F.R.I. PROJECT RECORD

NO. 1629

THE USE OF PHOSPHATE ROCK IN THE ESTABLISHMENT OF RADIATA PINE

- REPORTS FROM SEVEN TRIALS -

COMPILED
BY

M.F. SKINNER
E.D. ROBERTSON

REPORT NO. 14 SEPTEMBER 1987

Note: Confidential to Participants of the National Forest Fertilising Co-operative Program

: This material is unpublished and must not be cited as a literature referance

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CONTENTS

PREFACE

The research presented in the following papers was supported financially and otherwise by;

Carter Holt Harvey Forests Ltd
Timberlands Auckland District
Northern Pulp Ltd
Shell Forestry Ltd

Initially the results were detailed in confidential reports available only to these companies. However, the companies have now wholeheartedly endorsed the release of these reports to the National Forest Fertilising Cooperative.

Ak850 SERIES: ROCK PHOSPHATE AT ESTABLISHMENT

Ak850 SERIES: ROCK PHOSPHATE AT ESTABLISHMENT

MANAGEMENT SUMMARY

1. APPLY 115 KG P/HA AS A PAPR PRODUCT AT TIME-OF-PLANTING OR 145 KG P/HA AS THE FINELY GROUND UNREATIVE MATERIAL

2. AT AGE 3 APPLY 200 KG BOTH FOR UREA AND POTASSIUM CHLORIDE

3. REPEAT THE N APPLICATION AT AGE 6

This recommendation is based on early work with phosphate rock. Later work with types of PR (reactive/unreactive) and rates of PR show that marked reductions in application rates are possible. Trial Ak920 (Types Trial) on Te Kopuru Sand indicates a rate of 100 kg P/ha or less. Ak925/1 (Rates Trial) indicates still further reductions are possible. The Rates trials will be at age 6 in 1989.

INTRODUCTION

In the Auckland region, phosphorus has been the dominant nutrient deficiency in plantation forestry since the early 1950's. The nutritional needs of young radiata pine from time-of-planting are currently met with soluble fertilisers such as superphosphate and the ammonium phosphates. The life of these fertilisers is short. The problem lies in a mis-match of fertiliser solubility with the trees' nutrient requirements. The highly soluble fertilisers release too much nutrient too quickly. Within the first few years when the tree begins to make sustained demands on the soil for nutrients, the applied fertiliser is very much less effective (Hunter and Skinner, 1986).

Ground phosphate rock (GPR) is an "insoluble" source of P compared with the superphosphates. The work reported here was aimed at assessing the potential of phosphate rock to replace the superphosphates in establishment forestry.

MATERIALS AND METHODS

A series of cooperative trials were established in Northland, Auckland, Westland and Nelson to cover a range of soils with low to high P-fixing capacities. This report covers Ak850/1.

The site

The Morehurehu Block (Carter holt Harvey) at Te Kao was selected for the trial. The area is flat, with many "gum holes". The soil ,Te Kopuru Sandy Loam, had a light cover of manuka and wiwi rush. The site was prepared by rotary slashing in lines at 3m centres. The site was burnt 20.3.80. The fertilisers (see later) were applied and the site ripped and bedded 1.5.80

The trial

The design allows for the main effects of a basal application of P in combination with small "starter" doses of N,P and K, and the timing of a later application of soluble fertiliser (NPK) to be measured. The main treatments were:

1. control
2. 145 kg P/ha as GPR (Christmas A/Nauru A, 1:1 w/w at 14% P; 1 tonne/ha)
3. 115 kg P/ha as a 1:1 mix (w/w) of superphosphate and GPR.

The main treatments were replicated 3 times and randomly assigned to 9 plots. Each main plot accommodated 2 complete factorial designs in N,P and K applied (5 g/tree) at time-of-planting as spade slit applications. In the third growing season, one complete factorial was refertilised with NPK at rates of 90:100:100 kg element/ha.

THE EFFECT OF PHOSPHATE ROCK AT ESTABLISHMENT ON THE EARLY GROWTH AND NUTRITION OF RADIATA PINE

TRIAL AK850/1

M.F. Skinner

E.D. Robertson

A confidential report prepared for

Carter Holt Industries

April 1987

Soils and Site Amendment Section

Forest Management and Resouces Division

Ministry of Forestry

Forest Research Institute

RESULTS

Part A. To age 3 years

Radiata pine fertilised with the the NPK combination of nutrients at time-of-planting, in the absence of base P fertilisers, showed, by age 3, a small response to N, a larger response to P and an interaction between the N and the P (Fig.1). K had no effect on growth (Fig.2). In the presence of the GPR dressing, the effectiveness of the soluble nutrient combinations was in the order: NP>N>P>control. These differences were, however, not significant. Hereafter the NPK mix is referred to as a "starter" mix. An NP mix would have been comparable in performance.

By age 3 trees treated with GPR were 2 metres in height. With the GPR/Super mix the gain was 0.2 metres. In the presence of the "starter" mixes the gains were about 0.3 metres for both base P treatments (Fig.1).

Trees treated with the starter mix alone were, by age 2-3 comparable with the GPR and GPR/Super with or without starter doses (Fig.1). Between ages 2-3, trees treated with the starter mix alone showed a rapid decline in foliar P compared with the GPR treatments (Fig.3) In the third growing season, foliar N and P concentrations in the GPR treatments were satisfactory at 1.4% N and 0.14% P.

Part B. From age 3 (refertilisation) to age 6

The results for basal area and volume production are given in Figures 4 and 5 respectively. Foliar nutrient concentrations for N, P and K are given in Figures 6,7 & 8 respectively.

By age 6 radiata pine fertilised with either GPR or GPR/Super averaged 12.5 m2/ha and about 45 m3/ha, and had responded to NPK applied at age 3. The gains to refertilisation were 2.5 m2/ha (GPR) and 5 m2/ha (GPR/Super). The volume gains were 14 and 23 m3/ha respectively. The differences in productivity between the 2 base dressings after refertilisation were not statistically significant.

The effect of the NPK mix after age 3 appears to be due largely to the N and K component. Foliar P concentrations were above the critical level of 0.11% for both the GPR and GPR/Super treatments and elevated by 0.02-0.03% after the NPK addition. Both Foliar N and K had declined to deficiency levels between ages 3 and 6 in the unrefertilised treatments.

DISCUSSION

Te Kopuru Sand is extremely infertile with little capacity to retain soluble fertiliser. Early trials with soluble fertilisers (Hunter and Skinner, 1986) showed nutrient deficiencies in N,P and K after the first 2-3 years.

Trial Ak850/1 demonstrates that broadcast GPR is an alternative strategy to the use of soluble fertiliser at time-of-planting. Both the GPR and the GPR/Super mix (which mimics the PAPR type products recently available on the NZ market) gave comparable growth through to age 6. Both treatments responded to NPK additions at age 3. The gains to the NPK mix can be largely ascribed to nitrogen and potassium.

The Economics of the phosphate rock strategy

For this exercise the costs (Present Value) are through to age 6. The interest rate used was 10%. Several strategies are presented and compared. The strategies compare the existing management schedule (DAP and KCl) with GPR and PAPR. The difference in the rate of P applied between GPR (150 kg P/ha) and a PAPR product (115 kg P/ha) reflects the nature of Ak850/1 where 1 tonne GPR/ha and 1 tonne of a GPR/Super mix were used. Starter doses of NP are also presented with the GPR strategy based on 50% of the current application of DAP at establishment.

STRATEGY A

At establishment		Cost ($)
80 g DAP/seedling (1500/ha)		72
application		40
	Total	112

Age 3

500 kg DAP		280
application		65
200 kg KCl		60
application		65
	Total	470

Age 6

500 kg DAP		280
application		65
	Total	345

$$PV = 112/\ (1+0.1)^{0} + 470/(1+0.1)^{3} + 345(1=0.1)^{6}$$

$$= \$\ 660$$

STRATEGY B

At establishment

apply 1 tonne GPR (assume 15% P)	200
application	65
Total	265

Age 3

apply 200 kg KCl	60
application	65
apply 200 kg urea	80
application	65
Total	270

Age 6

apply 200 kg urea	80
application	65
Total	145

$$PV = 265/(1+0.1)^{0} + 270/(1+0.1)^{3} + 145/(1+0.1)^{6}$$

$$= \$ 550$$

STRATEGY C

At establishment

apply GPR at 1 tonne/ha (assume 15% P)	200
application	65
DAP at 40 g/seedling (1500/ha)	34
application	40
Total	339

Age 3

apply 200 kg KCl/ha	60
application	65
apply 200 kg urea/ha	80
application	65
Total	270

Age 6

apply 200 kg urea/ha	80
application	65
Total	145

$$PV = 339/(1+0.1)^{0} + 270/(1+0.1)^{3} + 145/(1+0.1)^{6}$$

$$= \$ 624$$

STRATEGY D

AT establishment

apply PAPR (assume 16% P) at 115 kg P/ha		227
application		65
	Total	292

Age 3

apply 200 kg KCl/ha		60
application		65
apply 200 kg urea/ha		80
application		65
	Total	270

Age 6

apply 200 kg urea/ha		80
application		65
	Total	145

$$PV = 292/(1+0.1)^{0} + 270/(1+0.1)^{3} + 145/(1+0.1)^{6}$$

$$= \$ 577$$

Summary of costs

Strategy	Comparative Cost
A	1.00
B	0.83
C	0.95
D	0.87

CONCLUSION

Trees fertilised with phosphate rock (as either the ground unreative GPR or the rock/super mix which would mimic a PAPR product) at time-of-planting on Te Kopuru Sand maintain their P nutrition above 0.11% through until at least age 6. With any of the soluble P fertilisers at least 2 applications, at establishment, and at age 3, would be required. From age 3, both N and K will limit growth. Urea (N) and potassium chloride (K) should be applied when foliar N and K levels decline to less than 1.5% and 0.3-0.4% respectively.

REFERENCES

HUNTER I.R. and SKINNER M.F. Establishing radiata pine on the North Auckland podzols. N.Z. Forestry 31 (3):17-23. 1986.

