crop 1 and at planting of crop 2.

Figure 4 shows that a large proportion of the mineral N was in the top 30 cm, and that measurements to this depth at planting accounted for 55% or more in the variation in fertiliser response. At planting soil mineral N levels need to be greater than 188 kg/ha to 30 cm and 253 kg/ha to 90 cm to achieve maximum numbers of Class 1 curds without the need for fresh fertiliser N.

These relationships between soil nitrogen and response to fertiliser N may not be valid on lighter soils or in different seasons where more leaching may occur, or where mineralisation of crop debris may follow a different pattern. It was surprising that measurements of mineral N at harvest explained so much of the variation in fertiliser response but this may be due to the narrow range of crop debris N content. There are several factors that should be taken into account when interpreting measurements of soil mineral N at harvest or planting:-

- <u>For measurements of mineral N at harvest</u>:-

  Measurements of mineral N at harvest do not allow a measurement of N contribution from crop debris - their amount or speed of mineralisation. If there is a gap between harvesting and planting an allowance will not be made for movement of N through leaching or soil cultivation by ploughing.

  However an advantage of measuring soil mineral N at harvest is that it allows more time to

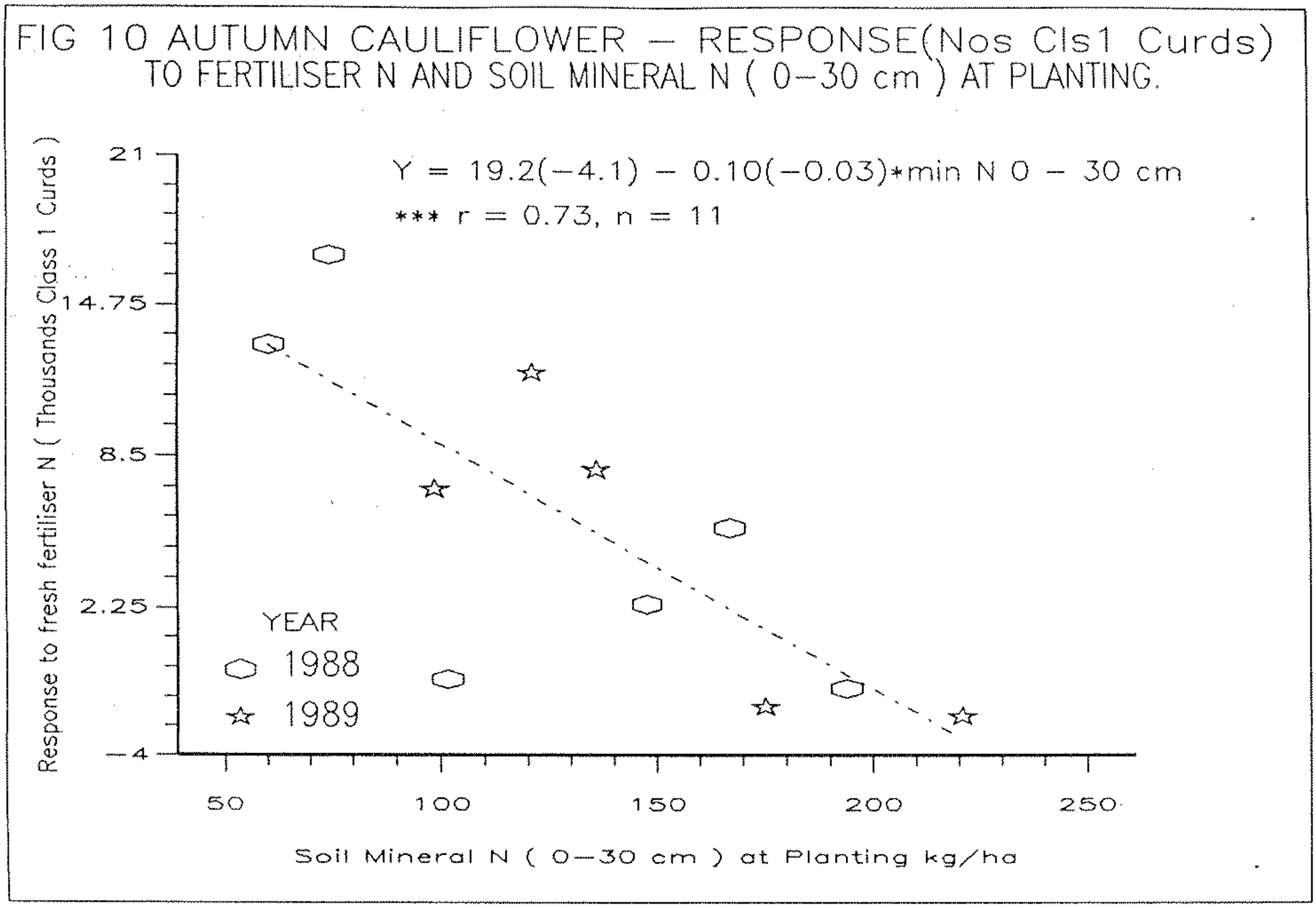
FIG 10 AUTUMN CAULIFLOWER – RESPONSE(Nos Cls1 Curds)
TO FERTILISER N AND SOIL MINERAL N (0–30 cm) AT PLANTING.
Y = 19.2(–4.1) – 0.10(–0.03)*min N 0 – 30 cm
*** r = 0.73, n = 11
Response to fresh fertiliser N (Thousands Class 1 Curds)
21
14.75
8.5
2.25
–4
YEAR
1988
1989
50
100
150
200
250
Soil Mineral N (0–30 cm) at Planting kg/ha

