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FINAL REPORT - COTTON RESEARCH COUNCIL

DAQ9L IRRIGATION AND NITROGEN MANAGEMENT OF COTTON.

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OBJECTIVES:

To study the response of cotton to varying nitrogen rates and times and methods of application under different irrigation strategies.

To demonstrate to cotton growers under commercial conditions the importance of irrigation and nitrogen management of their crops.

To obtain preliminary information on the effect of previous crop on cotton response to applied nitrogen.

METHODS:

Nitrogen Rate and Irrigation Experiments

Experimental work commenced in 1983/84 with irrigation and nitrogen rate experiments on two soil types (Basaltic BUg and Tertiary Basaltic TbUg).

There was no zero N treatment at the BUg site due to the inadvertent application of 100 Kg N ha^{-1} prior to commencement of the experiment. The results for the Tb Ug site only (Table 1) are presented. At this site, presowing nitrogen rates of 0, 100, 150, 200, 250 and 300 Kg N ha^{-1} were applied and there were two split application treatments (50 + 50 and 100 + 50 Kg N ha^{-1}). The 8 nitrogen treatments were replicated four times in each of two irrigation treatments.

In one irrigation treatment an irrigation deficit of 100 mm was adopted throughout the season whereas in the other irrigation treatment a variable deficit approach was adopted. A deficit of 80 mm was applied to first flower and a deficit of 120 mm was applied from first flower to maturity.

The experience and techniques developed in these preliminary experiments were applied in designing a more extensive series of experiments commenced in the 1984/85 season. A constant irrigation deficit approach was adopted in the 84/85 - 86/87 experiments. Experiment site characteristics and treatment details are included in Tables 1 and 2. All experiments were sown in October and harvested in mid to late March.

TABLE 1. Experiment Site Characteristics

Experiment & Season		Soil Unit	Slope %	Rooting Depth cm	PAW [1] Estimate mm	NO_3-N [2] Kg ha-1
1	83/84	Tertiary Basaltic TbUg (Scrub)	0.6	100	160	38.2
2	84/85	Basaltic BUg (Open Downs)	1.1	110	140	15.1
3	84/85	Tertiary Basaltic TbUg (Scrub)	0.6	120	160	29.5
4	84/85	Alluvial AUg (Alluvial)	0.3	120	130	17.8
5	85/86	Alluvial AUg (Alluvial)	0.1	120	130	32.5
6	85/86	Basaltic BUg (Open Downs)	1.0	80	140	7.0
7	86/87	Basaltic BUg (Open Downs)	1.0	80	140	5.9

[1] PAW = Total Plant Available Water, Shaw and Yule (1978).
[2] Samples collected prior to N application and presow irrigation.

TABLE 2. Irrigation and Nitrogen Treatments, Rainfall.

Experiment	Irrigation Treatment Deficits (mm) (No. of Irrigations)				Reps *	Total Rainfall mm	Nitrogen Rates Kg ha^{-1} N0	N60	N120	N180	N240	N300
1	80/120 (3)	100 (3) See Text			1	193			See Text			
2	45 (7)	80 (5)	120 (3)	150 (2)	3	236	x	x	x	x	x	x
3	45 (7)	80 (5)	120 (3)	150 (2)	2	265	x	x	x	x	x	x
4	45 (7)	70 (5)	110 (3)	150 (2)	2	176	x	x	x	x	x	x
5	45 (8)	70 (5)	110 (3)	-	3	235	x	x	x	-	x	-
6	50 (8)	70 (6)	-	-	2	189	x	x	x	-	x	-
7	-	75 (6)	-	150 (2)	3	241	x	x	x	x	x	x

* Replicates of Irrigation Main Plots.

Treatments were imposed using a split plot design with irrigation treatments as main plots and nitrogen rates as sub-plots (Table 2). Irrigation treatments were based on soil water deficits predicted from Class A pan evaporation and a crop factor multiplier (Keefer <u>et al</u>., 1982).

Nitrogen (as urea) was banded in the hill prior to sowing at a depth of approximately 20 cm (just below furrow depth). Additional nitrogen treatments included split applications between sowing and early square; foliar N applications before, during and after irrigations and periods of waterlogging.

Experiment 6 in 85/86 was specifically designed to assess waterlogging effects and included 3 additional irrigation treatments.

- 70 mm deficit with irrigation run for 3 days at first irrigation (squaring).

- 70 mm deficit with irrigation run for 10 days at first irrigation (squaring).

- 70 mm deficit with irrigation run for 3 days at peak flower.

Petiole nitrate samples were collected in experiment 6.

The cultivar Deltapine 61 was used in all experiments. The latest commercial cultivars Deltapine 90 and SioKra were also included in experiment 7 to assess cultivar interaction with irrigation and nitrogen management. In experiment 7 there were three replicates of the irrigation treatment main plots and nitrogen rate and variety subplots were arranged factorially.

<u>Crop Rotation Experiment</u>

A major factor influencing nitrogen management is the contribution to soil nitrogen levels of previous crop rotations. The objectives of this experiment were:

To determine the effect of previous crop on soil nitrate levels and the response of cotton to applied nitrogen.

To assess other effects of prior crops on cotton production.

A BUg site cropped with cotton in 1983-84 was subdived into four adjacent areas, two left fallow and two fertilised and planted with wheat. In November 1984 each of the fallow and wheat plots was subdivided for five cropping treatments, fallow, dryland soybean with nil and with 180 kg N ha^{-1}, irrigated cotton (Deltapine 61) with 60 and 180 kg N ha^{-1}. Subsequently, in November 1985 each plot was sown with irrigated cotton (Deltapine 90) receiving 25 and 175 kg N ha^{-1}. Soil profiles were sampled at strategic times for analysis. A key to the crop rotation and fertiliser treatments is presented in Table 3.

TABLE 3. Key to crop rotations and fertiliser treatments (Kg N/ha)

1983-84	1984 May to October	1984-85 November to April	1985-86 November to March
		Fallow	
	Fallow	Soybean (0N)	Cotton** (25N)
Cotton x	x	Soybean (180N) x	
	Wheat (120N)	Cotton* (60N)	Cotton** (175N)
		Cotton* (180N)	

* Irrigated Deltapine 61. ** Irrigated Deltapine 90.

RESULTS

Nitrogen and Irrigation Response

Cotton lint yield responses to applied nitrogen rates for the four seasons are shown in figures 1-4.

Lint yields over all seasons were generally higher on the Tb Ug soils than the BUg soils and lowest on the AUg soils. These differential responses should be independent of nitrogen rate and irrigation frequency as comparable treatments were imposed on each soil.

Table 1 shows that presowing soil NO_3-N was low for BUg soils (6-15 kg NO_3 N ha-1) intermediate to high for AUg soils (18-33 Kg NO_3 N ha-1) and high for Tb Ug soils (30-38 Kg NO_3 N ha-1). The lint yields of zero N plots were highly correlated (Figure 5) with presowing soil NO_3-N.

The magnitude of the lint yield response to applied nitrogen in the highest yielding irrigation treatment was 600-1300 Kg lint ha^{-1} on the BUg soils, 300-700 Kg lint ha^{-1} on the Tb Ug soils and 400-500 Kg lint ha^{-1} on the AUg soils. On the AUg soils in both the 84-85 and 85-86 seasons the maximum response was achieved with 60 Kg ha^{-1} of applied nitrogen.

Soil characteristisation data show that on both the AUg sites soil chloride levels were as high as 700 (mg/Kg) at 60 cm depth and 1600 mg/Kg below 80 cm. These high chloride levels would encourage shallow rooting and exacerbate the low PAW levels of these soils. This possible explanation of the low lint yields and lint yield responses on the AUg soils should be explored further.

Irrigation

Figures 1-4 indicate that responses to irrigation were evident on most sites in most seasons. In some cases the obvious differences due to irrigation frequency did not attain statistical significance because there were only two replicates of each irrigation treatment. Generally, most frequent irrigation (45 to 80 mm deficit treatments) produced highest yields. An exception was the 84/85 season when 122 mm of rain fell over a ten day period at early squaring. On the BUg site this rain period commenced 4 days after the first irrigation of the 80 mm treatment and 13 days after the first irrigation of the 45 mm treatment. Highest yields were obtained from the 45 mm treatment and yields of the 80 mm treatment were reduced to those of the 150 mm deficit treatment. In the 84/85 season a similar effect can be noted on the Tb Ug site (Figure 2B) and it is concluded that waterlogging and soil anaerobiosis (Hodgson and Chan, 1982) was the cause of these yield reductions in frequent irrigation treatments followed by rain.

Although the differences did not attain significance, the very frequently irrigated 45 mm treatment tended to outyield the 70 mm treatment on the AUg soil which has the lowest PAW of all three soils. High chloride levels below 80 cm could also restrict root penetration on this soil.

On all three soils, the yield response to the less frequent irrigation schedules (110-150 mm deficits) was dependent on timing of rainfall events in relation to irrigations particularly during flowering and early fruit set. A timely rainfall event could reduce the level of stress at critical times. In the 83-84 season on the Tb Ug site the constant deficit treatment outyielded the variable deficit treatment. While some variable deficit treatments may have merit it was decided to use the constant deficit approach in all later experiments to facilitate data interpretation and commercial application of results.

Nitrogen x Irrigation Interaction

Significant interactions between irrigation and nitrogen treatments were identified on the BUg soil in the 84-85 (Figure 2A) and 86-87 (Figure 4) seasons. For the variety Deltapine 61 with less frequent irrigation, yields did not change markedly at N application rates above 60 Kg N ha^{-1}. With more frequent irrigation of this variety yields tended to peak at 180 Kg N ha^{-1} and decline at higher levels of applied N. On the Tb Ug soil particularly in the 84-85 season yields tended to increase linearly as nitrogen rates increased from zero to 300 Kg N ha^{-1} (Figure 2B, 45 mm deficit treatment).