FIGURE 1

The effect of fertiliser on height growth Trial A850/1 at age 3

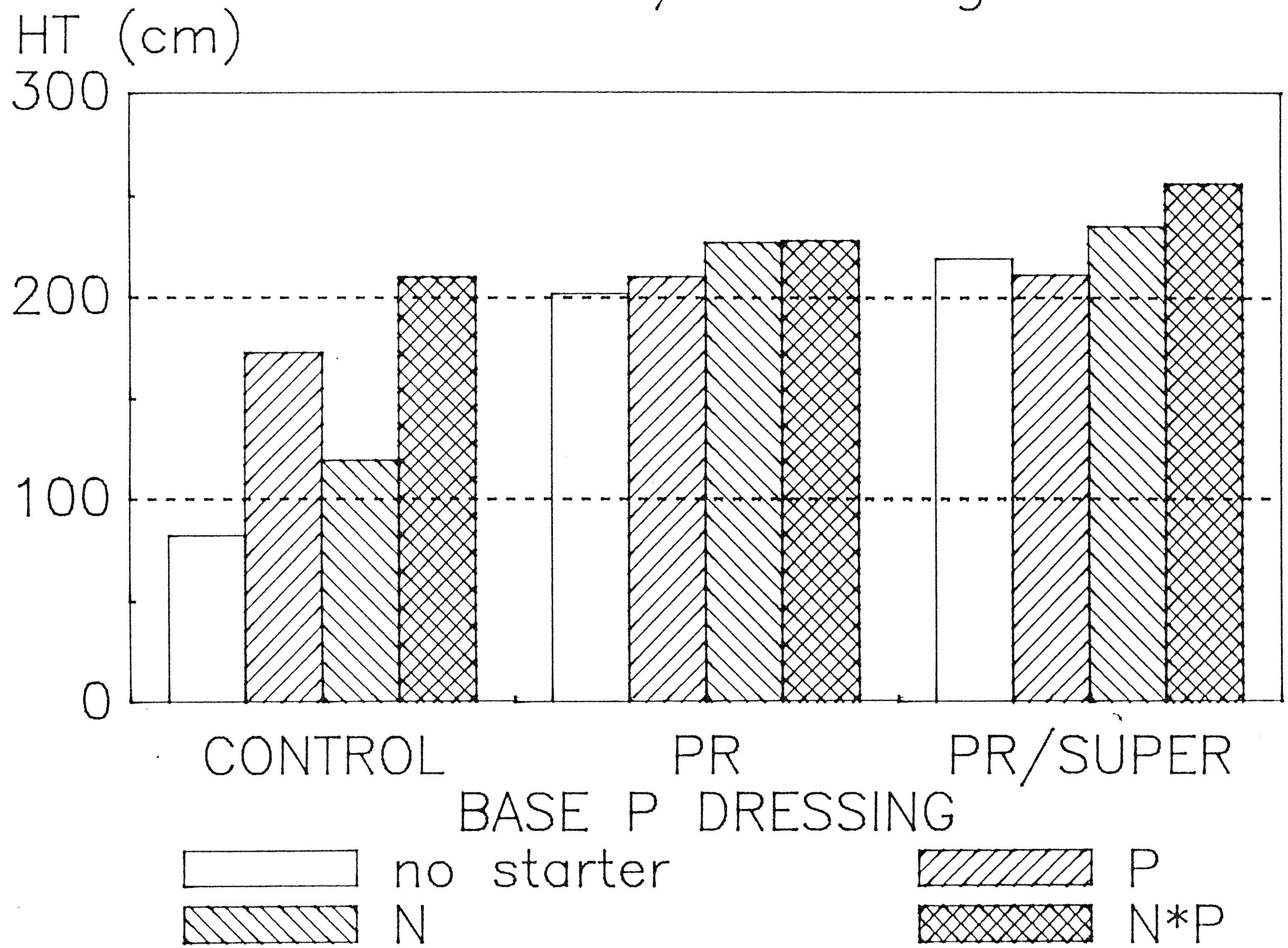


FIGURE 2

The effect of K in starter mix on foliar K
Trial A850/1

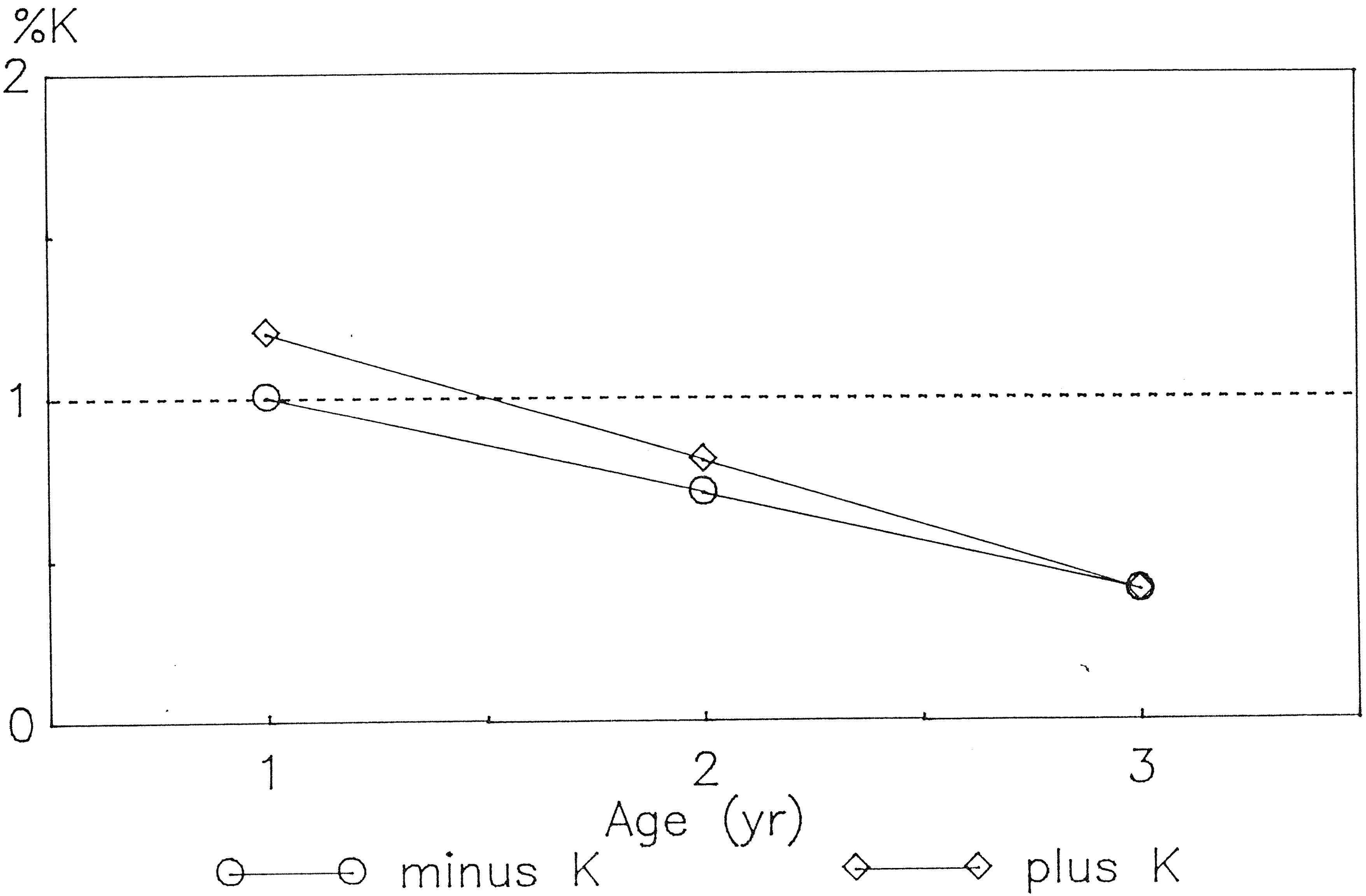
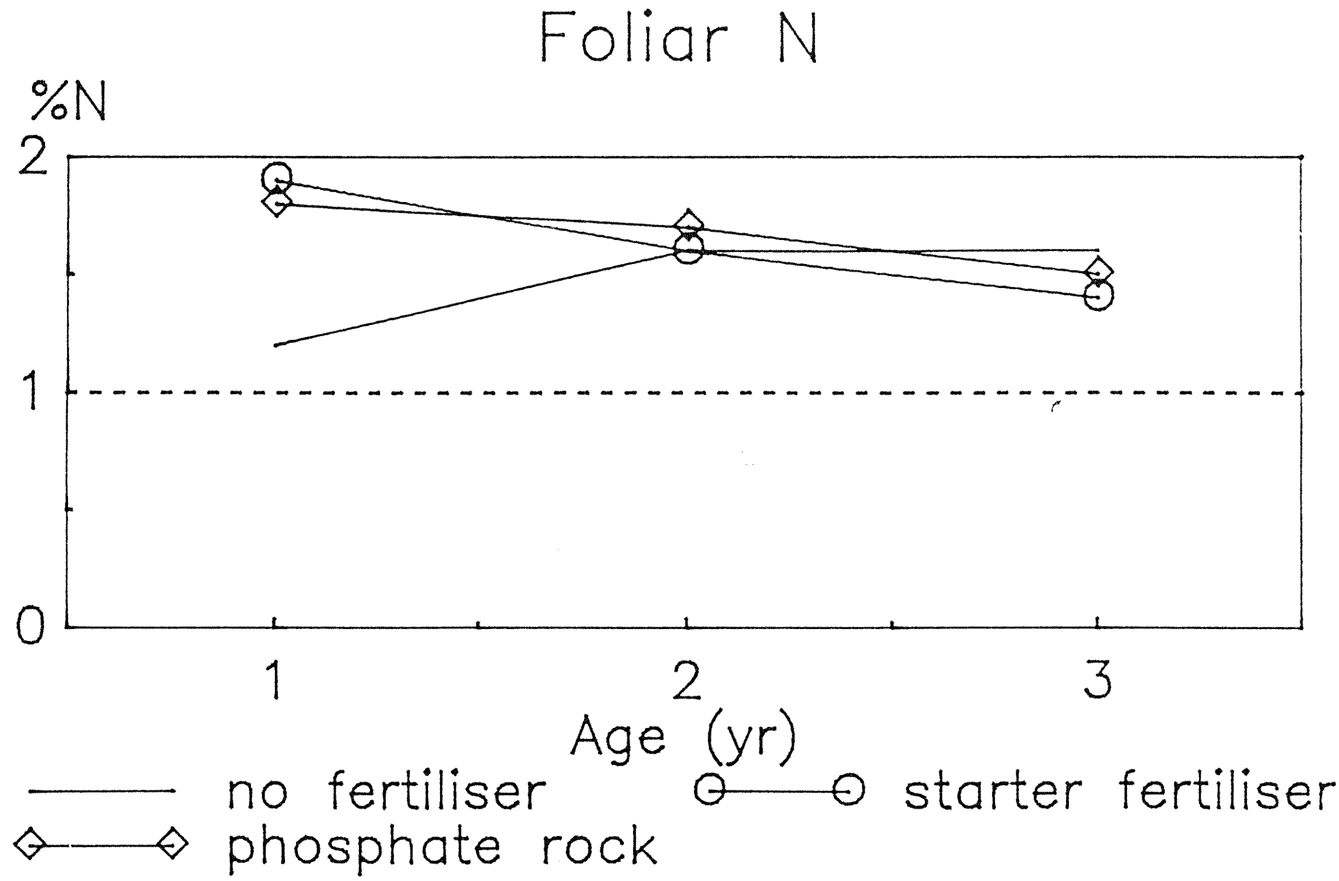


FIGURE 3


Foliar N
%N
2
1
0
1
2
3
Age (yr)
no fertiliser
starter fertiliser
phosphate rock

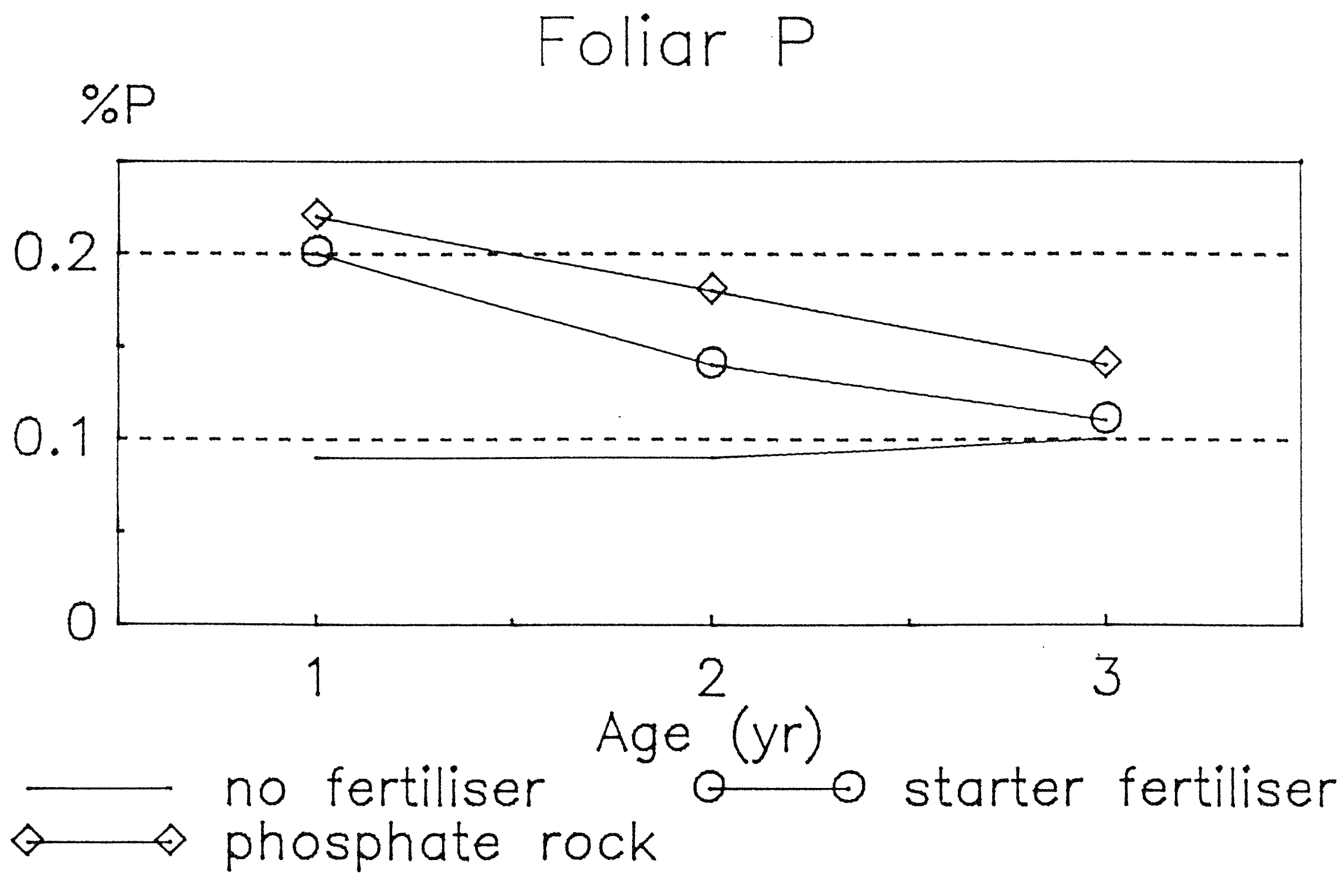

Foliar P
%P
0.2
0.1
0
1
2
3
Age (yr)
no fertiliser
starter fertiliser
phosphate rock

FIGURE 4

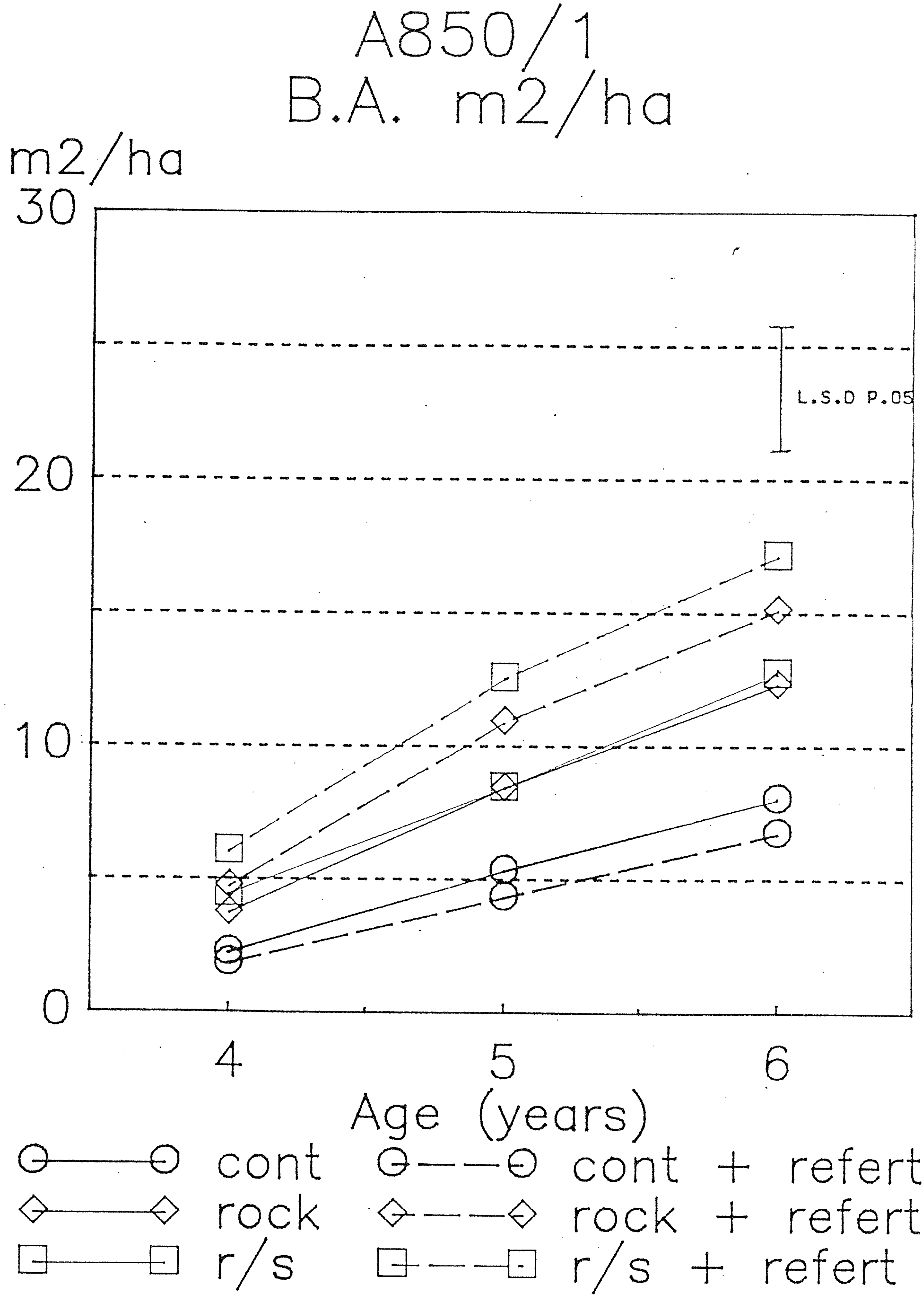
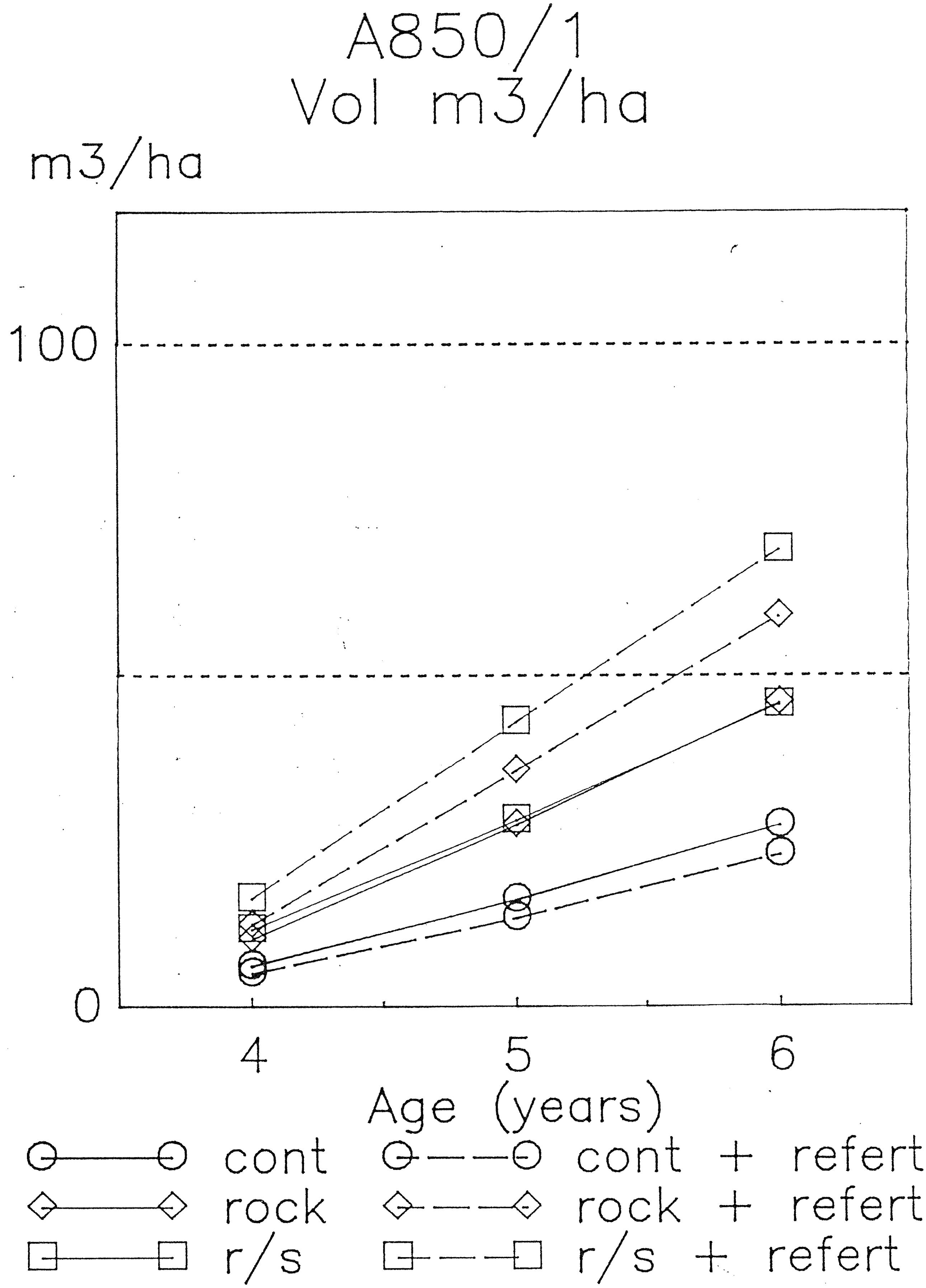
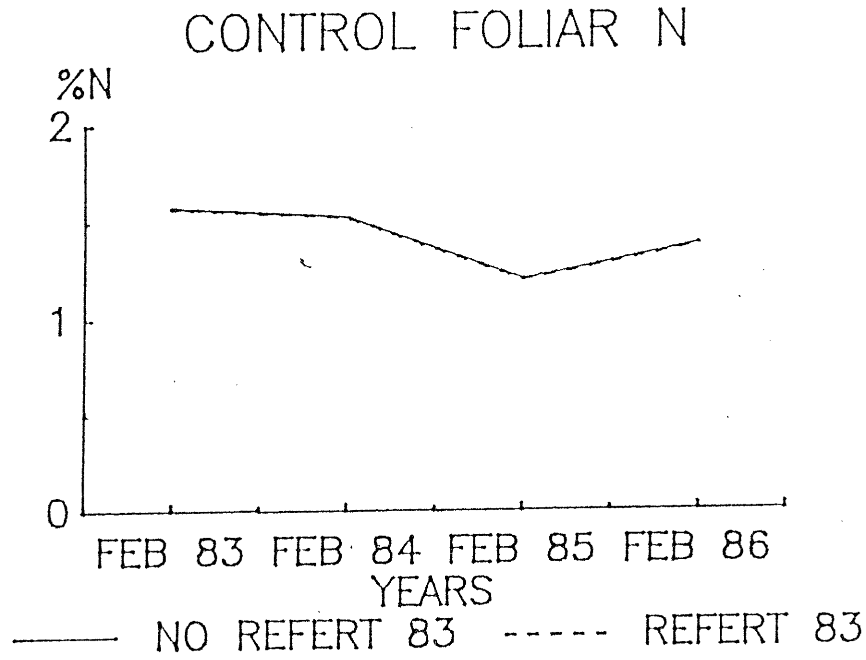