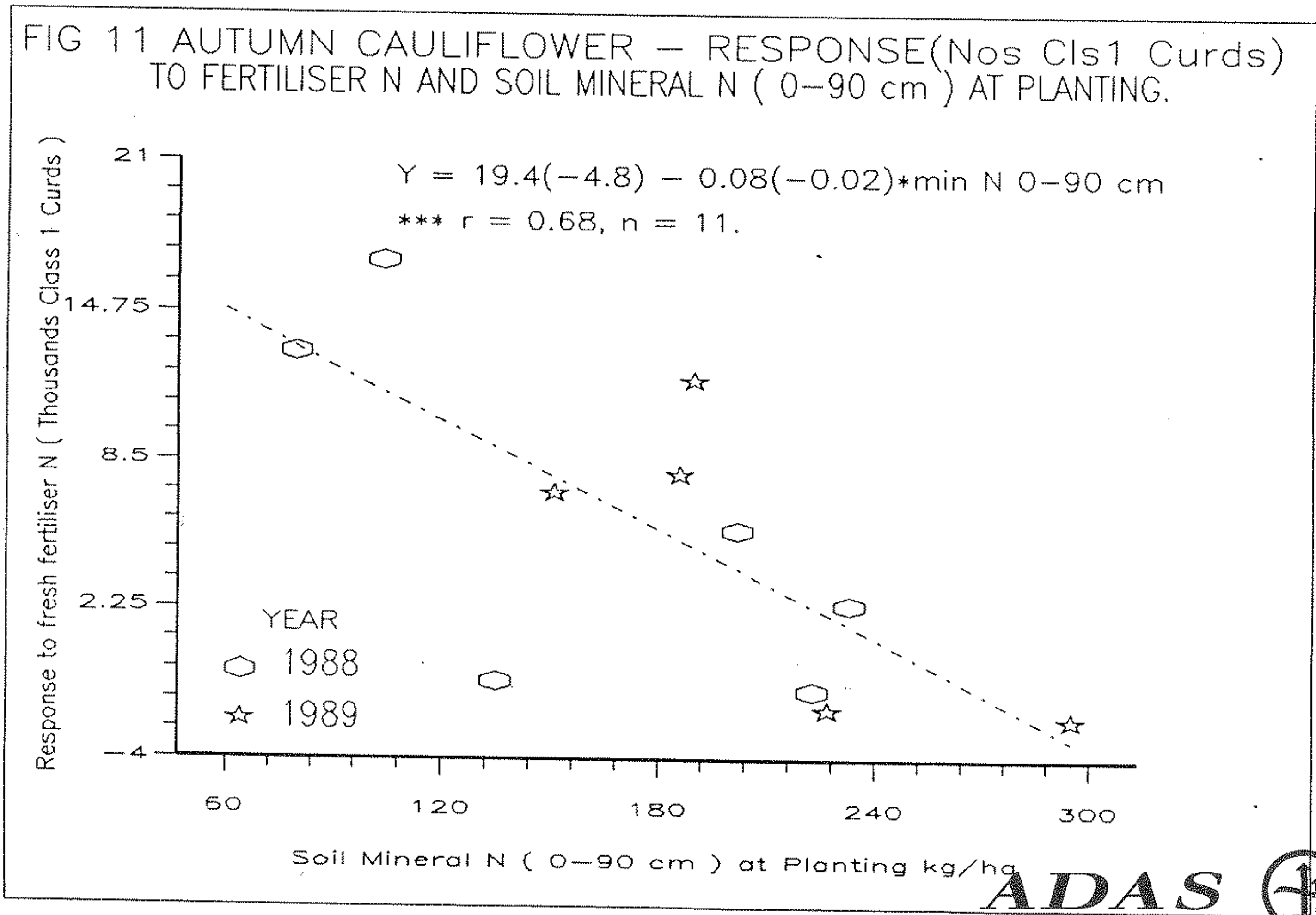
FIG 11 AUTUMN CAULIFLOWER – RESPONSE(Nos Cls1 Curds)
TO FERTILISER N AND SOIL MINERAL N (0–90 cm) AT PLANTING.
Y = 19.4(–4.8) – 0.08(–0.02)*min N 0–90 cm
*** r = 0.68, n = 11.
Response to fresh fertiliser N (Thousands Class 1 Curds)
21
14.75
8.5
2.25
–4
YEAR
1988
1989
60
120
180
240
300
Soil Mineral N (0–90 cm) at Planting kg/ha