Waterlogging Effects

As already stated, apparent waterlogging effects from rainfall following the first post sowing irrigation were observed during the 84-85 season.

The 85-86 experiment on the BUg soil (E6) was specifically designed to assess waterlogging effects. There were no significant differences between the two similar frequent irrigation strategies (50 and 70 mm deficit treatments) (Figure 3B). Extending irrigation up to 3 days at early square did not affect yield whereas prolonged waterlogging for 10 days after irrigation significantly reduced yields over a range of basal N application rates (results not shown). In the 85/86 season two rainfall events of 42 mm and 30 mm occurred at early square prior to first irrigation. The early rainfall could have stimulated root activity in the bed and moderated the waterlogging effects of the 3 day irrigation cycle.

Split Applications of Nitrogen and Foliar N

Results of split application treatments are shown in Table 4. Generally split applications of nitrogen between sowing and early squaring had no effect on lint yield. In some experiments there were small increases (eg. E1 - TB Ug) and in other experiments yields were decreased (eg. E2 - BUg). Similarly only small and non significant responses to foliar applied N were recorded even under waterlogged conditions. Such small responses would not appear to justify commercial foliar applications under most circumstances.

TABLE 4. Cotton lint yield responses (Kg lint ha^{-1}) with all nitrogen applied presowing and with equivalent rates split between presowing and sowing to early squaring.

Experiment (see Table 1)		Nitrogen Treatments Kg N ha^{-1}						LSD P<0.05
				100	50 + 50	150	100 + 50	
E1 Tb Ug	1			2299	2403	2347	2352	337
	2			2115	2457	2107	2169	244
		60	0 + 60	120	60 + 60	180	120 + 60	
E2 BUg	3	1356	1051	1464	1434	1534	1512	86
E3 Tb Ug	3	1679	1646	1848	1815	1883	1813	161
E4 AUg	3	1291	1230	1184	1280	1345	1229	121

[1] 100 mm deficit irrigation treatment.
[2] 80/120 mm deficit variable irrigation treatment.
[3] Means of all irrigation treatments.

Petiole Nitrate Results

Nitrogen uptake by the roots during and immediately following waterlogging decreased as indicated by the dramatic drop off of petiole nitrate. Nitrate nitrogen levels decreased from 14 000 mg NO_3-N/Kg to 4 500 mg NO_3-N/Kg for the 240 kg N/ha treatment, as a result of three days extended irrigation. (mg NO_3-N/Kg = ppm). Within the following five days nitrate levels recovered to at least match the levels for the same N treatment without extended irrigation and were similar at flowering. In contrast, petiole nitrate levels never recovered after prolonged waterlogging (10 days) such that at flowering levels were half those of treatments without waterlogging.

On the BUg site, 85/86, where maximum yields occurred at 240 kg N/ha, NO_3-N concentrations were 14 000 mg NO_3-N/Kg at squaring and 5 000 mg NO_3-N/Kg at flowering.

Differences in concentrations of petiole nitrate across nitrogen rates were greatest at flowering. In addition, at flowering, the spread of NO_3-N results was at least five times the spread of total N levels in leaves and stems, indicating it should be the best indicator of nitrogen status.

On the BUg site where yields were affected by nitrogen applied at planting, there were good relationships between petiole NO_3-N at flowering and applied N (R2 = 0.98, square root quadratic) and between lint yield and petiole NO_3-N at flowering (R^2 = 0.993, Mitscherlich model). However, the use of Nitrate monitoring to re-adjust fertiliser scheduling may not be practical at Emerald, as significant yield improvements to nitrogen applied post planting as either split or foliar applications were not demonstrated; yields were increased in some cases but not significantly so.

Nitrogen Uptake and Recovery

In all seasons, total nitrogen uptake (Peak LAI) increased linearly with increasing rate of nitrogen application on each soil type (Figure 6). With zero N applied, uptake was higher on Tb Ug and AUg soils (40-60 kg ha^{-1}) than on BUg soils (20-35 kg ha^{-1}). In the 84-85 season maximum uptakes were 115, 187 and 189 kg ha^{-1} on the BUg, Tb Ug and AUg soils respectively.

A significant soil type irrigation treatment interaction was indicated from the nitrogen uptake responses. On both the BUg and Tb Ug soils, frequent irrigation (at lower soil water deficits) restricted nitrogen uptake although this was less evident at high rates of applied N. It can be deduced that waterlogging on both soils reduces N uptake and this supports the waterlogging effects referred to previously. On the BUg soil N uptake was lower at an irrigation deficit of 150 mm than at an irrigation deficit of 120 mm but there were no such differences on the Tb Ug soil. This differential response could be related to the higher PAW capacity of the Tb Ug soils compared to the BUg soils. AUg soils are the reverse of those on the BUg and Tb Ug soils with uptake increasing as irrigation frequency is increased. This is in line with the lower PAW capacity of the AUg soils.

Relation between Lint Yield and Nitrogen Uptake

The relationships between nitrogen uptake and yield differed between soils as illustrated by the results for the 84-85 season (Figure 7). The different responses could result from differences in the native soil nitrate N supply or from factors not related to nitrogen or water.

On the Tb Ug soil maximum yields were obtained at nitrogen uptakes above 120 kg N ha^{-1} and there were no apparent differences due to irrigation treatment. On the BUg soil, the frequent (45 mm deficit) irrigation treatment increased lint yields per unit of nitrogen uptake whereas stress due to infrequent irrigation (120 and 150 mm deficits) or waterlogging (80 mm deficit) decreased lint yields per unit of nitrogen uptake. For all irrigation treatments the optimum nitrogen uptake for optimum yields was approximately 60-70 kg N ha^{-1}. Also, on the AUg soil nitrogen utilisation efficiency increased with increasing irrigation frequency. Again the evidence suggests that at all irrigation levels optimum yields were attained at around nitrogen uptake levels of 60-70 Kg N ha^{-1}. Even with frequent irrigation, the asymptotic yields were lower on the BUg and AUg soils than on the Tb Ug soils.

As irrigation frequency did not alter the point of inflection on the nitrogen uptake - lint yield relationships on any soil, the effects of nitrogen uptake and soil water availability or stress were independent of each other. On two soils (BUg and AUg) lack of stress increased yields resulting in a higher nitrogen utilisation efficiency. On the Tb Ug soil nitrogen utilisation efficiency was independent of water availability reflecting the higher PAW levels of this soil.

Cultivar Response

In the cultivar comparison experiment conducted in the 86-87 season, there was a significant lint yield response to nitrogen application for cultivars Deltapine 61, Deltapine 90 and SioKra for two irrigation frequencies (Figure 4). On this BUg site for all three cultivars, yields were significantly higher with more frequent irrigation. With more frequent irrigation (75 mm deficit) SioKra and Deltapine 90 significantly outyielded Deltapine 61 at all rates of applied N. At high rates of nitrogen application for both irrigation frequencies Deltapine 61 lint yields decreased at N rates above N 180 whereas yields of the other two varieties tended to increase or plateau off at rates above N 180.

Ginning Percentage and Quality

In Figure 8 ginning percentage has been averaged for irrigation frequencies at each site over the 84-85 and 85-86 seasons. Ginning percentage decreased with increasing nitrogen application rates and was consistently lower in the 85-86 season. Also ginning percentage decreased significantly with increasing rates of nitrogen application for three cultivars and two irrigation frequencies in 1986-87 (Figure 9). Deltapine 61 and 90 had lower ginning percentages than SioKra for each irrigation frequency and for all nitrogen rates. Under more frequent irrigation, ginning percentage decreased more markedly with additional nitrogen for Deltapine 61 and 90 than SioKra. For each cultivar there was a greater difference in ginning percentage for different irrigation frequencies at low rates of nitrogen application than at high rates.

The nitrogen and irrigation treatments did not produce any major differences in lint quality. In the 1986-87 cultivar experiment, the usual cultivar differences were observed with Deltapine 90 having greater fibre strength than SioKra and Deltapine 61.

Effects of Prior Crop on Soil Nitrate and Cotton Yield

Mean soil nitrate at 0 to 40 cm after wheat or fallow in 1984 was 8.4 Kg N/ha. By contrast the fallow accumulated a further 44 Kg N/ha from October 1984 to August 1985 which emphasises the influence of summer temperatures on mineralisation rates of these clay soils. Campbell *et al*. (1981) found that the mineralisation rate for an Emerald BUg increased by a factor of three as temperature increased from 5-10°C to 30°C.

For the 84-85 cotton crop lint yields in Kg ha^{-1} based on a 37% ginning outturn were:

1184 Fallow + 180 Kg N ha^{-1}

1258 Wheat + 180 Kg N ha^{-1}

962 Fallow + 60 Kg N ha^{-1}.

777 Wheat + 60 Kg N ha^{-1}

It was intended that the 84-85 soybean crop be fully irrigated which would have resulted in considerable nitrogen uptake and removal in the beans. Due to management factors the crop was grown solely on rainfall and was ploughed in as a green manure crop (above ground dry matter yield of 1700 $\pm$ 217 Kg ha^{-1}).

The presowing soil nitrate levels and lint yields for the 85-86 cotton crop are shown in Table 5.