A850/1
B.A. m2/ha
m2/ha
30
20
10
0
L.S.D P.05
4
5
6
Age (years)
cont
cont + refert
rock
rock + refert
r/s
r/s + refert

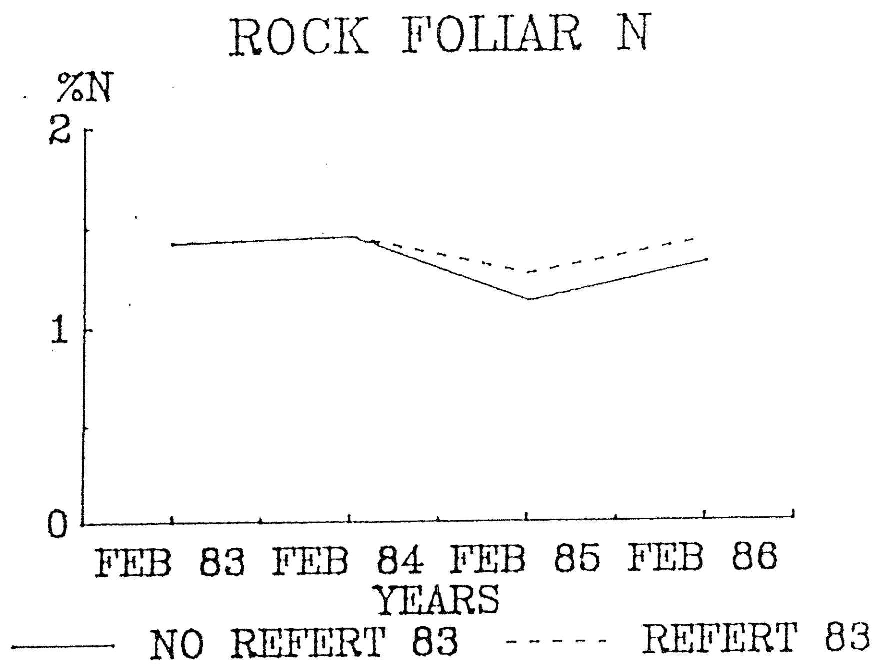
FIGURE 5



A850/1
Vol m3/ha
m3/ha
100
0
4
5
6
Age (years)
cont
cont + refert
rock
rock + refert
r/s
r/s + refert

FIGURE 6.


CONTROL FOLIAR N
%N
2
1
0
FEB 83 FEB 84 FEB 85 FEB 86
YEARS
NO REFERT 83
REFERT 83


ROCK FOLIAR N
%N
2
1
0
FEB 83 FEB 84 FEB 85 FEB 86
YEARS
NO REFERT 83
REFERT 83

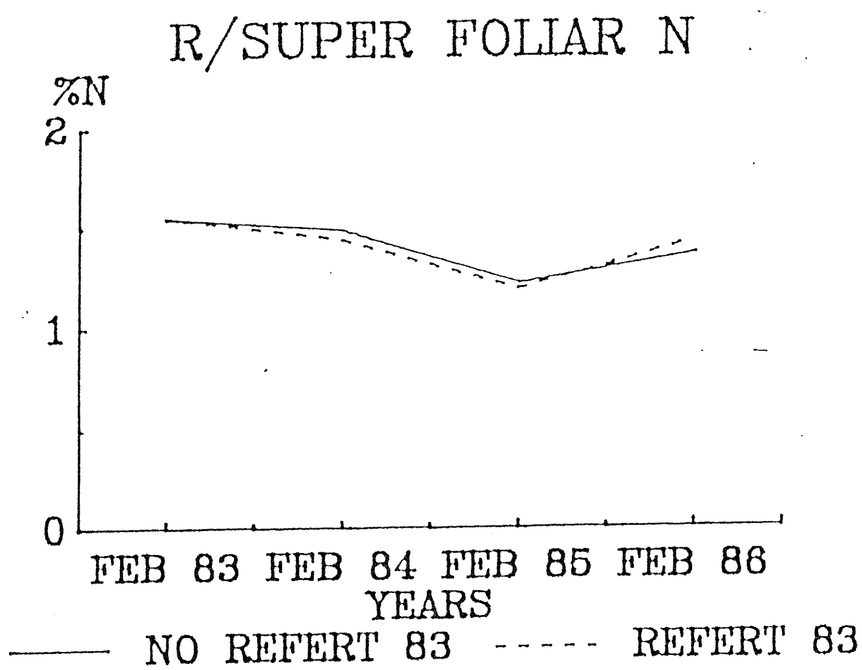
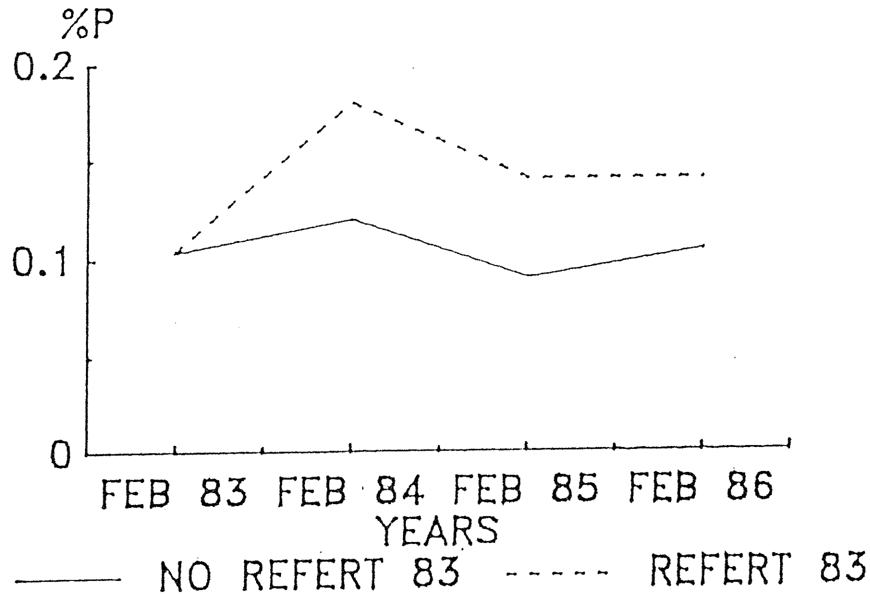

R/SUPER FOLIAR N
%N
2
1
0
FEB 83 FEB 84 FEB 85 FEB 86
YEARS
NO REFERT 83
REFERT 83

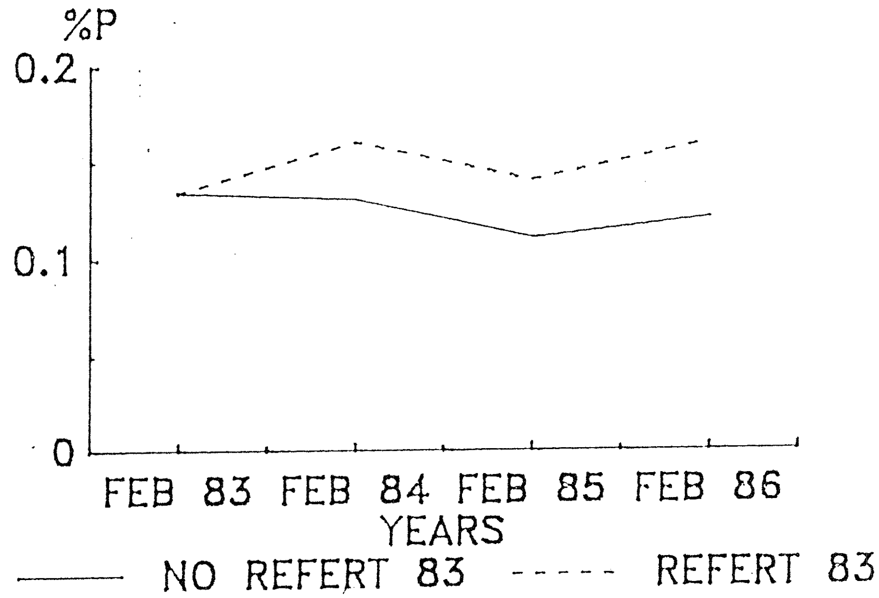
FIGURE 7

A850/1 ROCK PHOSPHATE TRIAL TE KAO.

CONTROL FOLIAR P



ROCK FOLIAR P



R/SUPER FOLIAR P

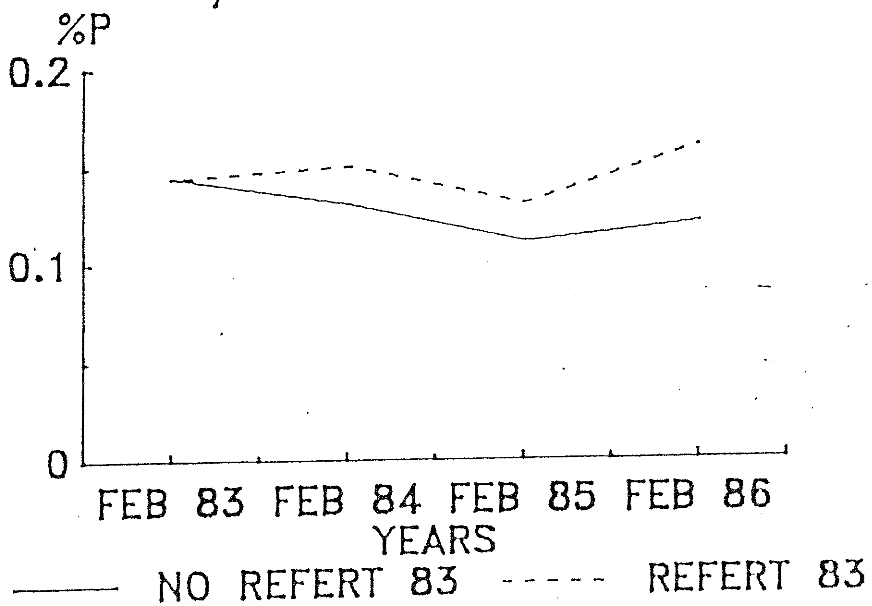
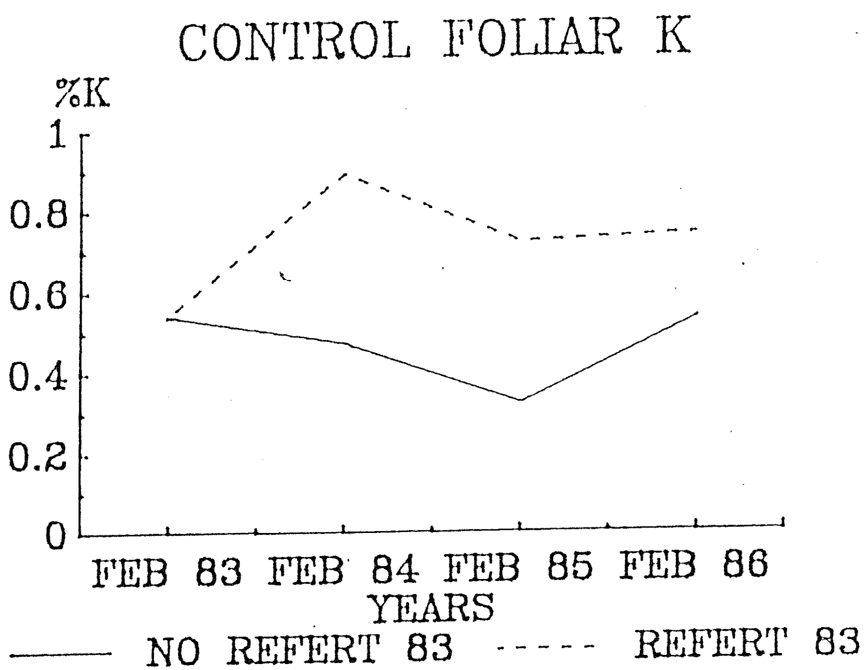
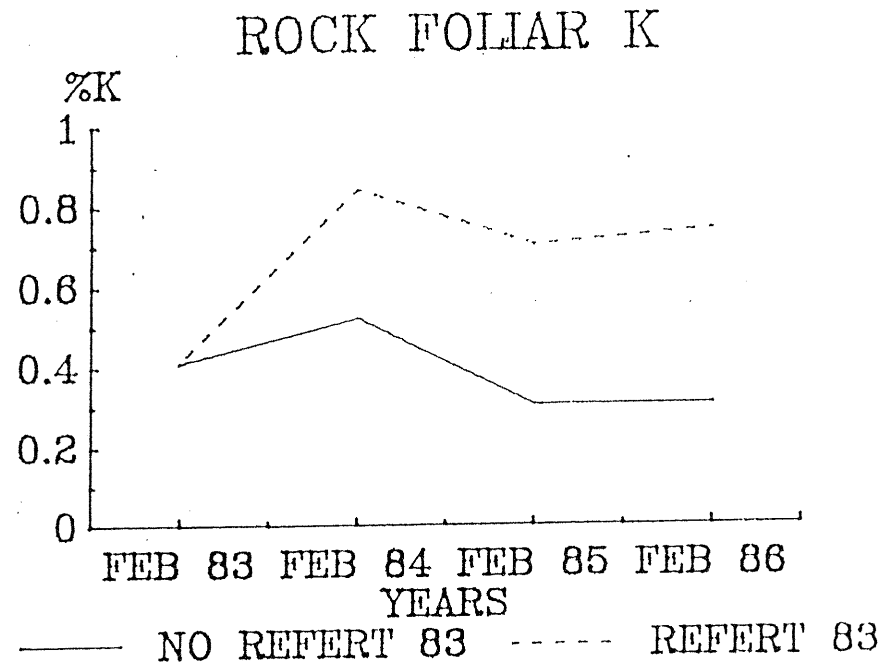
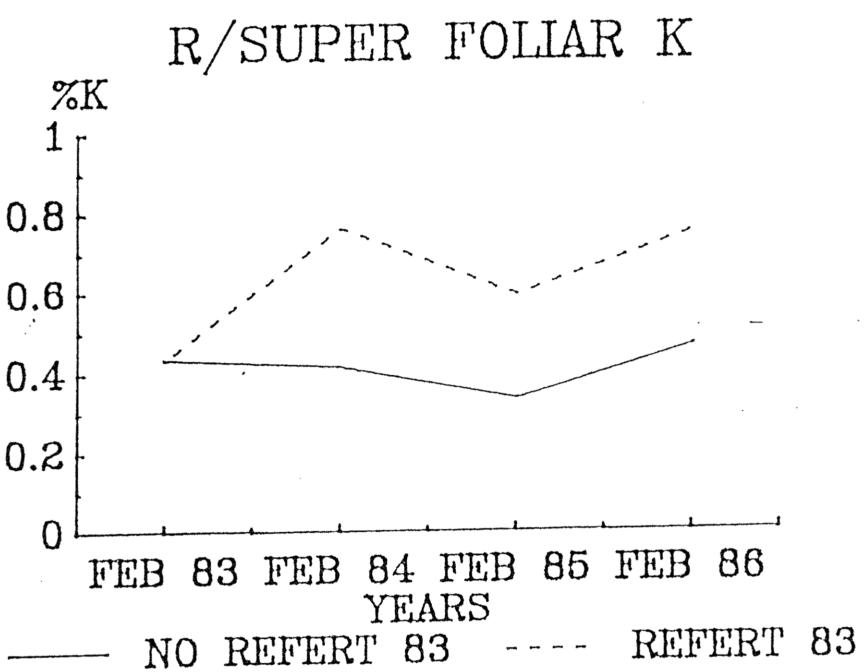


FIGURE 8


CONTROL FOLIAR K
%K
1
0.8
0.6
0.4
0.2
0
FEB 83 FEB 84 FEB 85 FEB 86
YEARS
NO REFERT 83
REFERT 83


ROCK FOLIAR K
%K
1
0.8
0.6
0.4
0.2
0
FEB 83 FEB 84 FEB 85 FEB 86
YEARS
NO REFERT 83
REFERT 83


R/SUPER FOLIAR K
%K
1
0.8
0.6
0.4
0.2
0
FEB 83 FEB 84 FEB 85 FEB 86
YEARS
NO REFERT 83
REFERT 83

THE EFFECT OF PHOSPHATE ROCK AT ESTABLISHMENT ON THE EARLY GROWTH AND NUTRITION OF RADIATA PINE

TRIAL AK850/2

M.F. Skinner

E.D. Robertson

A confidential report prepared for
New Zealand Forest Products Ltd

April 1987

Soils and Site Amendment Section
Forest Management and Resouces Division
Ministry of Forestry
Forest Research Institute

MANAGEMENT SUMMARY

1. APPLY 115 KG P/HA AS A PAPR PRODUCT AT TIME-OF-PLANTING.

2. MONITOR FOLIAR N AND K LEVELS FROM AGE 4 APPLY UREA WHEN N < 1.5% AND POTASSIUM CHLORIDE WHEN K < 0.4%.

This recommendation is based on early work with phosphate rock. More recent trials indicate that the above rates can be substantially reduced. Further recommendations will be available in 1989 when the Ak925 series of Rates Trials reaches age 6.