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analyse the soil samples prior to fertilising and planting the next crop.

- <u>For measurements of mineral N at or just before planting</u>

Measurements of mineral N at planting should permit an improved allowance for N mineralised from crop debris. They would also make allowance for any movement of N through leaching. This would be particularly important if shallow rooted crops were grown.

There may be some disadvantages. Measurements of mineral N at or just before planting could be inaccurate due to uneven incorporation of plant debris, if some soil cores contain rotting crop debris and some do not. (May explain erroneous values of mineral N at planting of second crop in Table 4). A very rapid soil analysis service would be required in order to decide on how much N should be applied to the next crop.

There is scope for further 'HDC' funded work to assess appropriate sampling techniques for the assessment of crop and soil residues at both harvesting of previous crop and planting of the next.

CONCLUSIONS

CONCLUSIONS

1. Early summer cauliflowers following low N residue crops (N index 0 soils) needed 240-300 kg/ha N to produce maximum marketable produce.

2. The contribution of residue N from the early summer cauliflowers to a following autumn cauliflower crop was in excess of that advised in current fertiliser recommendations. Nitrogen mineralised within 2 weeks from summer incorporated crop debris, so where 300 kg/ha N had been applied to the early summer cauliflowers the maximum number of autumn Class I curds were obtained without the addition of any fresh fertiliser nitrogen.

3. Soil nitrogen supply to cauliflower crops can be quantified by measuring soil mineral nitrogen. Timely measurements of soil mineral nitrogen were able to account for variations in response to fertiliser nitrogen. Measurements of soil mineral N could form the basis of an improved prediction of nitrogen requirements for cauliflowers grown in a brassica rotation.

4. Further investigations should be carried out to confirm the results from these experiments on other soil types. On lighter soils in the west and south west leaching may reduce the effectiveness of any incorporated N residues.

5. Further investigations are needed to examine the effect of nitrogen on the production of the highest quality Class I curds from the autumn cauliflower crop.

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APPENDIX

DIARY OF FIELD OPERATIONS

APPENDIX 1 **CROP 1 1988**

KIRTON CENTRE - DIARY SHEET

EXPERIMENT:	HDC/Nitrate Responses	CROP: E.S. Cauliflower
FIELD/SOIL TYPE:	Lane 1. Coarse silty marine alluvial	
PREVIOUS CROPPING:	1987 Grass	
	1986 A.S. Onion lifted + grass	
SOIL ANALYSIS:	pH 8.0, N index 1, P index 3, K index 1	
CULTIVATIONS:	Ploughed on 9-10/2/88 N -> S	
	Worked with Lely 7/3/88	
FERTILISER:	50 kg/ha P_2O_5, 432 kg/ha K_2O 7/3/88	
	N applied as trts 28-29/3/88 S. Science	
SOWING/PLANTING:	Sown Perfection in $6cm^3$ Blocks	
	Plant 30/3/88	
INSECTICIDES:	28/4/88 Birlane applied	
FUNGICIDES:		
HERBICIDES:	Albrass + Dacthal 6/4/88	
IRRIGATION:		
NOTES:		