Presowing mineral nitrogen levels on the fallow and green manure plots were three to four times higher than the level of 17 Kg NO_3-N ha^{-1} on the prior cotton plots. These presowing soil nitrate levels with mineralisation during the season contributed the equivalent of 150 Kg N ha^{-1} of applied fertiliser N ; that is one kg of native soil N prior to sowing is equivalent to 2-3 kg of applied fertiliser N. The Emerald observations agree with those of Constable and Rochester (1987) for Narrabri where fertiliser N is not recommended if presowing soil nitrate levels are above 28 Kg N ha^{-1}.

The yields of cotton following continuous cotton can be maintained with applied fertiliser N. Wheat, fallow or soybean produced no adverse effects on the following crops. Fallow or soybean as a green manure crop should avoid the need for nitrogen fertiliser on the next cotton crop or at least reduce the nitrogen fertiliser requirement. Soil testing prior to sowing can be used to refine fertiliser recommendations.

TABLE 5. Rotation Treatments Effects on presowing soil NO_3-N (0-40 cm) and lint yields (Kg ha-1) for the 1985-86 cotton crop.

	Treatments 1984-85 following wheat or fallow in Winter 1984				
	Fallow	Green Manure (Soybean) 0 N	Green Manure (Soybean) 180 N	Cotton 60 N	Cotton 180 N
Presow Soil NO_3-N	53 b	46 b	69 a	17 c	17 c
1985-86 N rate					
25	1519 a	1601 a	1605 a	958 b	1050 b
175	1620 a	1592 a	1599 a	1575 a	1563 a

Figures in each row followed by the same letter are not significantly different $P < 0.05$.

General Recommendations and Conclusions

In experiments on the BUg soil at Emerald since 1983-84 consistently high yields exceeding 8 bales lint per ha have been obtained by irrigating at a 75-80 mm deficit, based on evaporation and a crop factor multiplier. For maximum yields on the AUg soil more frequent irrigation at a 45-60 mm deficit is required while on the Tb Ug soil less frequent irrigation at 80-95 mm deficits should produce maximum yields.

Waterlogging from rain following the first post sowing irrigation was observed in one experiment on the BUg soil and one experiment on the Tb Ug soil. The steeper slopes at Emerald appear to alleviate waterlogging problems and well formed beds can also help to alleviate waterlogging.

Reciprocal quadratic regression curves fitted to the Emerald nitrogen response data indicate that on all soil types maximum yields are obtained in the range 180-300 Kg ha^{-1} of applied N.

It is difficult to make general recommendations because optimum economic fertiliser rates are influenced by many factors - presowing soil nitrate levels, prices of fertiliser, anticipated cotton lint prices and the growers expectations of marginal returns for dollars outlayed on fertiliser.

When all these factors are taken into account optimum economic fertiliser rates for the BUg soils would generally be in the range 120-200 Kg N ha^{-1}. Similar rates could be used on the Tb Ug soils but lower optimum rates are indicated on the AUg soils.

Results of the 1986-87 cultivar experiment indicate that the more recent introductions Deltapine 90 and Siokra would benefit from an extra 10-20 kg N ha^{-1} compared with the cultivar used in most of these experiments Deltapine 61.

On the BUg and AUg soils maximum yields are generally achieved at nitrogen uptake levels of 60-120 kg N ha^{-1} and on the Tb Ug soils maximum yields are generally achieved at higher nitrogen uptake levels of 120-180 kg N ha^{-1}. A number of factors need to be considered in budgeting nitrogen requirements to match these uptake levels.

Recovery levels of fertiliser applied N can range from 14 to 80 percent. At low fertility sites recovery may increase with increased rates of applied N whereas at medium to high fertility sites recovery may decrease at higher rates of applied N. For budgeting purposes a recovery rate of 50 percent can be assumed.

Split applications of fertiliser and foliar applied N do not appear to be justified on the results obtained in this series of experiments. Therefore petiole nitrate tests would have limited application.

On the other hand, the importance of presowing soil nitrate levels and the effects of prior crops on these levels should be exphasised. Soil testing prior to sowing could be used to refine fertiliser recommendations and improve the efficiency of fertiliser use. With mineralisation during the season, 20 kg N/ha prior to sowing could be equivalent to 80 kg of nitrogen uptake per ha. It is for this reason that Constable and Rochester (1987) from work on Narrabri soils suggest that no applied fertiliser may be required at presowing nitrate levels greater than 25 kg N ha^{-1}.

Further detailed analysis of the results from Emerald and other centres will help to refine the cotton nitrogen budgeting process. Consultation with extension staff and growers will enable these budgeting techniques to be applied in a realistic and practical way.

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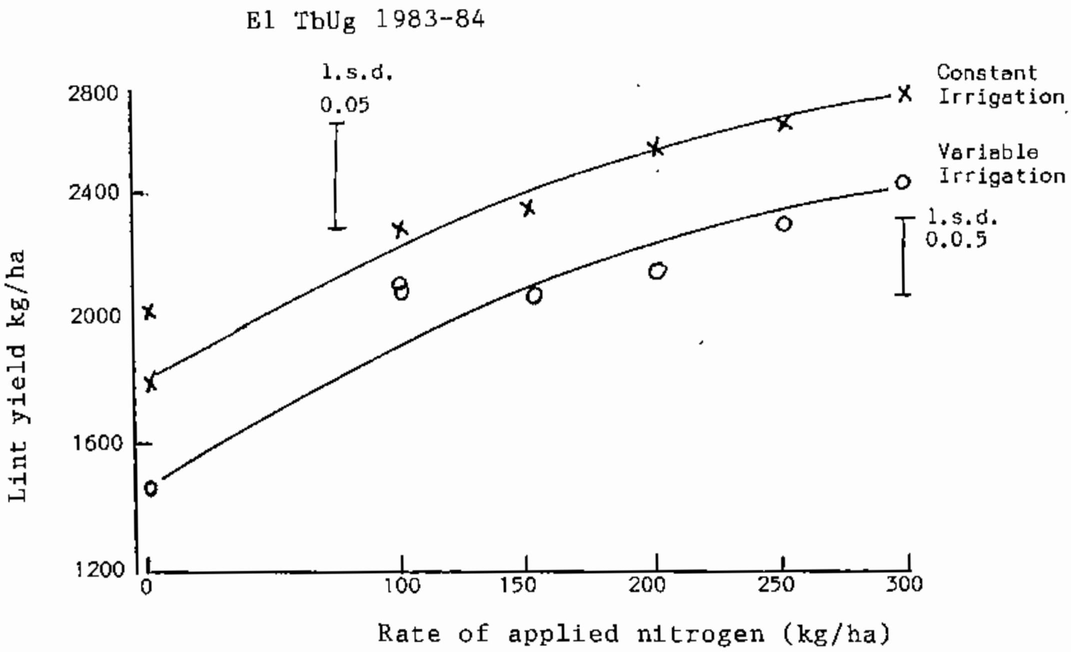


Figure 1. Cotton lint yield response of variety Deltapine 66 to applied nitrogen rates at two irrigation frequencies El TbUg 1983-84