INTRODUCTION

In the Auckland region, phosphorus has been the dominant nutrient deficiency in plantation forestry since the early 1950's. The nutritional needs of young radiata pine from time-of-planting are currently met with soluble fertilisers such as superphosphate and the ammonium phosphates. The life of these fertilisers is short. The problem lies in a mis-match of fertiliser solubility with the trees' nutrient requirements. The highly soluble fertilisers release too much nutrient too quickly. Within the first few years when the tree begins to make sustained demands on the soil for nutrients, the applied fertiliser is very much less effective (Hunter and Skinner, 1986).

Ground phosphate rock (GPR) is an "insoluble" source of P compared with the superphosphates. The work reported here was aimed at assessing the potential of phosphate rock to replace the superphosphates in establishment forestry.

MATERIALS AND METHODS

A series of cooperative trials were established in Northland, Auckland, Westland and Nelson to cover a range of soils with low to high P-fixing capacities. This report covers Ak850/2.

The site

The trial is sited on the Maramaku Block (NZ Forest Products Ltd) on a Wharakohe/Hukerenui silty loam complex. The site was roller crushed and burnt in 1979. The area was cultivated in 1980. Cultivation was at 3 metre centres at right angles to the contour.

The trial

The design allows for the main effects of a basal application of P in combination with small "starter" doses of N, P and K, and the timing of a later application of soluble fertiliser (NPK), to be measured. The main treatments were:

1. control
2. 140 kg P/ha as GPR (Christmas A/Nauru A, 1:1 w/w at 14% P; 1 tonne/ha)
3. 115 kg P/ha as a 1:1 mix (w/w) of superphosphate and GPR.

The main treatments were replicated 3 times and randomly assigned to 9 plots. Each main plot accommodated 2 complete factorial designs in N,P and K applied (5 g/tree) at time-of-planting as spade slit applications. In the third growing season, one complete factorial was refertilised with NPK at rates of 90:100:100 kg element/ha.

RESULTS

Part A. To age 3 years

i. The effect of the "starter" nutrients on growth

In the absence of the base P dressing, the "starter" nutrients improved the growth of radiata pine over the unfertilised controls. The K component of the mix had no effect on growth, and the results for the + and - K treatments have been averaged with the N*P results. By age 3 trees treated with P averaged 2 m in height (Fig.1). The N*P combination improved growth by a further 0.5 m. N alone treated trees were similar to the controls (at 1.5 m). K had no effect on maintaining foliar K levels above the NP treatment (Fig.2). Between ages 2 and 3 trees treated with the starter mix alone showed a rapid decline in foliar P (Fig.3).

ii. Base P dressings and tree growth

Trees treated with the "starter" mix alone were, by age 3, comparable with the GPR and GPR/Super treatments irrespective of whether or not starter doses were used (Fig.1).Between ages 2 and 3 the GPR and GPR/Super treatments maintained foliar P and N levels at 0.14% and 1.5% respectively (FIg.3).

Part B. From age 3 (refertilisation) to age 6

The results for Basal Area and Volume production are given in Figures 4 and 5 respectively. Foliar nutrient concentrations for N, P and K are given in Figures 6,7 & 8 respectively.

By age 6 radiata pine fertilised with GPR averaged 20 m2/ha basal area and 86 m3/ha. With the GPR/Super mix there were gains of 7 m2/ha and 27 m3/ha. The addition of NPK at age 3 improved growth only in the GPR treatment. The was no growth improvement in the GPR/Super treatment. The GPR treatment after refertilisation with NPK was similar to the GPR/Super treatment alone.

The difference in productivity between the GPR and the GPR/Super treatment by age 6 is associated with poorer N nutrition in the GPR treatment, where N had declined to 1.2% by age 6.

Foliar P concentrations were above the critical level of 0.11% for both the GPR and GPR/Super treatments and elevated by 0.02-0.03% after the NPK addition. Foliar K values remained satisfactory in all cases.

DISCUSSION

Trial Ak850/2 shows broadcast GPR to be an alternative strategy to the use of soluble fertiliser (e.g superphosphate) as a slit application at time-of-planting. With GPR alone growth through to age 6 was limited by N. With the GPR/Super mix, the N restraint was not recorded. The reasons for this difference can only be guessed at. The soluble P component in the mix may have encouraged increased root growth. The GPR/Super result can be equated to the use of a PAPR type product, of which several commercial labels are available.

The economics of phosphate rock

For this exercise the costs (Present Value) are presented through to age 6. The interest rate used was 10%. Several strategies are presented, and compared. The strategies compare the existing management schedule (DAP) with GPR and PAPR. Starter doses of NP are also presented with the GPR strategy based on 50% of the current application of DAP at establishment.

STRATEGY A

At establishment		Cost ($)
80 g DAP/seedling (1500/ha)		72
application		40
	Total	112
Age 3		
500 kg DAP		280
application		65
	Total	345
Age 6		
500 kg DAP		280
application		65
	Total	345

PV = 112/ (1+0.1) + 345/(1+0.1) +345/(1=0.1)

= $ 566

STRATEGY B

At establishment

apply 1 tonne GPR (assume 15% P)		200
application		65
	Total	265

Age 3

apply 200 kg urea/ha		80
application		65
	Total	145

$$PV = 265/(1+0.1)^{0} + 145/(1+0.1)^{3}$$

$$= \$\ 374$$

STRATEGY C

AT establishment

apply PAPR (assume 16% P) at 115 kg P/ha		227
application		65
	Total	292

$$PV = 292/(1+0.1)^{0}$$

$$= \$\ 292$$

Summary of costs

Given that the cost of the DAP treatment is set to unity. the cost effectiveness of the strategies is in the order:

Strategy	Comparative Cost
A	1.00
B	0.66
C	0.52

CONCLUSION

Trial Ak850/2 shows that an application of a PAPR fertiliser can maintain the P nutrition of radiata pine on Wharakohe/Hukerenui soils through to at least age 6. The use of the cheaper GPR requires an application of N at age 3 to maintain productivity. The reason(s) for the difference in N nutrition are unknown.

REFERENCES

HUNTER I.R. and SKINNER M.F. Establishing radiata pine on the North Auckland Podzols. N.Z.Forestry 31 (3): 17-23, 1986.

FIGURE 1

The effect of fertiliser on height growth
Trial A850/2 at age 3

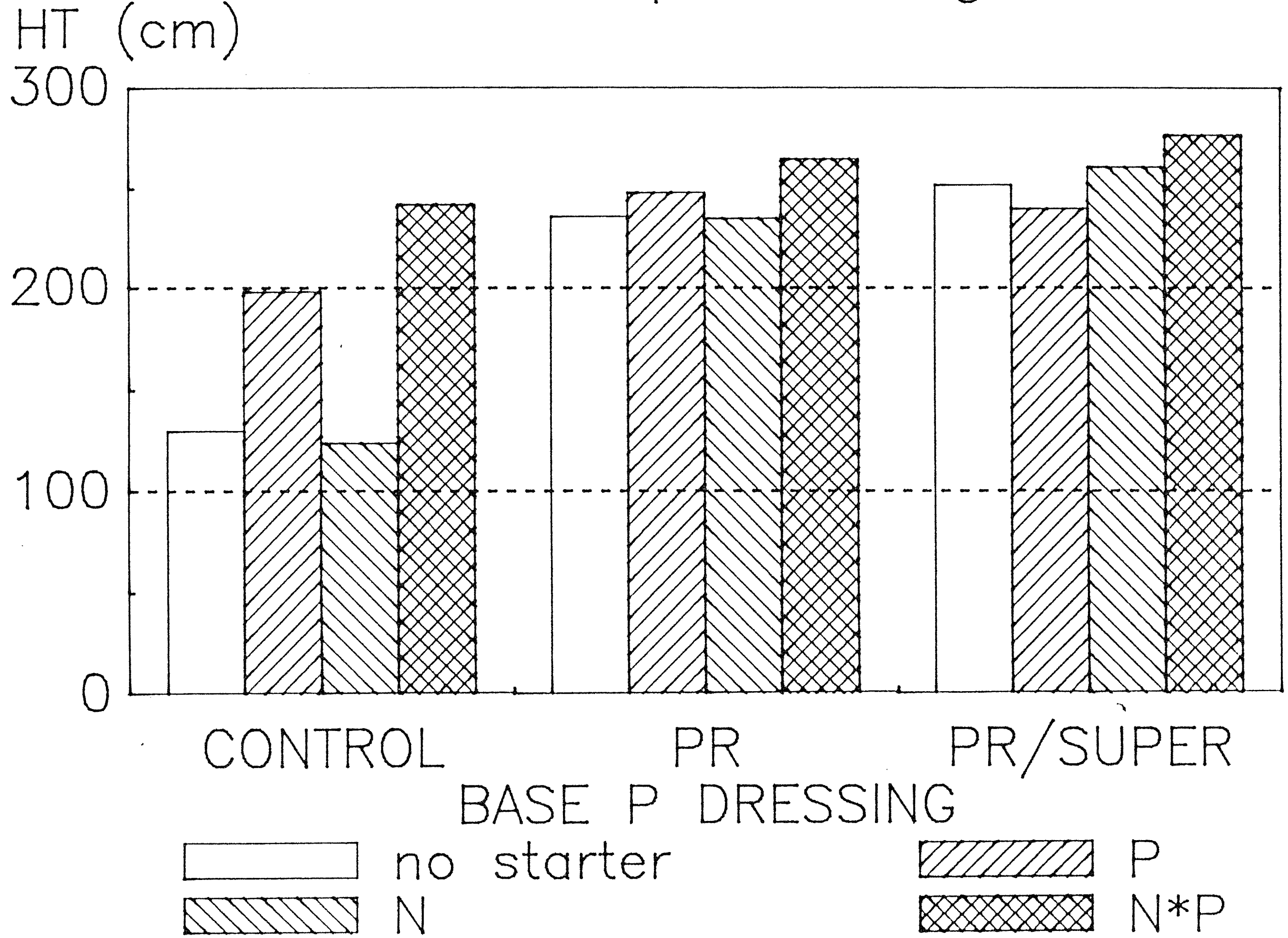


FIGURE 2

The effect of K in starter mix on foliar K
Trial A850/2

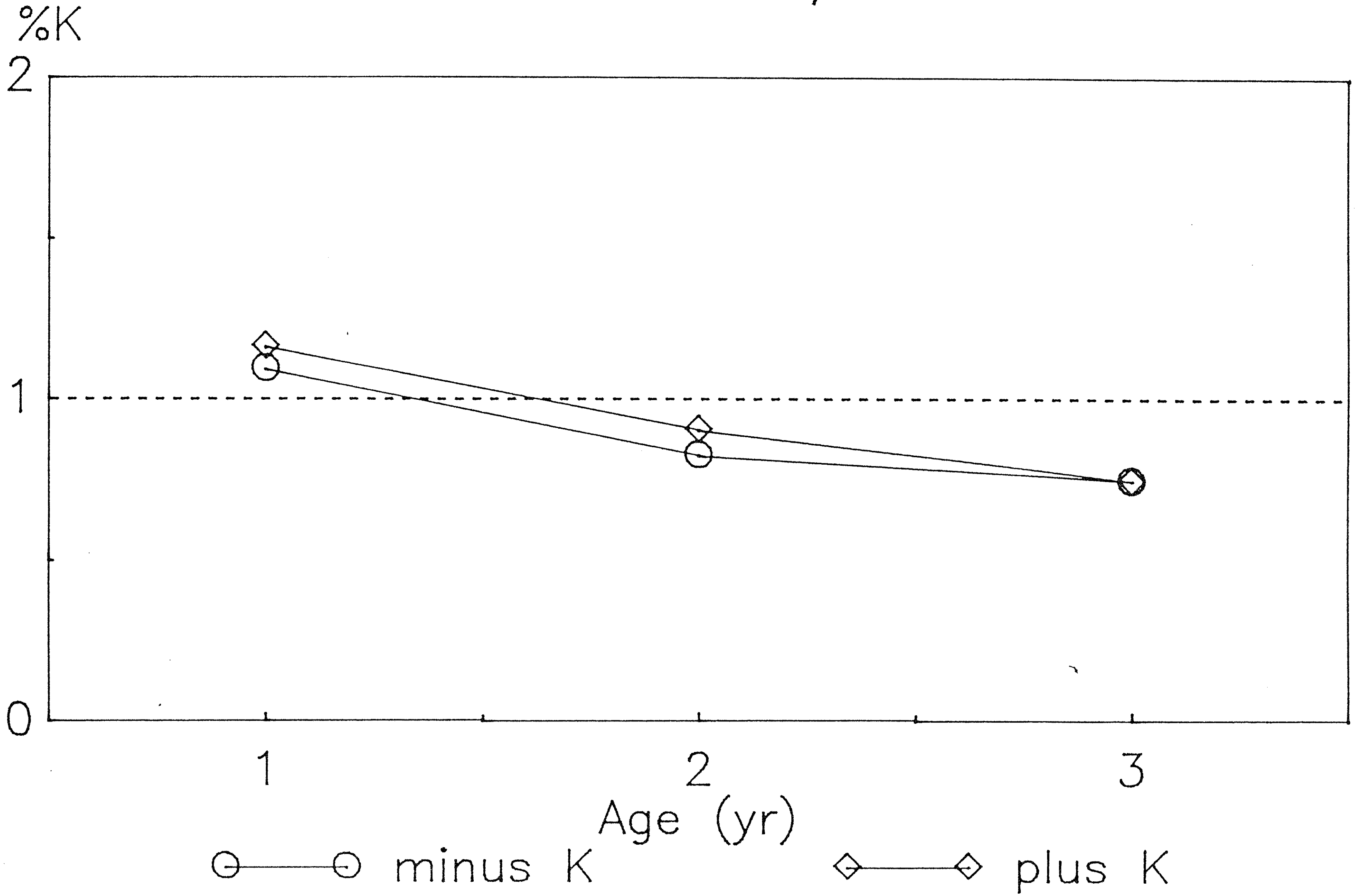
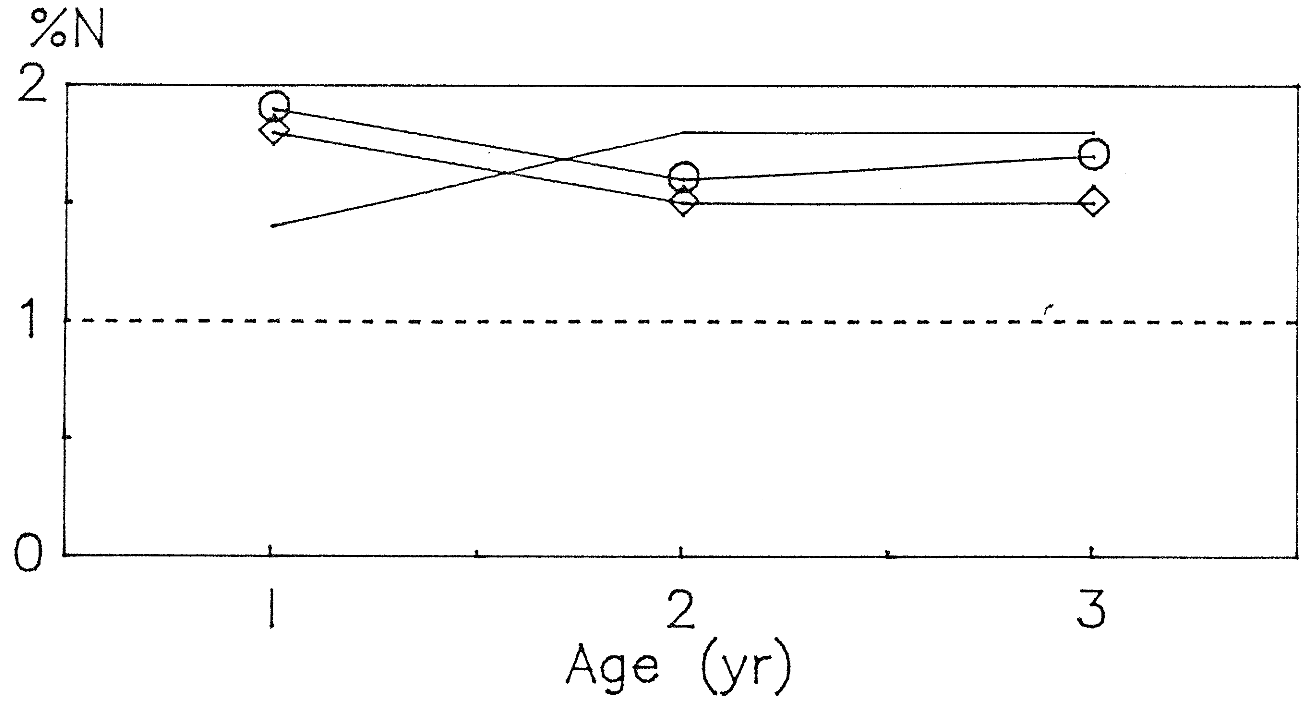