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APPENDIX 1 **CROP 2 1988**

KIRTON CENTRE - DIARY SHEET

TRIAL:	HDC/Nitrate Responses	CROP: S. Cauliflower
FIELD/SOIL TYPE:	Lane 1. Coarse silty marine alluvial	
PREVIOUS CROPPING:	1987 Grass	
	1986 A.S. Onion lifted + grass. Double crop.	
SOIL ANALYSIS:	pH 8.0, N index 1, P index 3, K index 1	
CULTIVATIONS:	Ploughed on 9-10/2/88 N -> S E.S. crop rotavated ploughed in on 24/6/88, area also rolled	
FERTILISER:	N trts applied by S. Sci	
	No K_2O applied but 50 kg/ha P_2O_5 applied 6/7/88	
SOWING/PLANTING:	23/5/88 74 SWC 308 trays sown with W Rock	
	Planted by machine 8/7/88	
INSECTICIDES:		
FUNGICIDES:		
HERBICIDES:	Albrass + Dacthal 11/7/88	
IRRIGATION:		
NOTES:		
4/8/88	Gapped up plants due to bad infection of Rhizoctonia	
12/7/88	Toppel sprayed repeated on 1/8	

ADAS

KIRTON EXPT - EXPT DIARY SHEET

EXPERIMENT:	Brussels sprouts 1989/90 - Soil Science Nitrate Response Trial
FIELD/SOIL TYPE:	Lane 1/ Coarse Silty Marine Alluvial
SOIL ANALYSIS:	pH 7.5, N index 1, P index 3, K index 1
PREVIOUS CROPPING:	1987 - Grass 1988 - Cauliflowers
CULTIVATIONS:	Ploughed - 15 December 1988, E-W, turning soil to N
FERTILISER:	HDC trial area (4227 m²) given P & K only - 150 kg sulphate of potash and 48 kg Triple Super Phosphate on 17 May 1989.
SOWING/PLANTING:	Sown - w/b 13 March 1989, all Stephen, GPG 308 Planted - 19 May 1989 by machine

NOTES:

9 & 10 May 1989	Field ploughed
19 May 1989	Trial planted by machine
1 June 1989	Sprayed with 6 pts Albrass + 5½ lb Dacthal/acre
10 June 1989	Sprayed with 8 fl oz Metasystox/acre in at least 90 gals
26 June 1989	Sprayed with 6 oz/ac Aphox and 3½ fl oz/ac Toppel
3 July 1989	Sprayed as above with Aphox and Toppel
9 July 1989	Sprayed with 8 fl oz Metasystox + 4½ fl oz Toppel/acre
7 August 1989	Sprayed with 42 fl oz/acre Chiltern Olé, for powdery mildew
9 August 1989	Sprayed with 8 oz Metasystox + 3½ fl oz Toppel/acre
23 August 1989	Sprayed with 7 fl oz Bayfidan/acre
20 September 1989	Sprayed with 7 fl oz Bayfidan + 28 fl oz Folio/acre
23 September 1989	Sprayed with 8 fl oz Metasystox + 3½ fl oz Toppel 10/acre
10 October 1989	Sprayed with 7 fl oz Bayfidan/acre
23 October 1989	Sprayed with 8 fl oz/acre Metasystox plus wetter
15 December 1989	Measurements and field assessments taken for all plots.
26 January 1990	Ploughed

KIRTON CENTRE - EXPT DIARY SHEET

NOTES:

21/2/90	Cultivation with Lely
21/2/90	Drilled with 'Blenheim' at 154 kg/ha
1/6/90	Calixin spray
6/8/90	Harvested plot combine