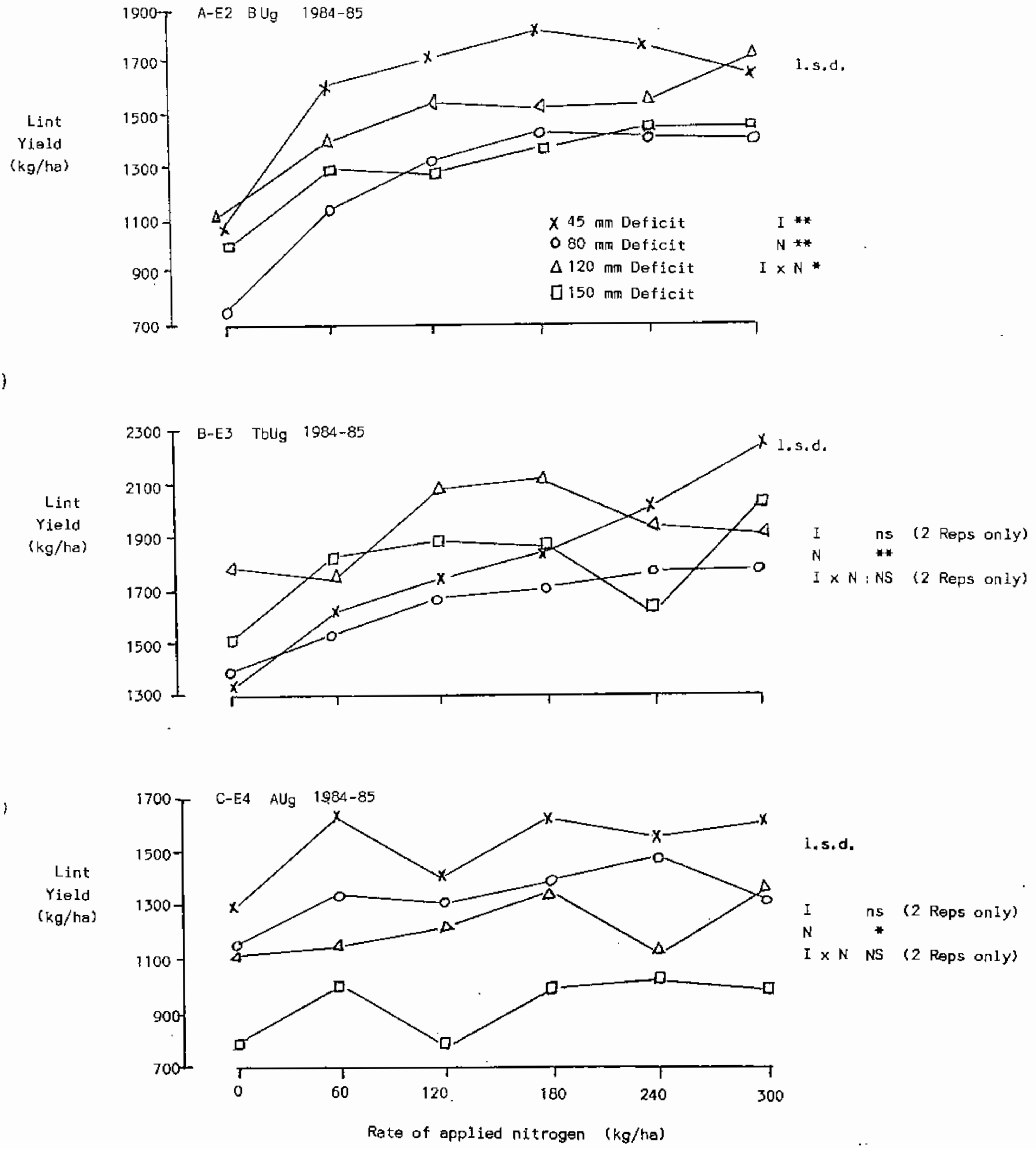
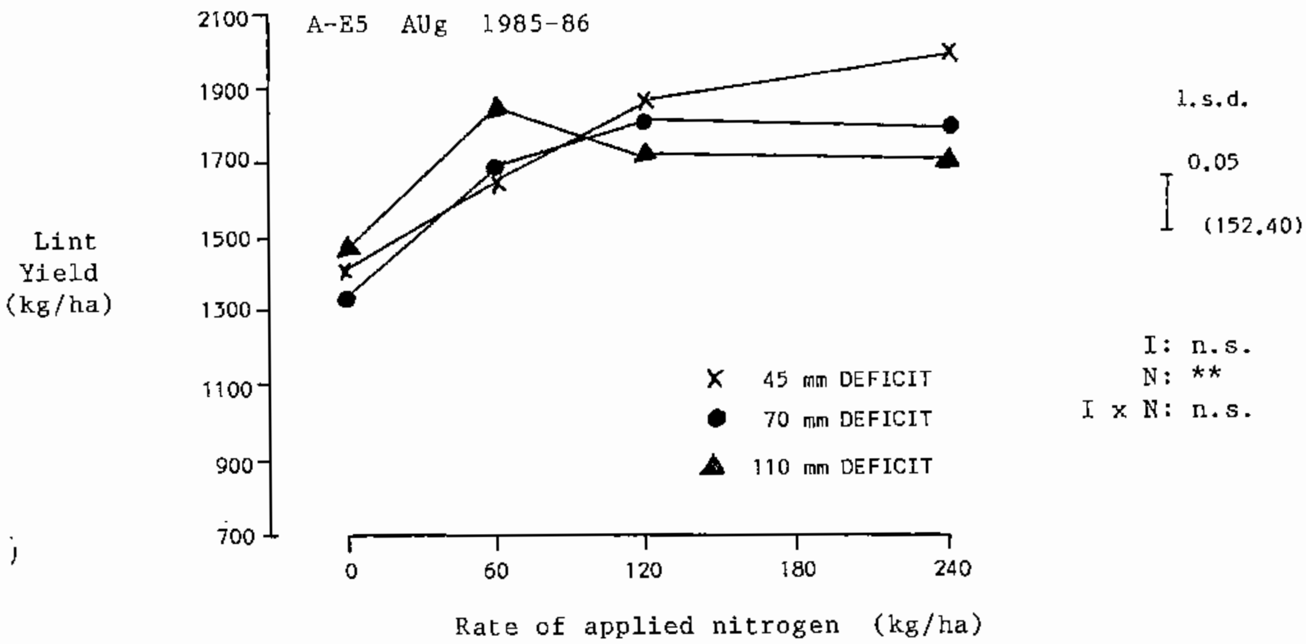


Figure 2. Cotton lint yield responses of variety Deltapine 61 to applied nitrogen rates at 4 irrigaton frequencies for 3 soils in 1984-85.



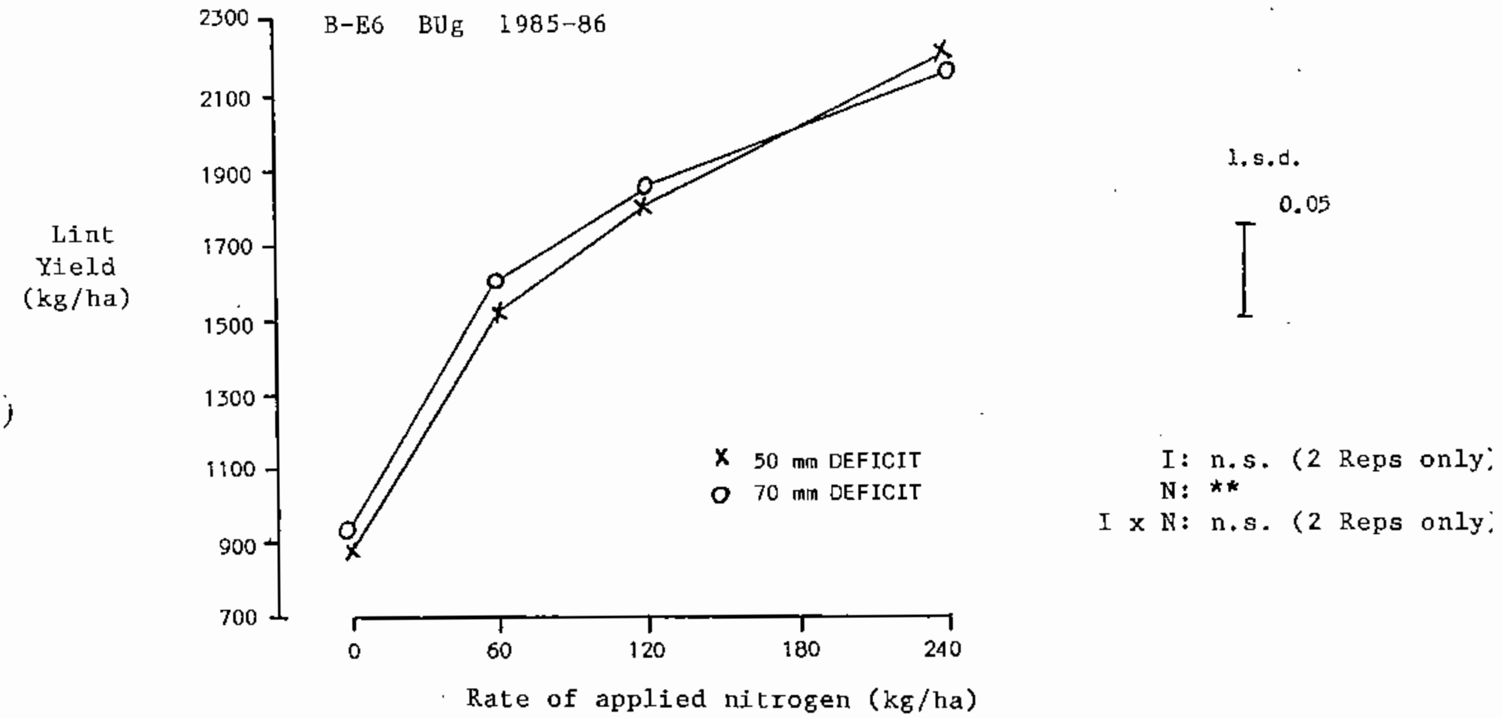


Figure 3. Cotton lint yield responses of variety Deltapine 61 to applied nitrogen rates and irrigation frequencies for two soils in 1985-86.

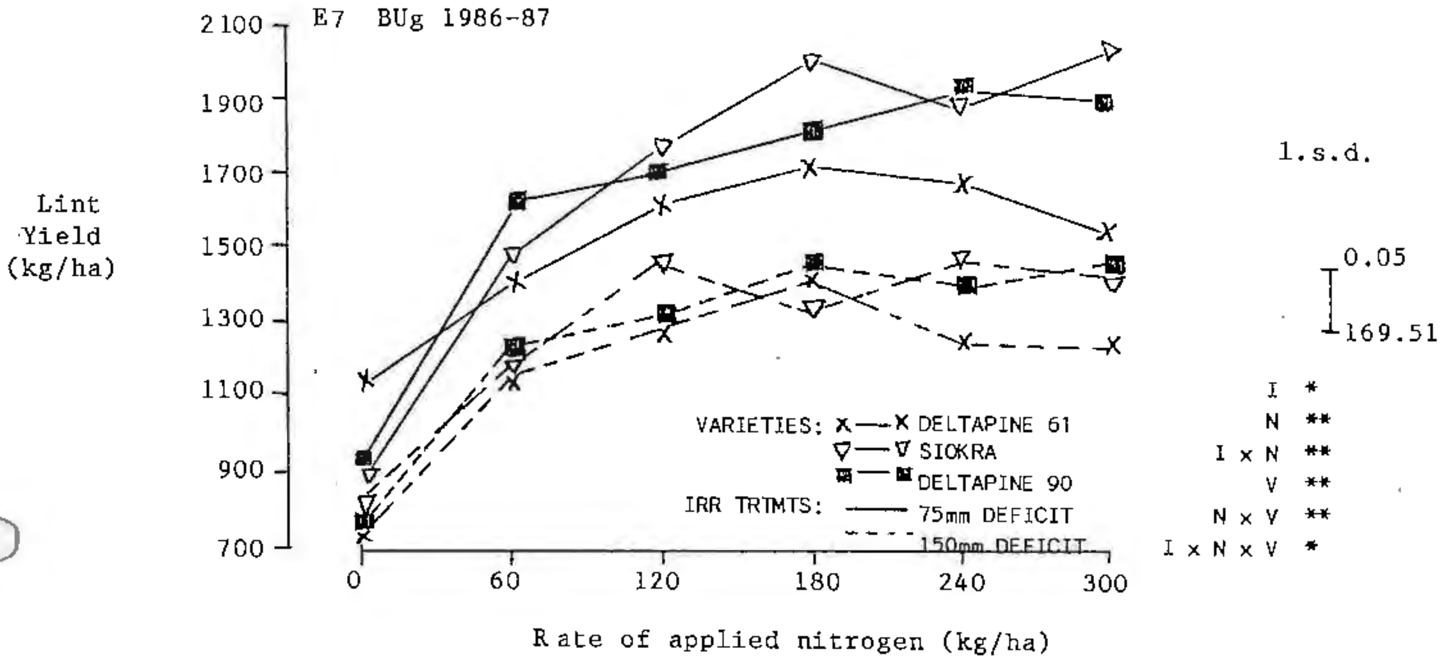


Figure 4. Cotton lint yield responses to applied nitrogen rates for three cultivars on a BUg soil in 1986-87.