FIGURE 3

Foliar N



Foliar P

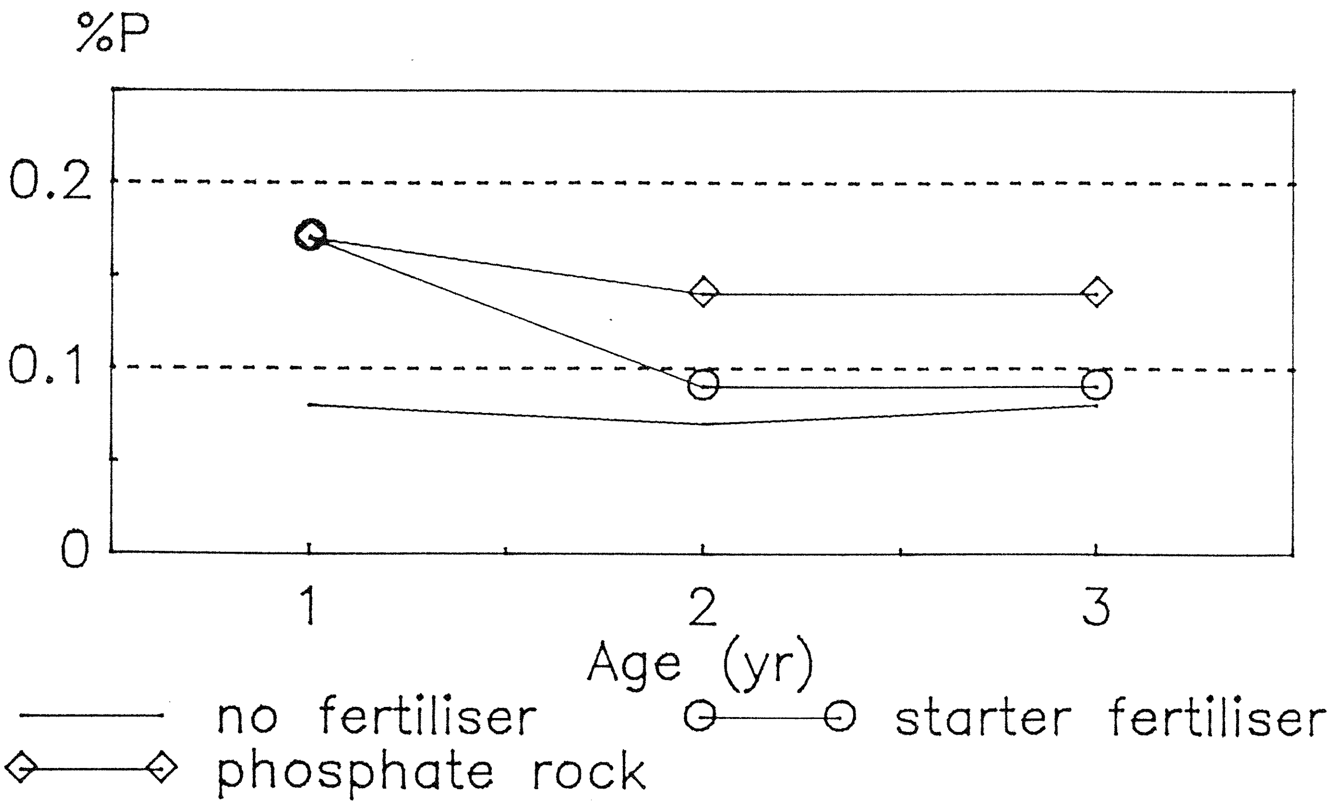


FIGURE 4

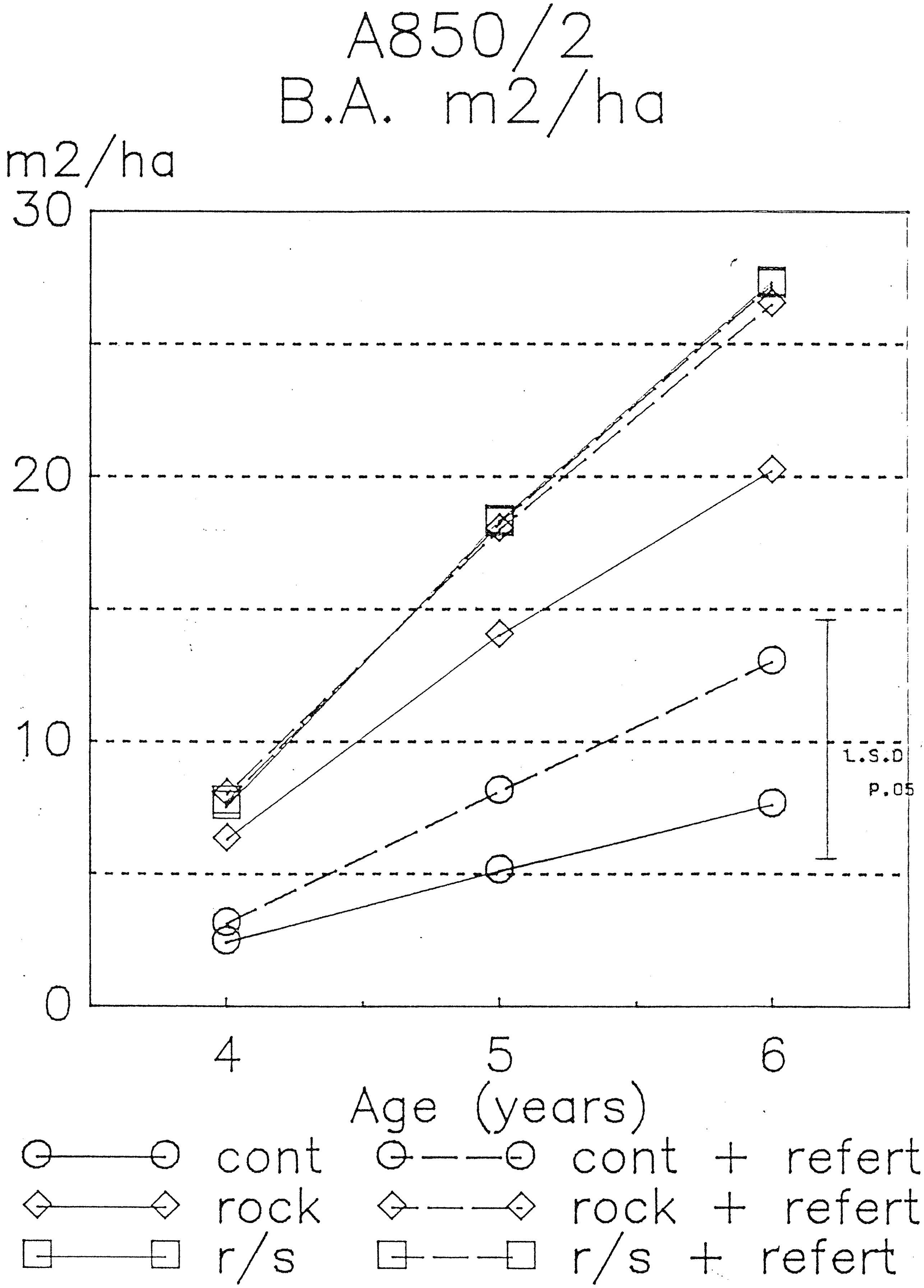

A850/2
B.A. m2/ha
m2/ha
30
20
10
0
4
5
6
Age (years)
L.S.D
P.05
cont
cont + refert
rock
rock + refert
r/s
r/s + refert

FIGURE 5

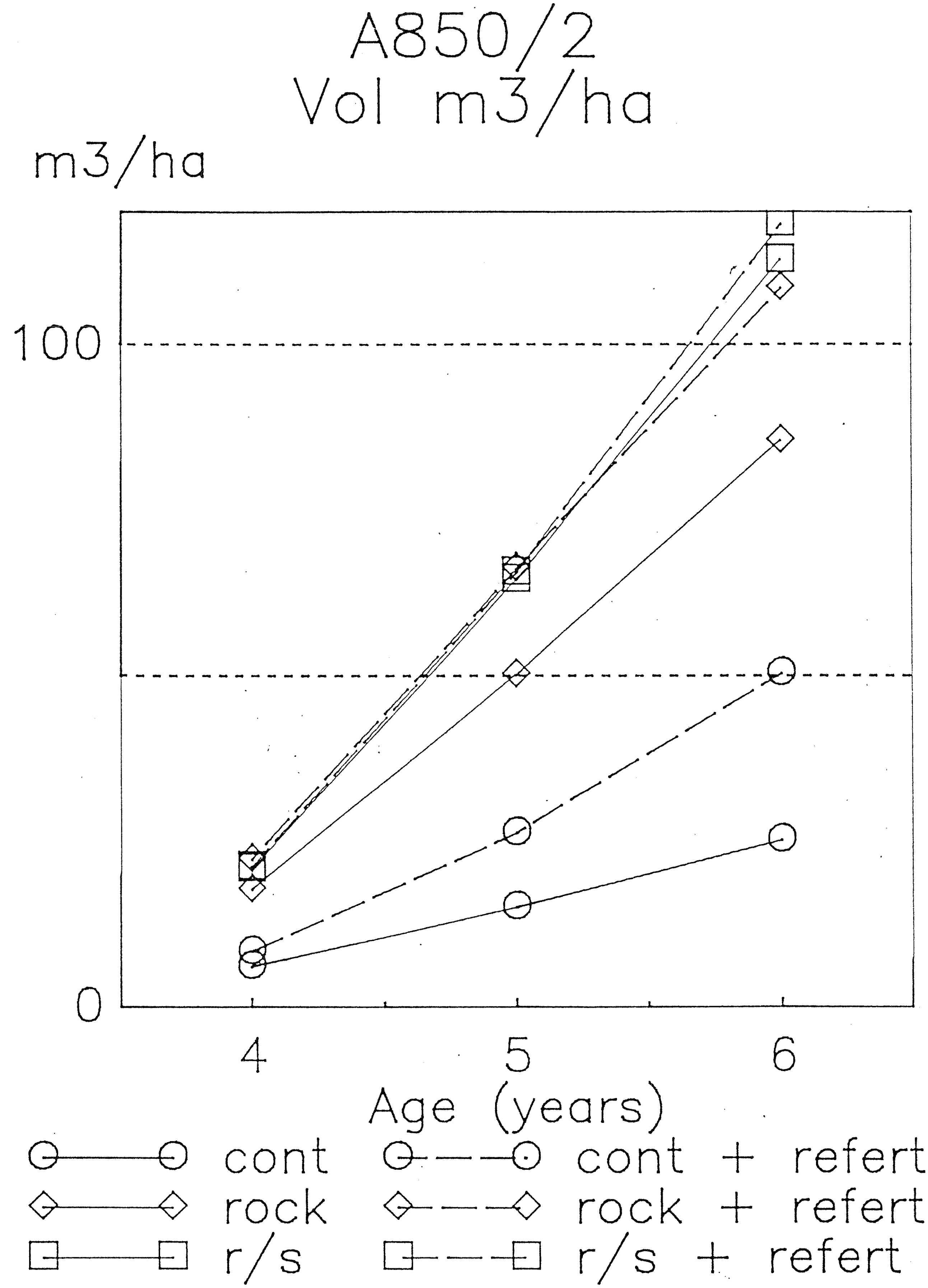
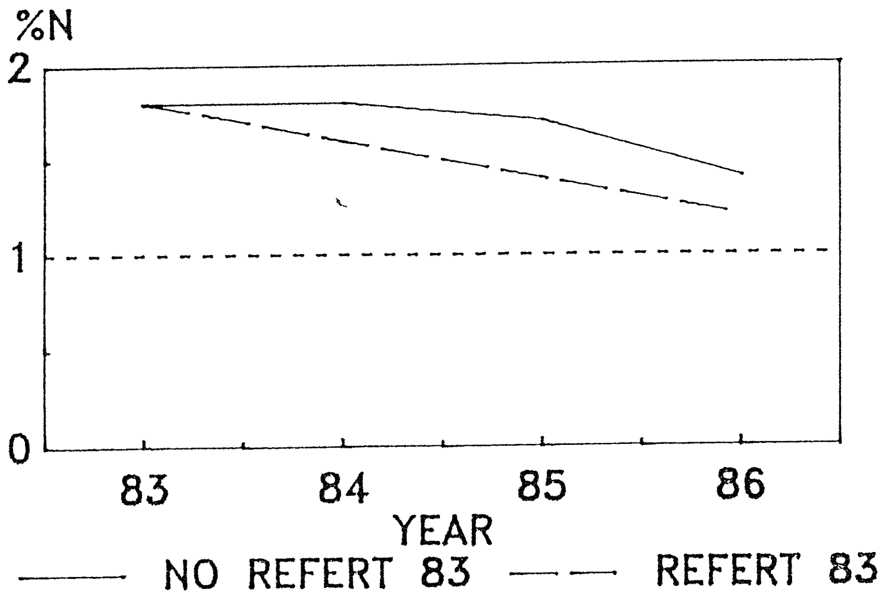
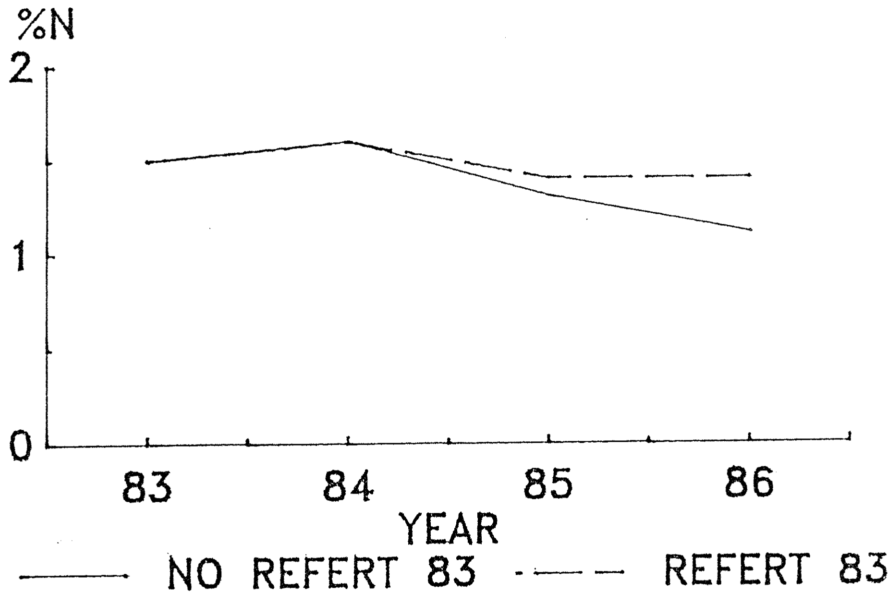

A850/2
Vol m3/ha
m3/ha
100
0
4
5
6
Age (years)
cont
cont + refert
rock
rock + refert
r/s
r/s + refert

FIGURE 6.