KIRTON CENTRE - EXPT DIARY SHEET

EXPERIMENT:	S. Science - Nitrates CROP: E.S. Cauliflower 1989
FIELD/SOIL TYPE:	Asplands 1 - Gley soil. Coarse silty marine alluvial
PREVIOUS CROPPING:	1987 Brassica
	1988 Barley
SOIL ANALYSIS:	Sept 88 - pH 7.5, N index 0, P index 2, K index 1.
CULTIVATIONS:	Ploughed 5/12/88. One pass with Lely at planting
FERTILISER:	S.S. do N trts. 27/2/89 63.82 kg Sulphate of Potash & 26.6 kg Triple super phosphate
SOWING/PLANTING:	Sown: 17/10 Perfection 24 308 GPG trays
	5/12 308 -> P. Blocks 70 trays
	Planted: 8/3/89 as plan
INSECTICIDES:	10/6/89 Toppel
FUNGICIDES:	
HERBICIDES:	11/3 Ramrod/Dacthal applied
IRRIGATION:	
NOTES:	In prop - sprayed Filex & Basilex when stood in Venlo, then sprayed Repulse on 3/11. 11/11, 25/11, 9/12. 23/12, 6/1, 27/1
6/2	Fans put in Venlo
22/2	stood out on standing ground

KIRTON CENTRE - TRIAL DIARY SHEET

EXPERIMENT	S. Science - Nitrates CROP: A. Cauliflower 1989
FIELD/SOIL TYPE:	Asplands 1 - Gley soil. Coarse silty marine alluvial
PREVIOUS CROPPING:	1987 Brassica 1988 Barley
SOIL ANALYSIS:	Sept 88 - pH 7.5, N index 0, P index 2, K index 1,
CULTIVATIONS:	Double crop. E.S. Disced in 22/6/89 + ploughed
FERTILISER:	S.S. do N trts. 3/7/89 63.8 kg Sulphate of Potash & 26.6 kg Triple super phosphate
SOWING/PLANTING:	Sown: 20/5/89. 20x 308 trays W. Rock Planted: 5/7/89 Dursban trt
INSECTICIDES:	31/7/89 Toppel & Aphox. Repeat 22/8 & 16/9
FUNGICIDES:	
HERBICIDES:	11/7/89 Ramrod & Dacthal
IRRIGATION:	
NOTES:	

KIRTON CENTRE - EXPT DIARY SHEET

EXPERIMENT:	Brussels sprouts 1990/91 - Nitrate Responses
FIELD/SOIL TYPE:	Asplands 1/Gley soil - Course Silty Marine Alluvial
SOIL ANALYSIS:	pH 7.3, N index 0, P index 4, K index 2
PREVIOUS CROPPING:	1988 - Wheat
	1989 - Double cropped cauliflowers
CULTIVATIONS:	16-19 February 1990 - ploughed
FERTILISER:	
SOWING/PLANTING:	Sown: 16 March 1990 (5 GPG 308 trays Dolmic)
	Planted: 16 May 1990
	Chlorpyrifos applied pre-planting as a Dursban 4 drench
NOTES:	
23 May 1990	Propachlor as 9 l/ha Albrass and Chlorthal-dimethyl as 6 kg/ha Dacthal applied
13 June 1990	Demeton-S-methyl as 560 ml/ha Metasystox 55 plus Agral applied
18 July 1990	Triazophos as 840 ml/ha Hostathion applied
27 July 1990	Disulfotan as 14 kg/ha Disyston applied 90 gals
1 August 1990	Chlorothalonil & metalaxyl as 2 l/ha Folio 575 FW applied
21 August 1990	Demeton-S-methyl as 560 ml/ha Metasystox 55 and Cypermethrin as 250 ml/ha Ambush C applied
24 August 1990	Chlorothalonil & metalaxyl as 2 l/ha Folio 575 FW applied
4 September 1990	Demeton-S-methyl as 560 ml/ha Metasystox 55 and Cypermethrin as 250 ml/ha Ambush C applied
14 September 1990	Triadimenol as 500 ml/ha Bayfidan applied
14 September 1990	Trichlorfon as 1.75 kg/ha Dipterex 80 applied
7 November 1990	Heptenophos as 840 ml/ha Hostaquick and Deltamethrin as 150 ml/ha Decis applied
6 December 1990	Ploughed
14 January 1991	2 t/acre lime applied

APPENDIX 1 **SPRING WHEAT 1991**

KIRTON CENTRE - EXPT DIARY SHEET

NOTES:

21 January 1991	Ploughed
22 February 1991	Cultivation with Lely and Tonic drilled a 154 kg/ha seed
24 August 1991	Harvested with plot combine