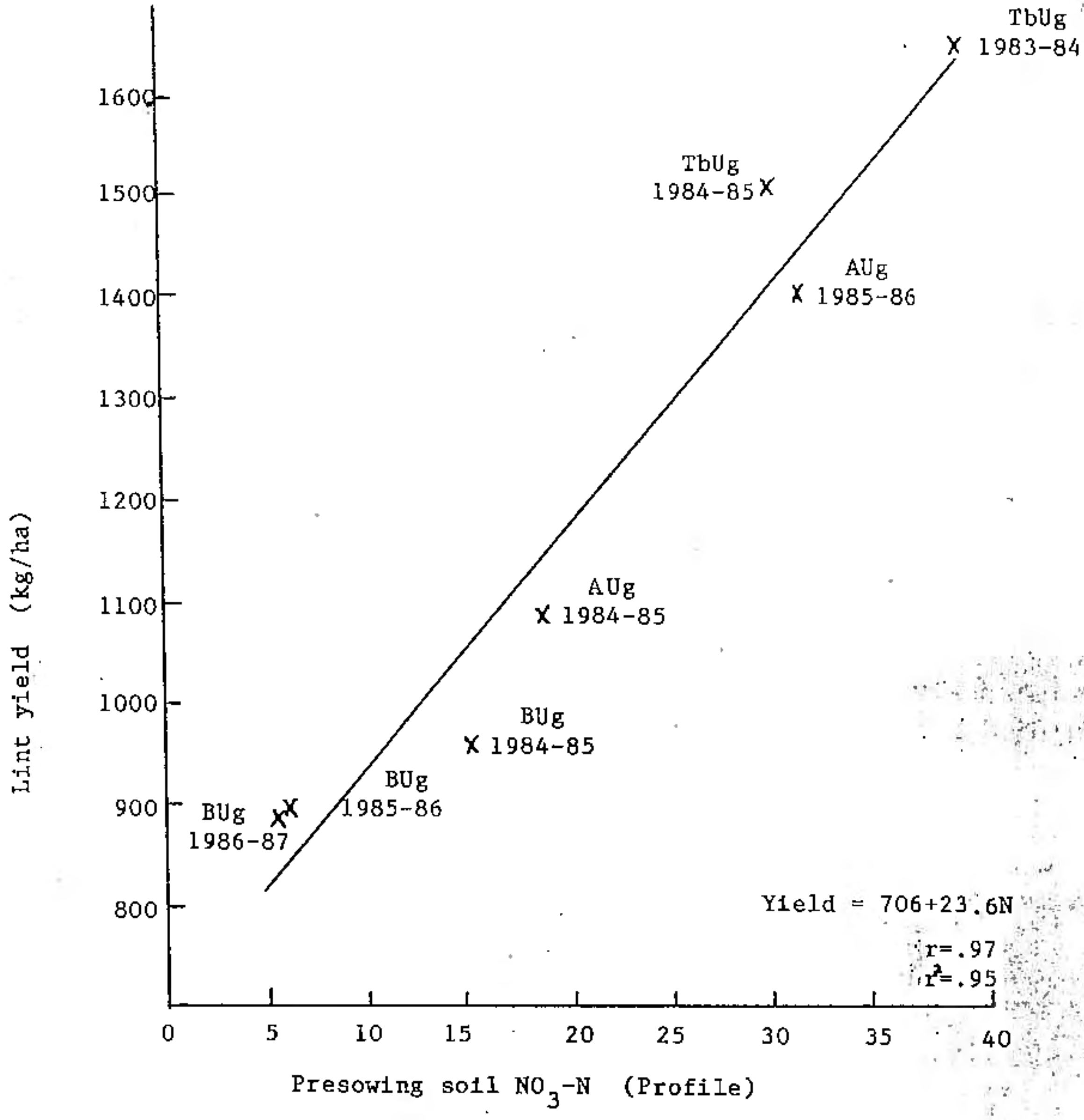


Figure 5. Presowing soil nitrate levels and yields of the zero N treatments for all sites in 1984-85 and 1985-86 seasons.

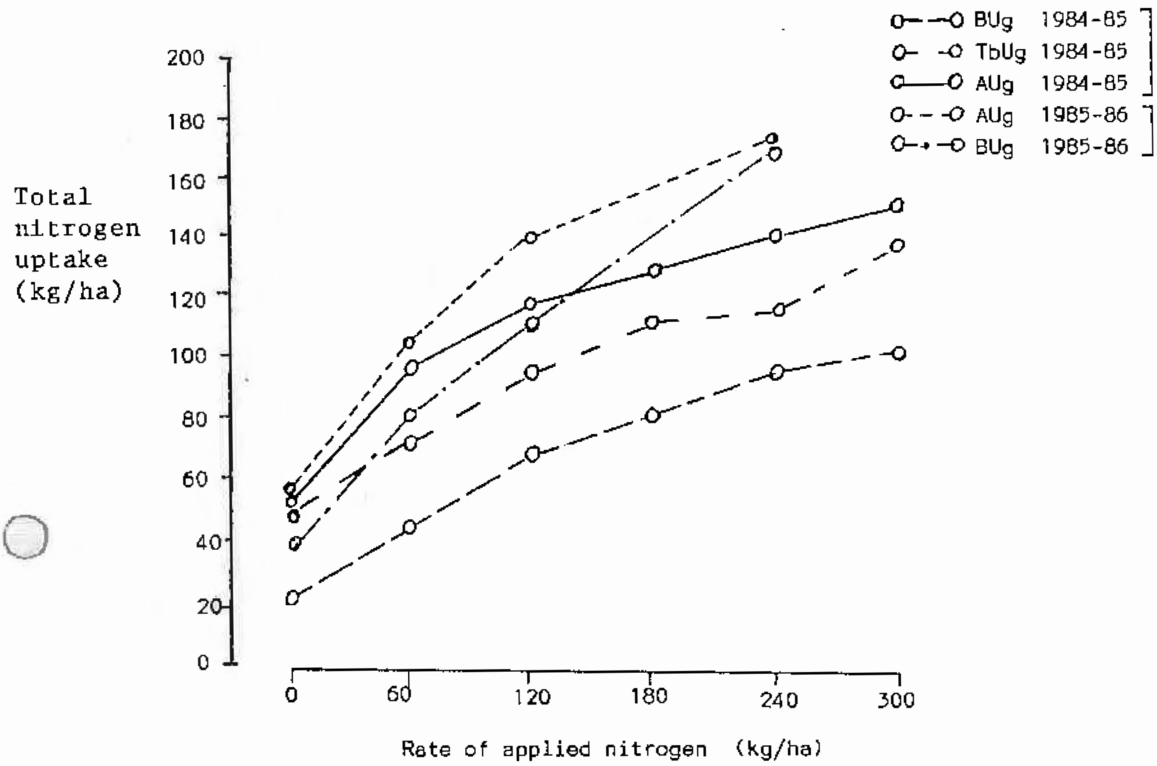


Figure 6. Total nitrogen uptake of cotton variety Deltapine 61 at different nitrogen application rates in 1984-85 and 1985-86.

Linear correlations:	r^2	gradient (slope)
BUg 1984-85	.96	.2740
TbUg 1984-85	.96	.2887
AUg 1984-85	.88	.3053
AUg 1985-86	.91	.4787
BUg 1985-86	.99	.5454