CONTROL %N



ROCK %N



ROCK/SUPER %N

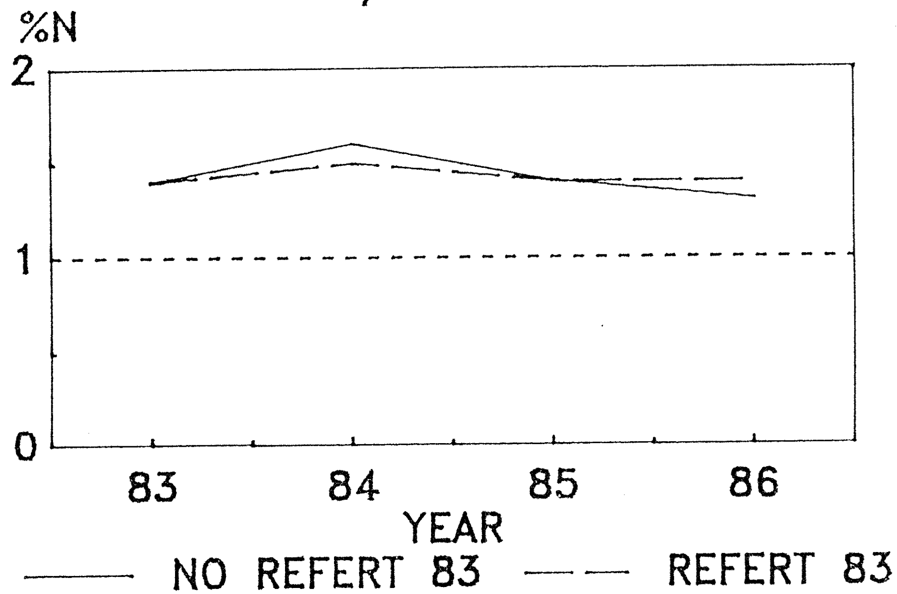
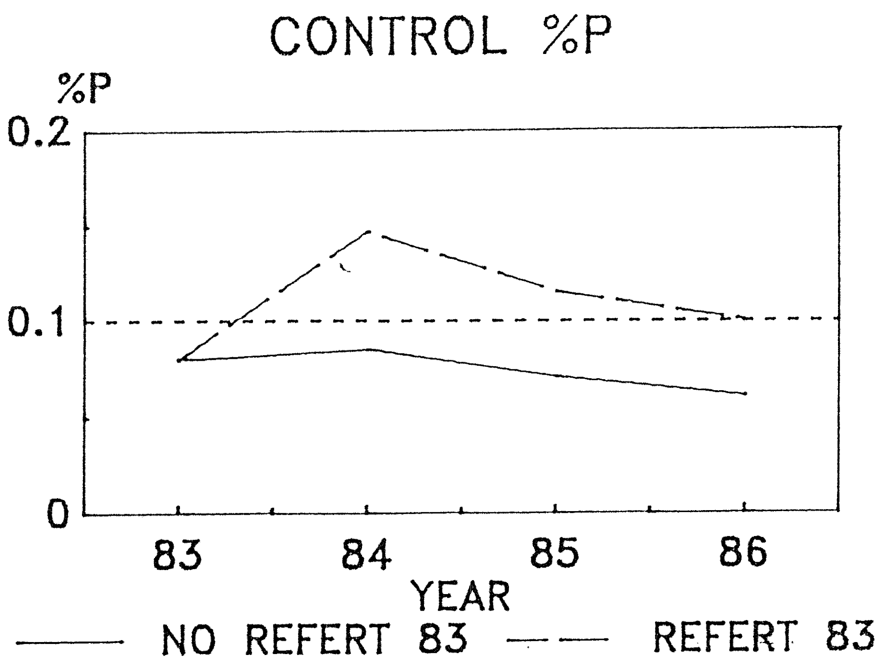
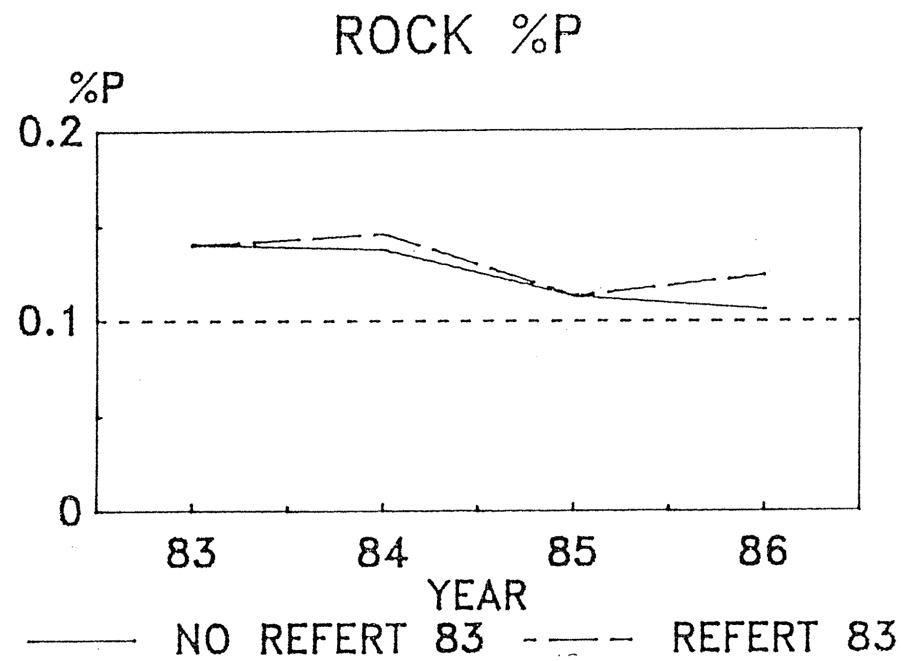


FIGURE 7


CONTROL %P
%P
0.2
0.1
0
83
84
85
86
YEAR
NO REFERT 83
REFERT 83


ROCK %P
%P
0.2
0.1
0
83
84
85
86
YEAR
NO REFERT 83
REFERT 83

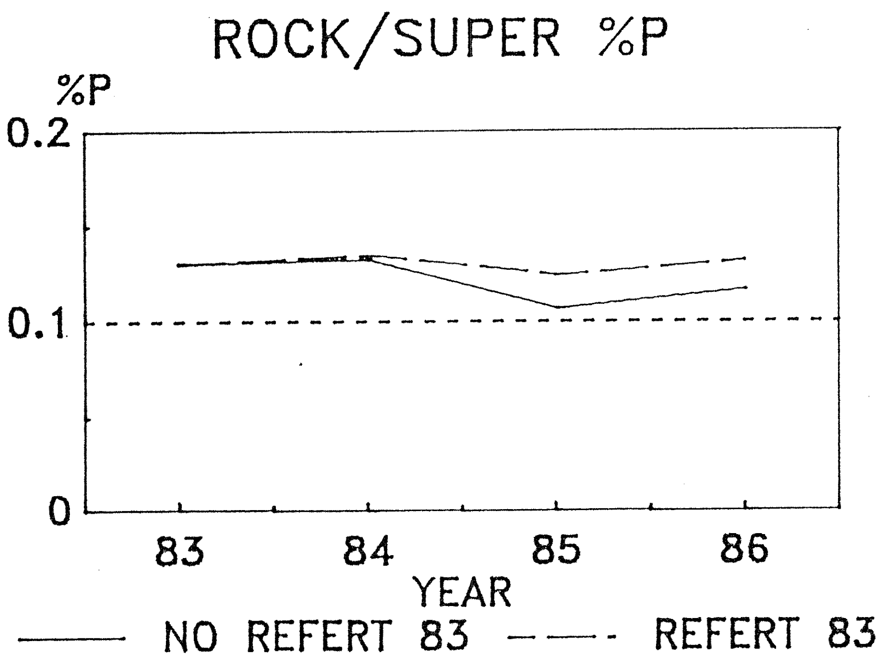
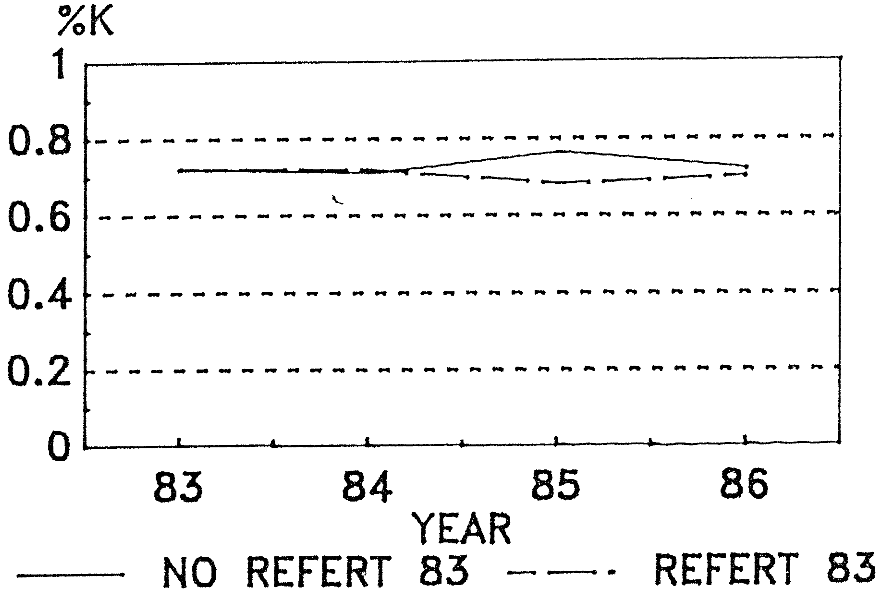
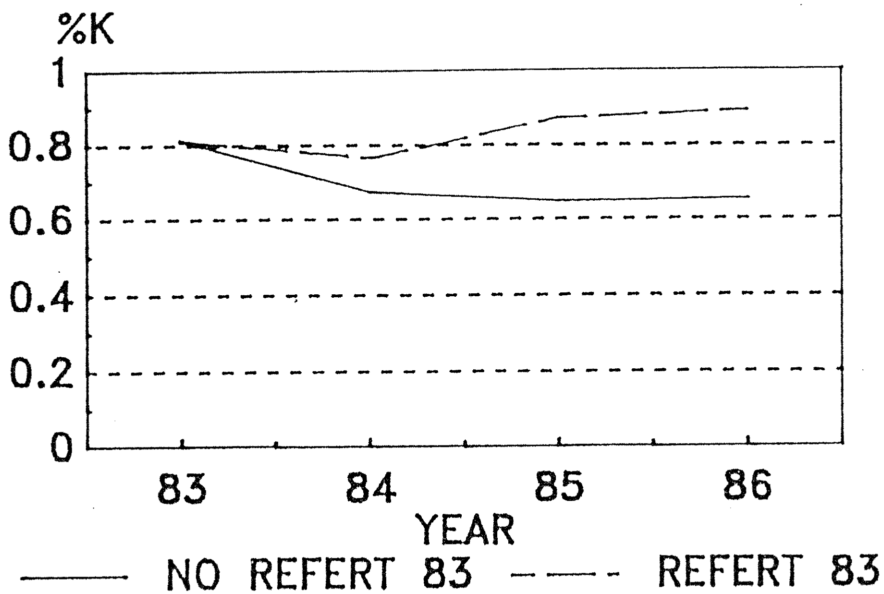

ROCK/SUPER %P
%P
0.2
0.1
0
83
84
85
86
YEAR
NO REFERT 83
REFERT 83

FIGURE 8

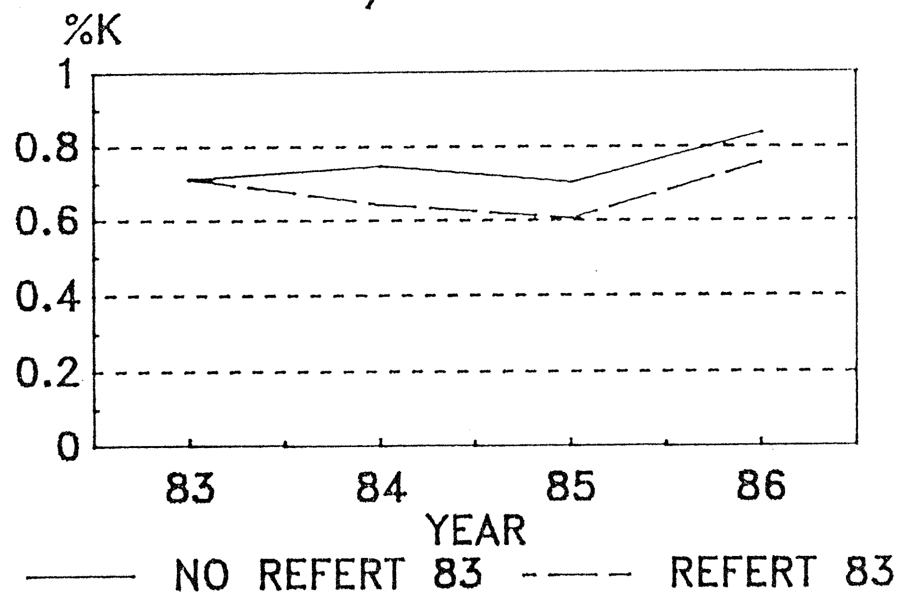
CONTROL %K



ROCK %K



ROCK/SUPER %K



THE EFFECT OF PHOSPHATE ROCK AT ESTABLISHMENT ON THE EARLY GROWTH AND NUTRITION OF RADIATA PINE

TRIAL AK850/3

M.F. Skinner

E.D. Robertson

A confidential report prepared for the
NZ Forestry Corporation (Auckland)

April 1987

Soils and Site Amendment Section
Forest Management and Resouces Division
Ministry of Forestry
Forest Research Institute

MANAGEMENT SUMMARY

RADIATA PINE CAN BE SUCCESSFULLY ESTABLISHED ON WHANGAMATA ASH WITHOUT PHOSPHATE FERTILISER. P DEFICIENCY IS, HOWEVER, LIKELY TO DEVELOP BY AGE 5. AN APPLICATION OF GPR OR AN ACIDULATED PRODUCT WILL THEN BE REQUIRED.

INTRODUCTION

In the Auckland region, phosphorus has been the dominant nutrient deficiency in plantation forestry since the early 1950's. The nutritional needs of young radiata pine from time-of-planting are currently met with soluble fertilisers such as superphosphate and the ammonium phosphates. The life of these fertilisers is short. The problem lies in a mis-match of fertiliser solubility with the trees' nutrient requirements. The highly soluble fertilisers release too much nutrient too quickly. Within the first few years when the tree begins to make sustained demands on the soil for nutrients, the applied fertiliser is very much less effective (Hunter and Skinner, 1986).

Ground phosphate rock (GPR) is an "insoluble" source of P compared with the superphosphates. The work reported here was aimed at assessing the potential of phosphate rock to replace the superphosphates in establishment forestry.

MATERIALS AND METHODS

A series of cooperative trials were established in Northland, Auckland, Westland and Nelson to cover a range of soils with low to high P-fixing capacities. This report covers Ak850/3.

The site

The trial is sited at Tairua Forest (Forestry Corporation) on Whangamata Ash and Lapilli over weathered Waihi Ash. Regenerating native scrub was felled and burnt in Feburary 1981. The area was lightly cultivated to reduce the possibility of the applied GPR being transported by surface run-off in the event of heavy rainfall after application.

The trial

The design is a split-plot factorial with GPR as the main plots replicated 3 times. Small starter doses of N and/or P were applied as sub-plots. Each main plot (10 tree rows) was divided to allow refertilisation in the third growing season.

The main plots are:

1. control
2. 100 kg P/ha Christmas A/Nauru A, 1:1 w/w at 14% P
3. 500 kg P/ha Christmas A/Nauru A, 1:1 w/w at 14% P
4. 100 kg P/ha Sechura, at 13% P
5. 500 kg P/ha Sechura, at 13% P
8. 100 kg P/ha as 50 kg P Christmas A/Nauru A = 50 kg P as superphosphate
7. 500 kg P/ha as 450 kg Christmas A/Nauru A + 50 kg Superphosphate

The plots were hand fertilised in May 1981.

RESULTS

Growth and nutrition to age 2

The response of radiata to fertiliser 2 years from planting was minimal. An application of GRP increased height growth by about 10 cm for height and 3 mm for diameter, irrespective of type or rate. The starter dose of N further improved growth by about 8 cm for height and 3 mm for diameter. The GRP treatments resulted in elevated foliar P concentrations (Table 2) above the controls at 0.13%. All other nutrient concentrations were satisfactory.

The effect of refertilisation at age 3 on growth and nutrition to age 5

Growth was not significantly affected by the refertilisation treatment applied at age 3 (Table 3). Prior to refertilisation foliar P concentrations were in excess of 0.13% (Table 2). Two years after refertilisation control trees (i.e those not fertilised at establishment or fertilised at age 3) were marginal for P at 0.10% (Fig.1).

DISCUSSION

Although there were no practical growth gains with fertiliser at establishment, or with fertiliser applied at age 3, the low foliar P concentrations in control trees at age 5 indicate a likely decrease in the growth of control trees, relative to the treated trees, will follow.

CONCLUSION

On Whangamata Ash, radiata pine fertilised with GRP did not exhibit any growth gains through to age 5. Foliar P concentrations were in excess of 0.13% in the GRP treated trees, but less than 0.11% in untreated trees. The decline in foliar P concentration occured during the fourth growing season. Growth gains in the GRP treated trees relative to the controls may be expected to follow.

REFERENCES

HUNTER I.R. and SKINNER M.F. Establishing radiata pine on the North Auckland podzols. N.Z. Forestry 31 (3):17-23. 1986.

Table 1. The effect of P source and starter dose on height growth of radiata pine by age 2

P Source	Starter Formulation							
	N0P0	N0P1	N1P0	N1P1	N0P0	N0P1	N1P0	N1P1
	Ht(cm)				Dia (mm)			
Control	161	175	147	172	39	45	34	41
GRP	172	173	182	182	42	42	45	46

Table 2. Foliar nutrient concentrations according to P source and rate.

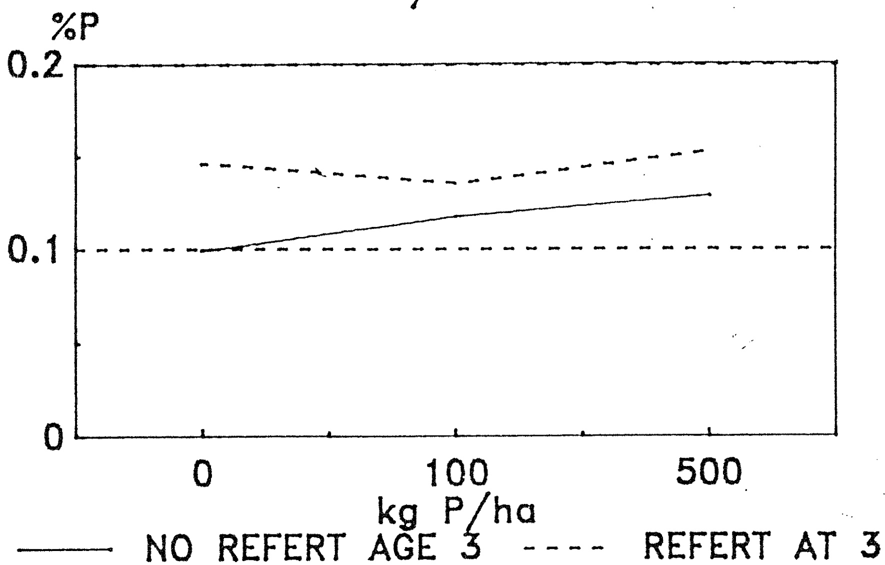
P source	N	P	K	Ca	Mg
			%		
Part A. Age 2					
Control	1.6	0.13	1.0	0.15	0.12
C/N 100	1.6	0.14	1.1	0.15	0.12
C/N 500	1.5	0.15	1.1	0.15	0.13
Sechura 100	1.6	0.14	1.1	0.15	0.13
Sechura 500	1.5	0.15	1.1	0.17	0.13
C/N+Super 100	1.6	0.15	1.1	0.16	0.13
C/N+Super 500	1.6	0.16	1.1	0.17	0.13
Part B. Prior to refertilisation.					
Control	1.7	0.14	-	-	-
C/N 100	1.8	0.14	-	-	-
C/N 500	1.7	0.15	-	-	-
Sechura 100	1.7	0.14	-	-	-
Sechura 500	1.7	0.15	-	-	-
C/N+Super 100	1.8	0.15	-	-	-
C/N+Super 500	1.7	0.17	-	-	-

Table 3. The effect of P source and refertilisation on growth to age 5.

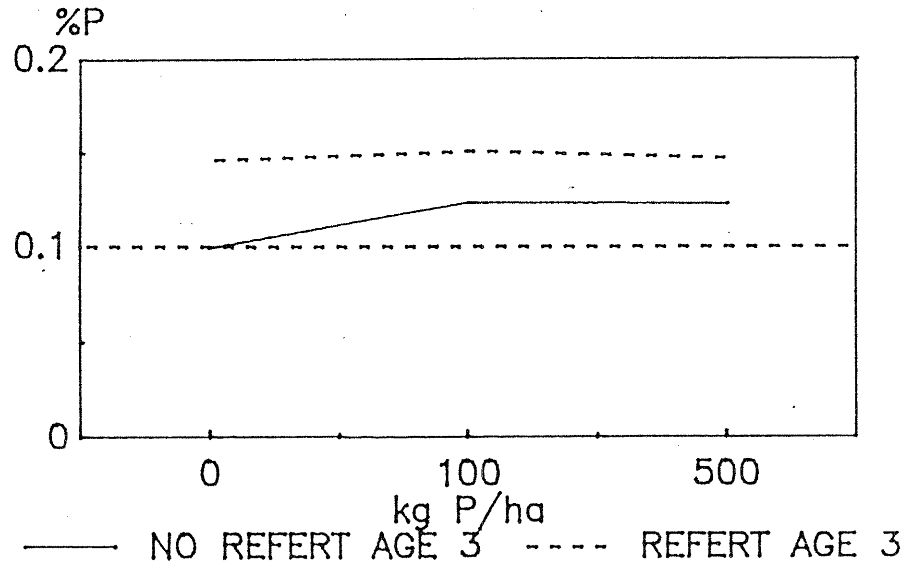
P SOURCE	B.A. (m2/ha) not refertilised	refertilised
Control	7.7	8.0
C/N 100	8.3	10.1
C/N 500	9.6	9.9
Sechura 100	7.3	8.6
Sechura 500	10.4	8.0
C/N+Super 100	8.5	9.9
C/N+Super 500	8.1	9.7

FIGURE 1

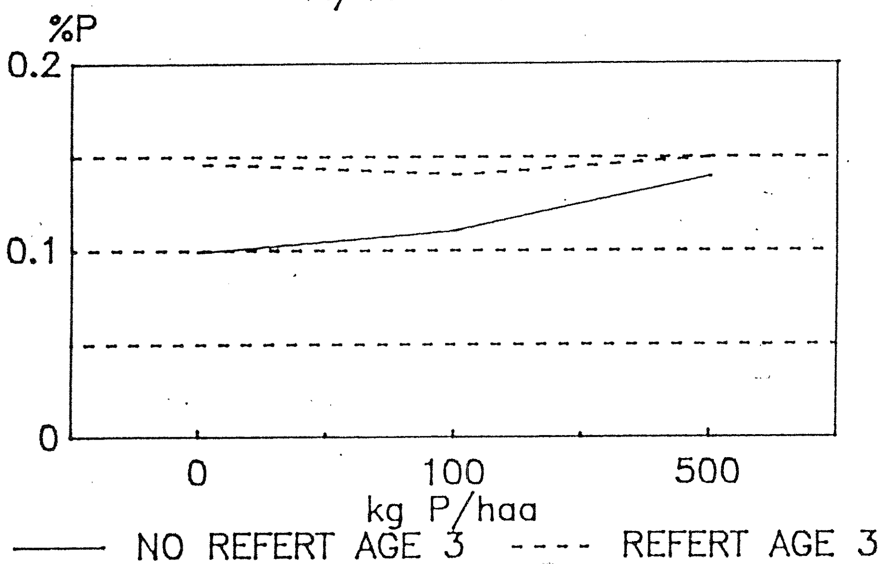
FOLIAR P AGE 5
XMAS/NAURU



FOLIAR P AGE 5
SECHURA



FOLIAR P AGE 5
X/N—SUPER



N-030 - TYPES OF ROCK PHOSPHATE

THE EFFECT OF PHOSPHATE ROCK AT ESTABLISHMENT ON THE EARLY GROWTH AND NUTRITION OF RADIATA PINE

TRIAL AK920

M.F. Skinner

E.D. Robertson

A confidential report prepared for
Carter Holt Industries

April 1987

Soils and Site Amendment Section
Forest Management and Resouces Division
Ministry of Forestry
Forest Research Institute

MANAGEMENT SUMMARY

1. APPLY GPR (EITHER SECHURA OR CHRISTMAS IS/NAURU) AT 100 KG P/HA*

2. APPLY 10 G UREA/SEEDING AT TIME-OF-PLANTING

* See AK925/1 report for update.

INTRODUCTION

Ground phosphate rock can be described, agronomically, as either "reactive" or "unreative", as a P source for the growth of crops and pasture. An example of "unreactive" GPR is Christmas A/Nauru A mix used in the manufacture of superphosphate. As a P fertiliser for radiata pine it appears to be satisfactory (Hunter and Skinner, 1986). The effectiveness of "reactive" GPR fertilisers as long term sources for radiata is not known. On an equivalent weight of P basis, it is likely that the "reactive" materials will give higher P concentrations in radiata foliage than "unreactive" GPR. The likely improvement in foliar P status is not known.

MATERIALS AND METHODS

Site

The site is close to Te Kao (Parengarenga) on Carter Holt Harvey Land. The soil has been tentatively classified as Ohia Sand.

Trial Design

The trial is a split plot between GPR types (main treatment) and starter doses of NP and K (sub-treatments). The main treatments are:

1. control - no GPR	)
2. Christmas/Nauru mix	)
3. Sechura	) 100 kg P/ha
4. Christmas-Nauru/Superphosphate 1:1 w/w)	)
5. Arad	)

The P fertilisers were applied at a rate of 100 kg P/ha to the cultivated beds (ripped, bedded and recompacted by roller). The sub-plots were composed of starter doses of N, P and K in factorial combination (5 g each element/seedling). The trial was established in August 1982.

RESULTS

The growth and nutrition to age 2

The data for the K component of the sub-plot treatments have been averaged with the N and P results, since K had no effect on growth through to age 2 (Table 1).

The results (Table 2 and Fig.1) show that both the starter P dose and the GPR treatment were comparable in their effects on height growth (about 20 cm) i.e. there is no advantage in using a starter P dose in combination with the GPR treatment. The addition of N alone depressed growth in the control (no GPR) which was expected for this soil type. With all GPR types, the addition of N alone markedly improved growth (a strong N response in the presence of adequate P) by about 25 cm. The gains with N and P in the starter dose were comparable the results from N alone. The foliar P values at age 2 show that GPR has been more effective in maintaining above the critical level than the starter application (Table 3).

The effect of GPR type on growth to age 4

All GPR types had comparable effects on both height and diameter (DBH) growth to age 4. Controls averaged a little over 2.5 metres in height and 6 cm DBH; fertilised trees were about 3.2-3.3 metres in height and about 8 cm in DBH (Fig.2).

The effect of GPR type on foliar nutrient concentrations to age 4

The data has been extracted from GPR treatments only, at age 2, and from composite samples from the GPR treatments for ages 3 and 4. The results (Figs 3 and 4) show little difference between the types of GPR in foliar P levels. A possible exception may be the Christmas/Nauru-Superphosphate mix where foliar P appears to be slightly elevated.

By age 4 both N and K are marginal. These nutrients are likely to be growth limiting in successive years. (It is planned to refertilise the GPR plots in 1987 to eleviate this problem; this is important if the true ability of the GPR treatments to sustain foliar P above the critical level is to be monitored).

DISCUSSION

This trial shows there to be little difference between GPR types in their ability to sustain foliar P concentrations above the critical level of 0.11%, at least for the first 4 years from establishment. By age 4 the marginal results for N and K indicate that refertilisation with these nutrients is now a prerequisite for the continuation of the trial. If N and K remain growth limiting, the trial will not be a true test for the longevity of the P response.

CONCLUSION

On Ohia Sand, both the "reactive" and "unreative" phosphate rocks are comparable in their ability to supply available P for the growth of radiata to at least age 4.

REFERENCES

HUNTER I.R. and SKINNER M.F. Establishing radiata pine on the North Auckland podzols. N.Z. Forestry 31 (3):17-23. 1986.

Table 1. The effect of K in the starter mix on height growth to age 2.

Rock Type	Height (cm) -K	+K
Control	98	92
Christmas/N	119	117
Sechura	123	123
Christmas/N/Super	121	121
Arad	126	121

l.s.d. 18 cm

Table 2. The effect of GPR type and starter formulation (N and/or P) on the height growth of radiata by age 2.

Rock type	Starter formulation			
	N0P0	N1P0	N0P1	N1P1
	Ht (cm)			
Control	83	75	92	129
X/N	105	132	108	128
Sechura	108	132	108	142
X/N-Super	108	135	113	130
Arad	118	128	111	142

l.s.d. 20 cm

Table 3. The effect of starter doses of N and P on foliar nutrients to age 2.

Phosphate Rock	Starter formulation			
	N0PO	N1P0	N0P1	N1P1
	%P			
Absent	0.10	0.10	0.15	0.14
Present	0.19	0.19	0.20	0.20

FIGURE 1

The effect of fertiliser treatment on height growth
Trial AK920 age 2

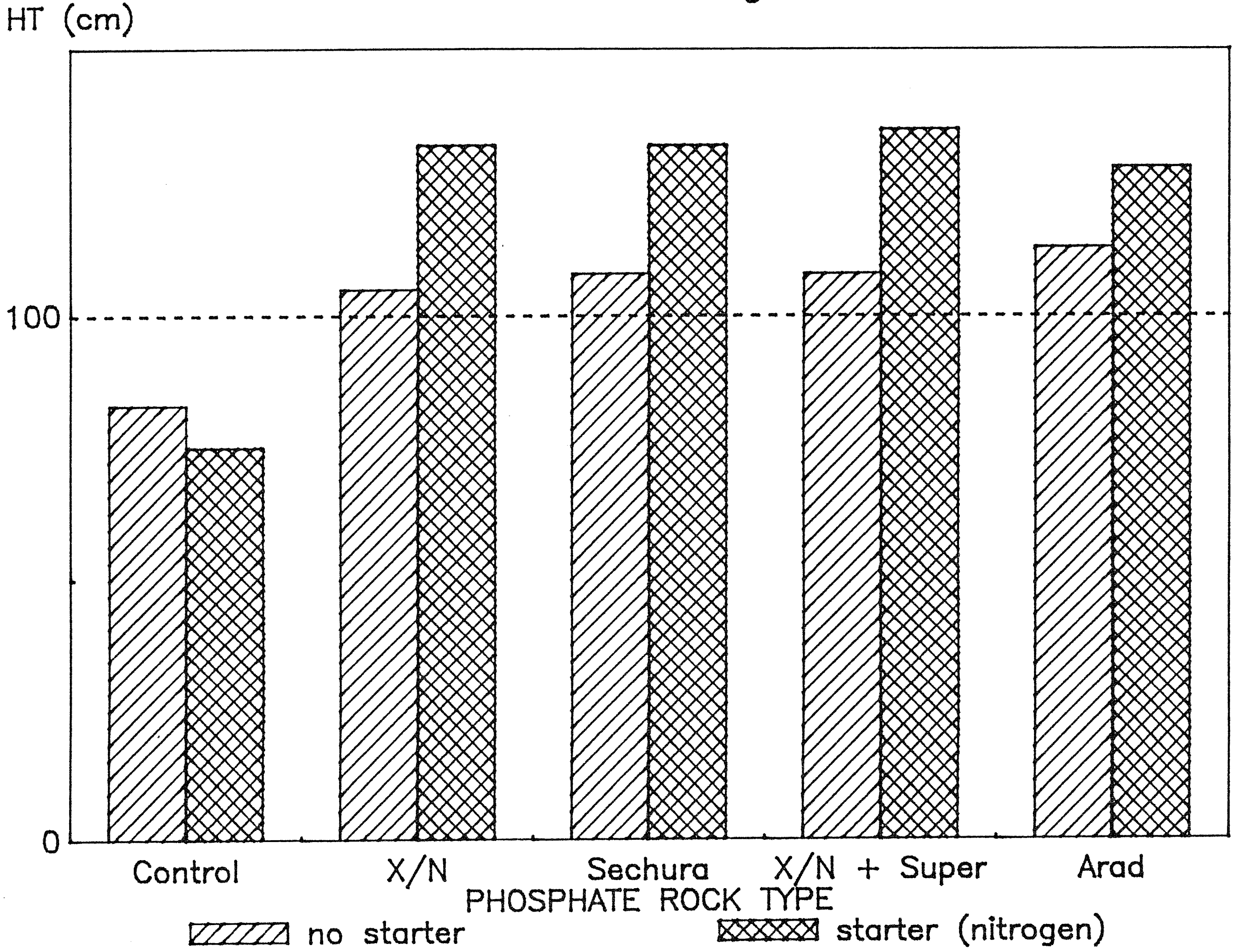
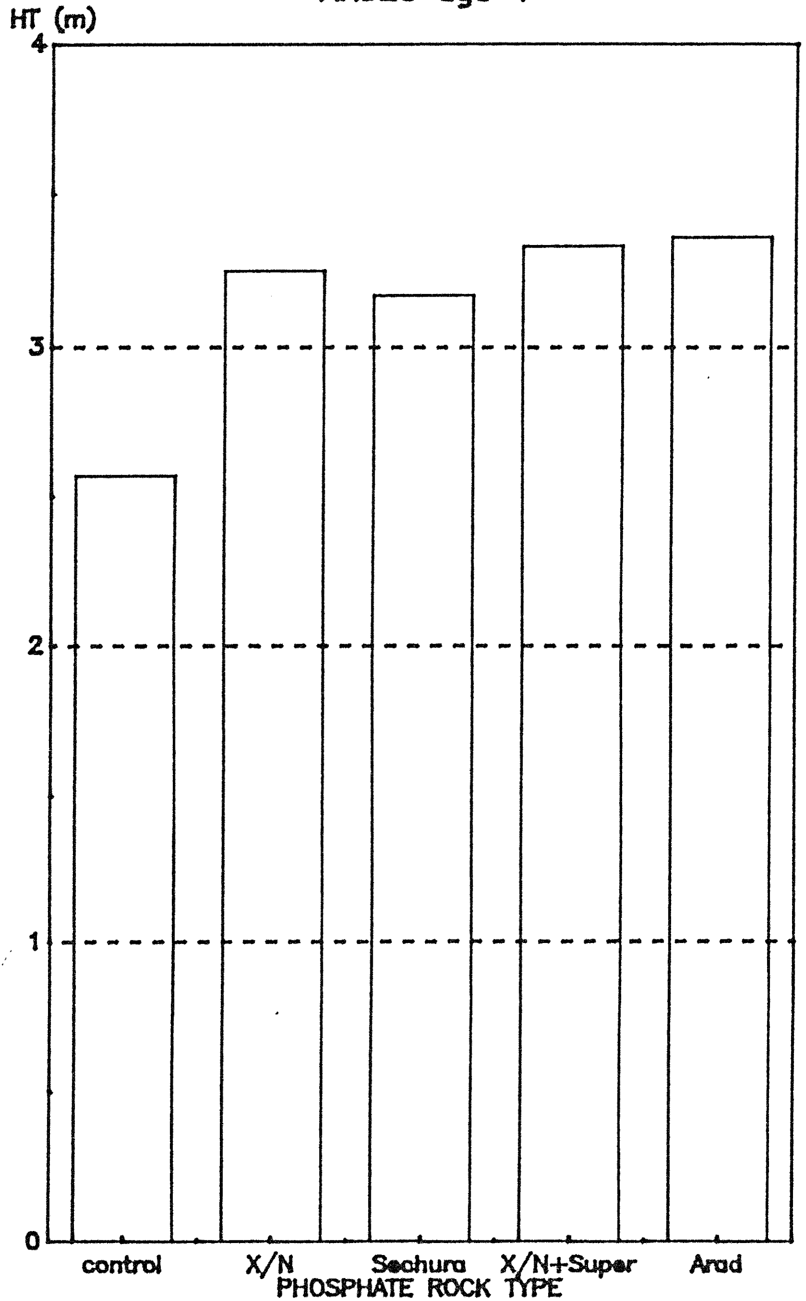