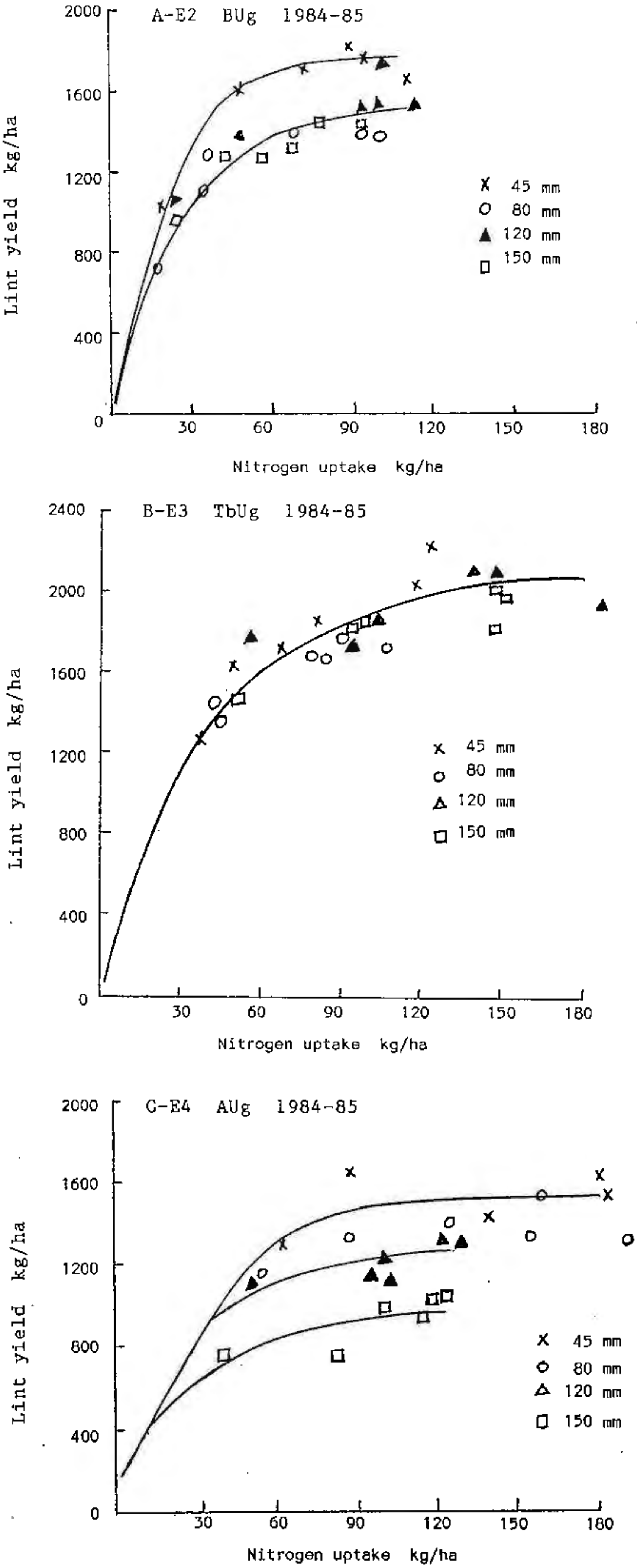


Figure 7. Relationships between lint yields and nitrogen uptake at Peak LAI on three soils in the 1984-85 season.

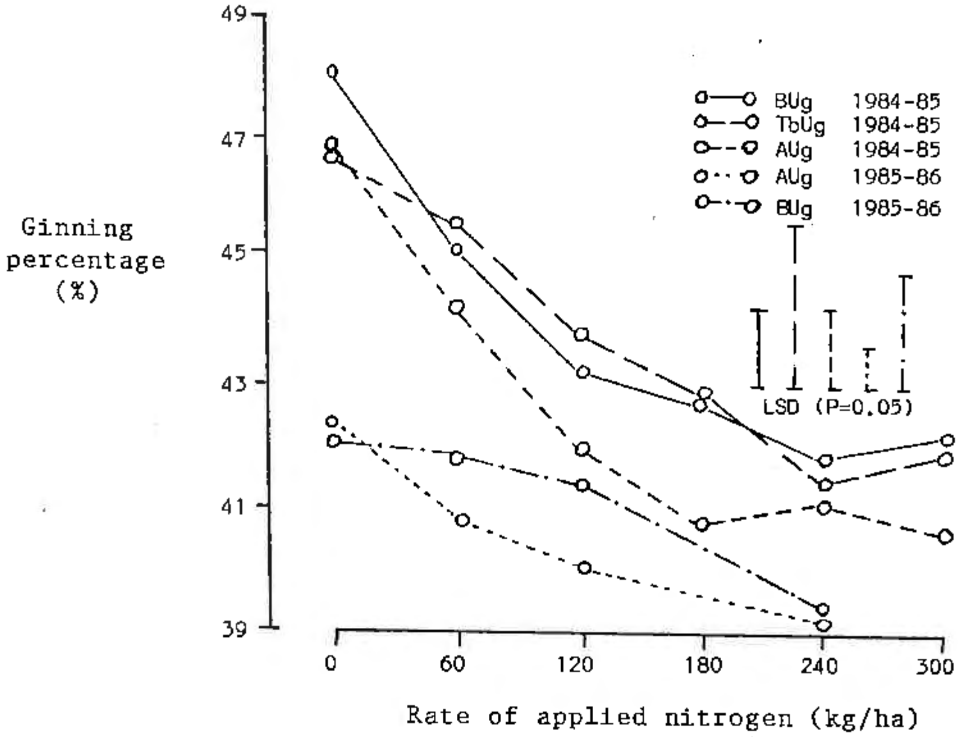


Figure 8. Ginning percentage responses of variety Deltapine 61 to applied nitrogen rates at five sites in 1984-85 and 1985-86.

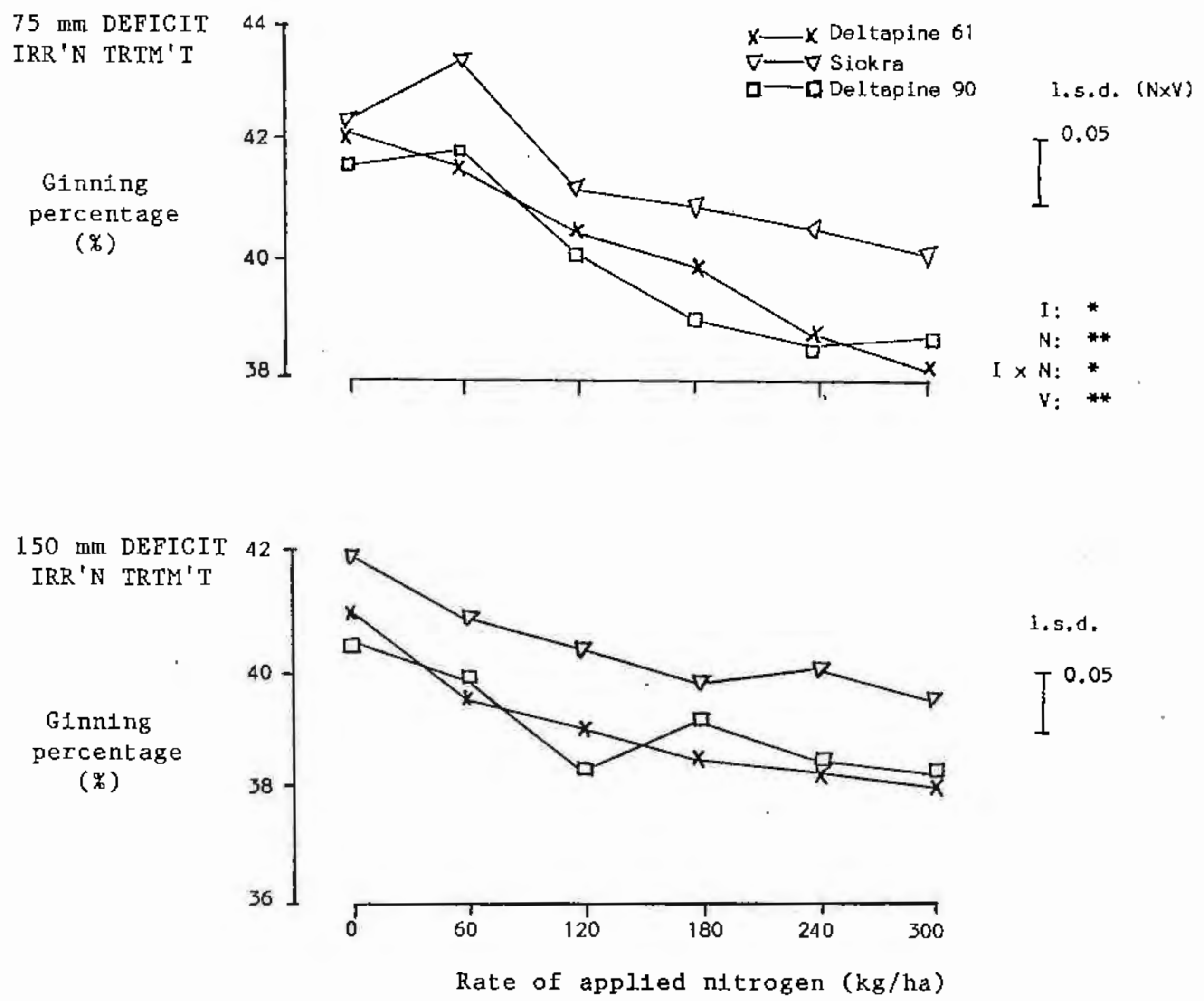


Figure 9. Ginning percentage responses to applied nitrogen rates for three cultivars on a BUg soil in 1986-87.

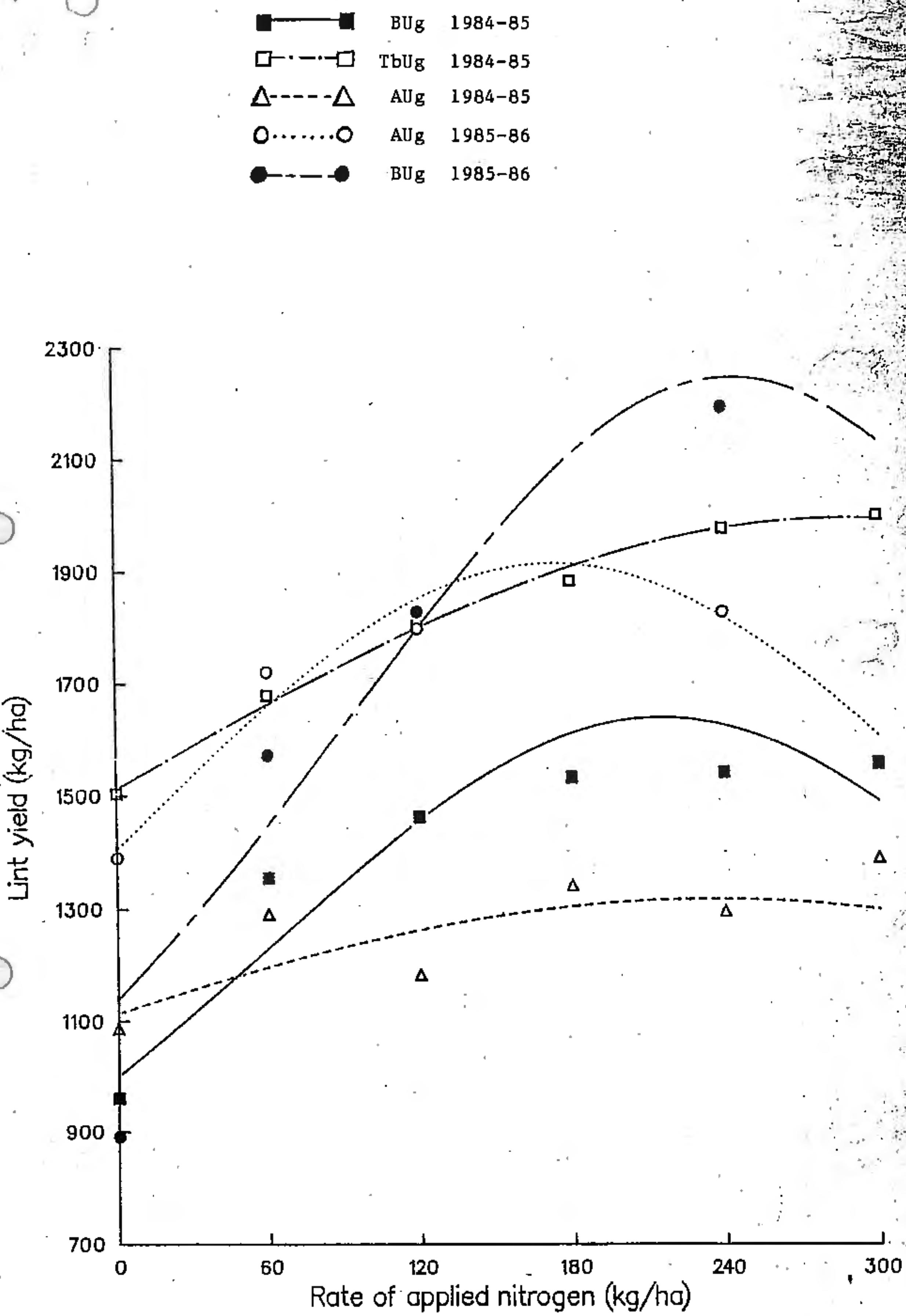
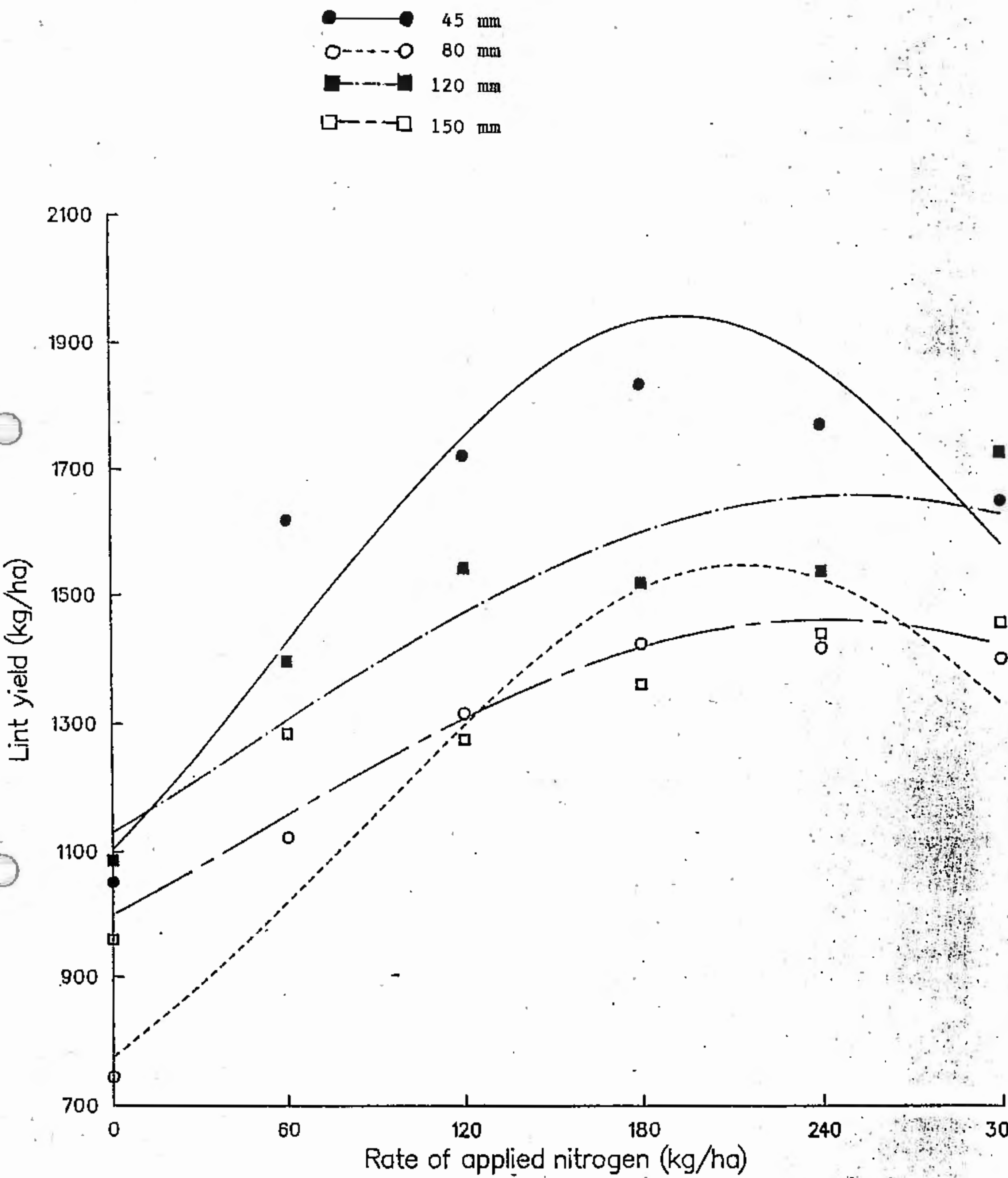
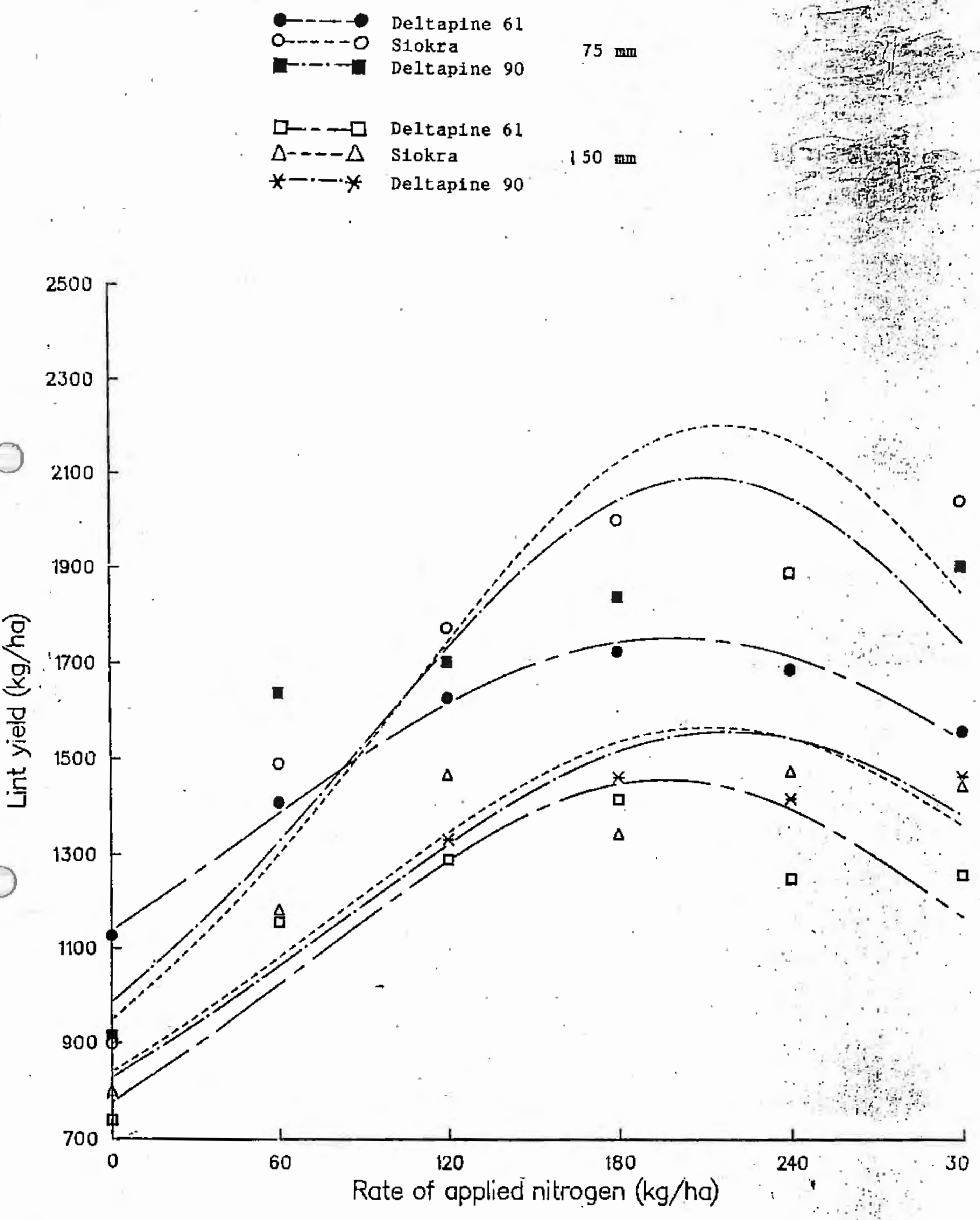

BUg 1984-85
TbUg 1984-85
AUg 1984-85
AUg 1985-86
BUg 1985-86
Lint yield (kg/ha)
2300
2100
1900
1700
1500
1300
1100
900
700
0
60
120
180
240
300
Rate of applied nitrogen (kg/ha)

Figure 1.



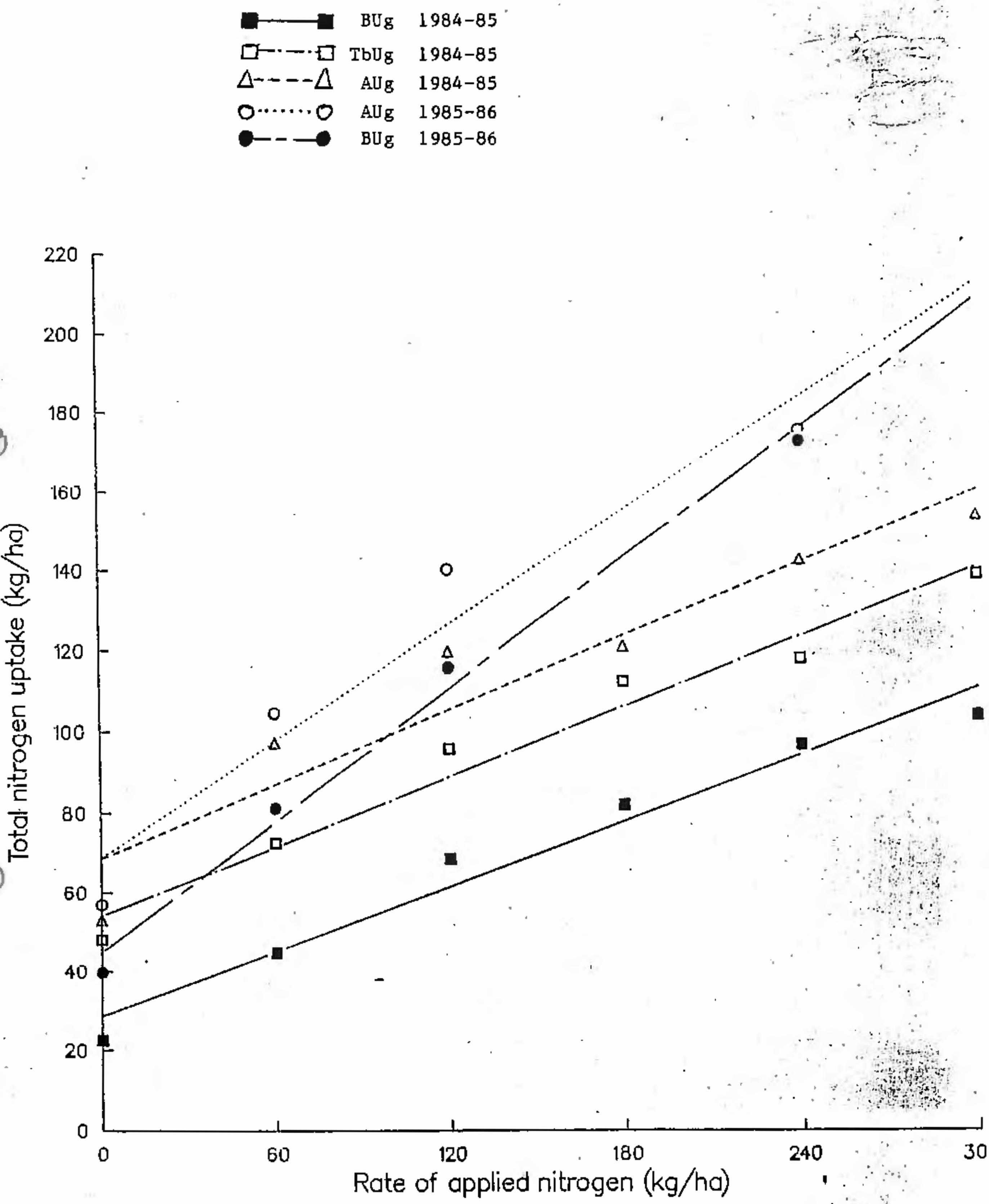
45 mm
80 mm
120 mm
150 mm
2100
1900
1700
1500
1300
1100
900
700
Lint yield (kg/ha)
0
60
120
180
240
30
Rate of applied nitrogen (kg/ha)

Figure 2.



Deltapine 61
Siokra
Deltapine 90
75 mm
Deltapine 61
Siokra
Deltapine 90
150 mm
2500
2300
2100
1900
1700
1500
1300
1100
900
700
Lint yield (kg/ha)
0
60
120
180
240
30
Rate of applied nitrogen (kg/ha)

Figure 3.



BUg 1984-85
TbUg 1984-85
AUg 1984-85
AUg 1985-86
BUg 1985-86
220
200
180
160
140
120
100
80
60
40
20
0
Total nitrogen uptake (kg/ha)
0
60
120
180
240
30
Rate of applied nitrogen (kg/ha)

Figure 6.

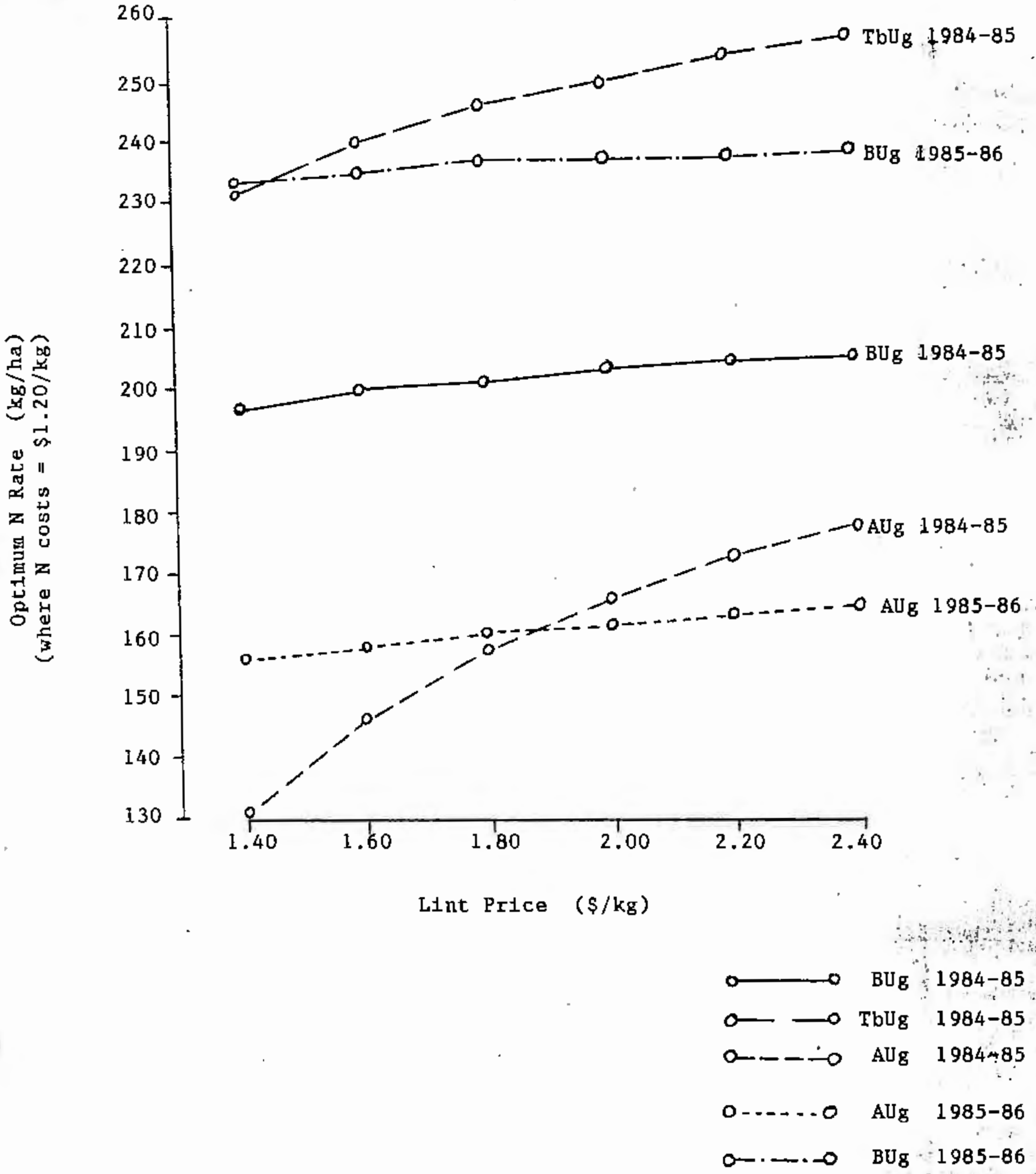


Figure 7. Response of optimum N rate to changes in lint price (where N costs are fixed at $1.20) for cultivar. Deltapine 61 at five sites in 1984-85 and 1985-86