FIGURE 2

The effect of PR type on height growth
AK920 age 4



The effect of PR type on DBH
AK920 age 4

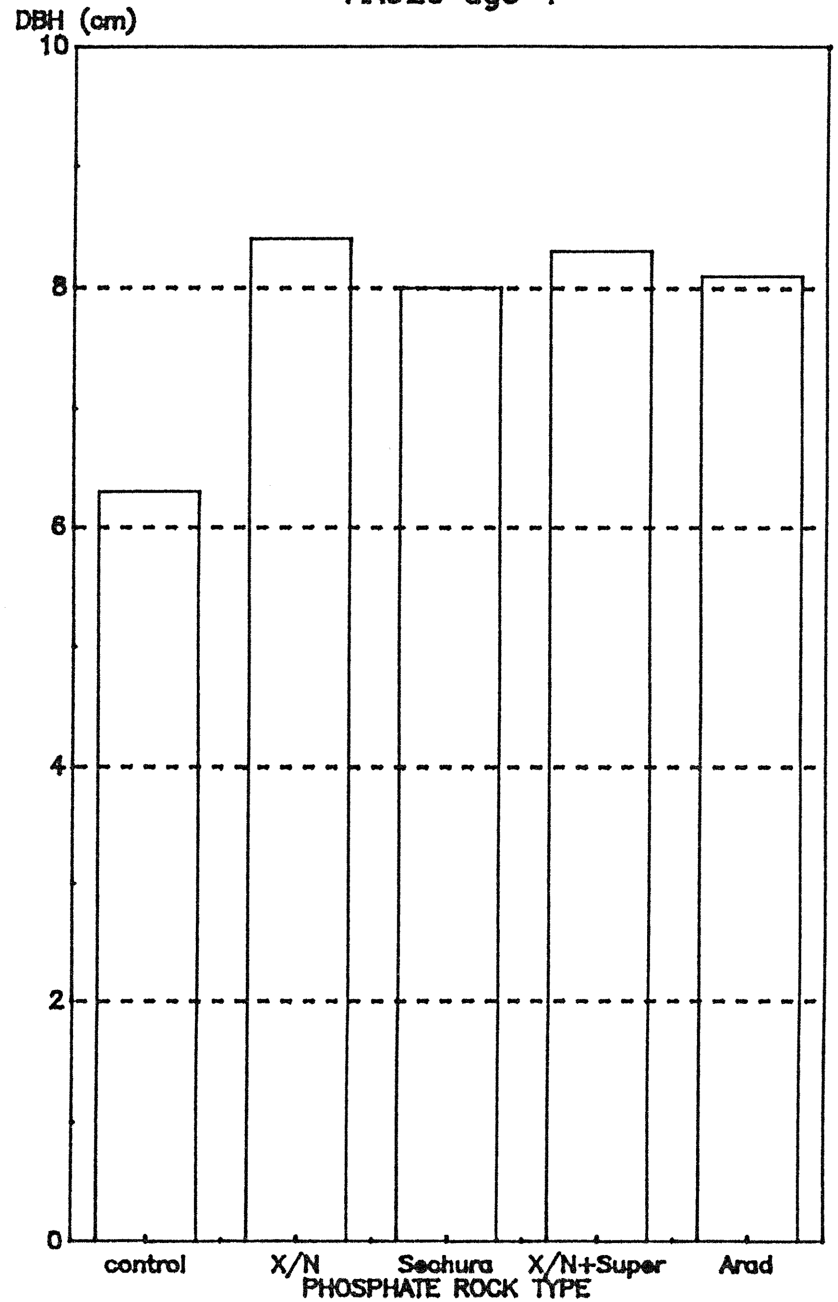


FIGURE 3

%P

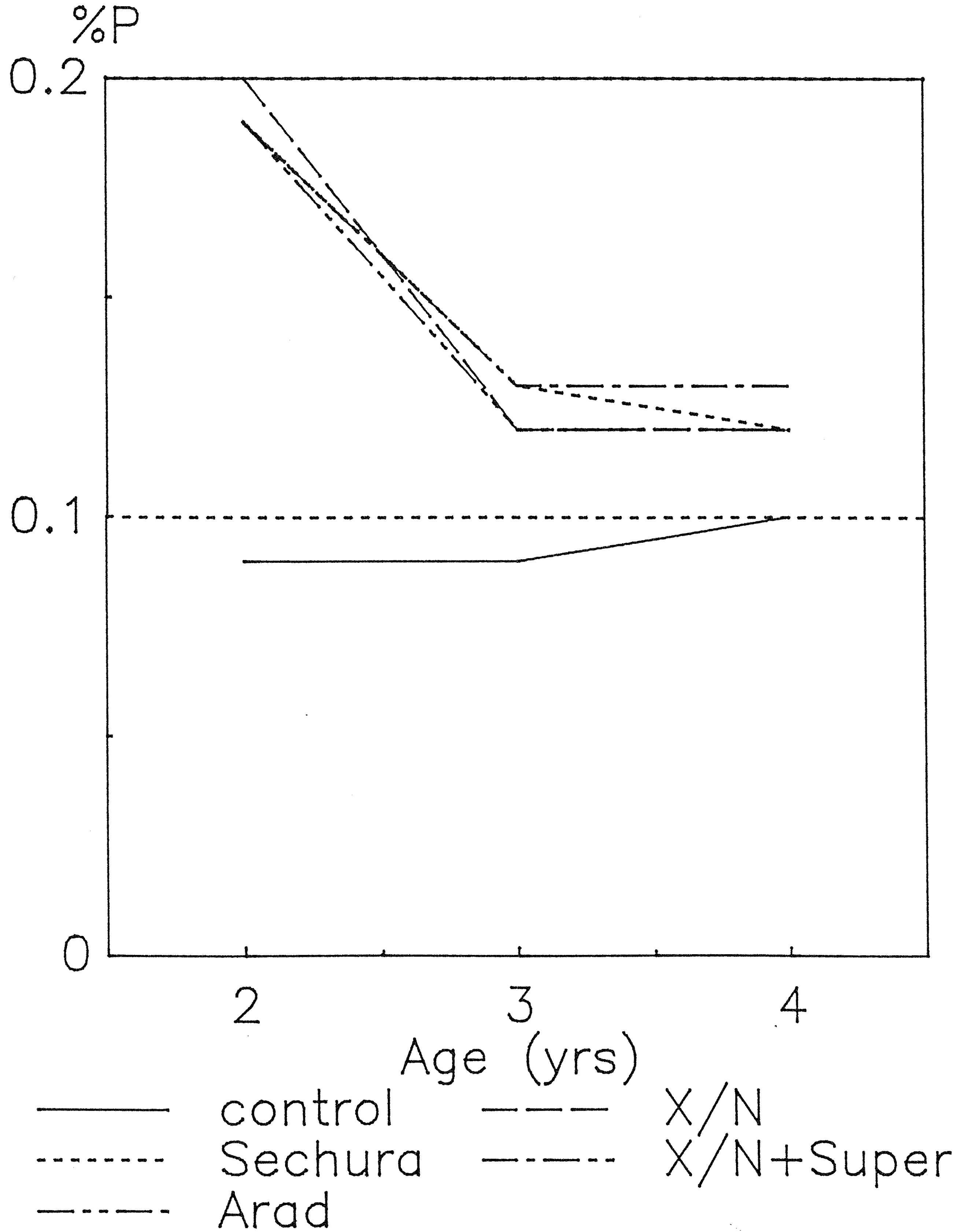
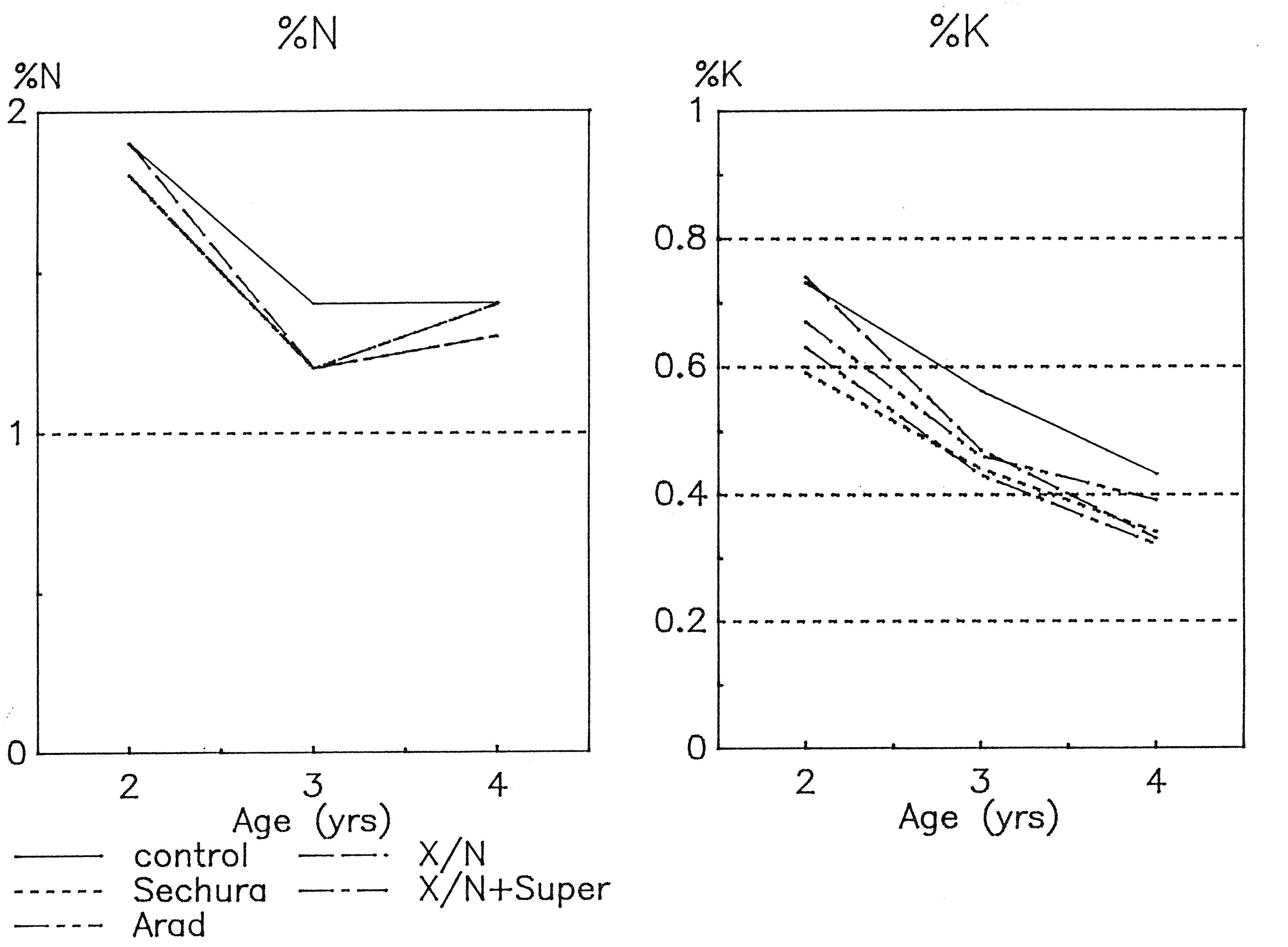


FIGURE 4


%N
%N
2
1
0
2
3
4
Age (yrs)
control
Sechura
Arad
X/N
X/N+Super
%K
%K
1
0.8
0.6
0.4
0.2
0
2
3
4
Age (yrs)

A1-025 SERIES: RATES OF ROCK PHOSPHATE

REFINING THE PHOSPHATE ROCK STRATEGY, RATES OF PHOSPHATE ROCK AT ESTABLISHMENT

TRIAL AK925/1

M.F. Skinner

E.D. Robertson

A confidential report prepared for
Carter Holt Industries

April 1987

Soils and Site Amendment Section
Forest Management and Resouces Division
Ministry of Forestry
Forest Research Institute

MANAGEMENT SUMMARY

1. APPLY GPR AT 25 KG P/HA
2. APPLY 40 G DAP/SEEDING AT TIME-OF-PLANTING

RESULTS

Growth and Nutrition

In the first year from planting DAP was the only fertiliser treatment to significantly improve the growth of radiata pine. DAP-treated trees were 0.7 metres in height and 20 mm in root collar diameter, (Table 1, Fig.1 and 2) compared with controls at 0.46 m height and 11 mm r.c.d. Tree growth in the 4 GRP treatments remained unaffected, although foliar P concentrations were in excess of 0.14% and foliar N at about 1.5% (Table 2, Fig. 3 and 4). The foliar P concentration in the DAP treatment was 0.22%, with the N concentration at 1.8%.

By age 2, the GPR trees averaged 1.15 metres in height and showed growth gains of 0.17-0.22 m and 2-5 mm in r.c.diameter over untreated trees. These gains bordered statistical significance (P.05). By comparison the DAP-treated trees were 1.7 metres in height (a gain of 0.7 m over control and 0.5 m over GPR), and 44 mm in r.c.diameter (a gain of 18 mm over control, and 15 mm over GPR).

By age 3 the GPR trees averaged 1.96 m in height and showed growth gains of 0.38 m over controls. By comparison the DAP-treated trees were 2.47 m in height (gain of 0.89 m over control and 0.51 m over GPR).

Between ages 2 and 3 foliar P levels remained more or less unchanged for the GPR treatments, and in excess of 0.11% (from 0.11% at 25 kg P/ha to 0.16% at the 280 kg P/ha rate. with intermediate values at the intermediate treatments. Foliar P levels in the DAP treatment remained constant at 0.13%. Foliar K values were satisfactory (Table 2, Fig.5).

DISCUSSION

The control (unfertilised) trees averaged about 1.5 metres in height by age 3 and were clearly deficient in P (foliar levels were at 0.08%). The soils were clearly N deficient as evidenced by the marked response to DAP (the N component). The lack of a marked response to P as GRP in the first year can be ascribed to lack of soil N; trees accumulated P with increasing rates of GRP, but soil N was insufficient to sustain higher growth rates. In the second year and beyond, the broadcast nature of the GRP probably compensated for the lack of soil N by (a greater volume of exploitable soil).

The economics of phosphate rock

The following analysis is based on calculating the present value of the fertilisers assumed to be required over the first 4-6 years of the rotation. An interest rate of 10% has been assumed.

Strategy A

At establishment	
Apply 80 g DAP/seedling @ 1500/ha	$72
Application	40
	112

Age 4	
500 kg DAP/ha	280
Application	65
200 kg KCl/ha	60
Application	65
	470

$$\text{Present value} = 112(1.1)^{0} + 470(1.1)^{4}$$

$$= \$\ 433$$

Strategy B

At establishment	
Apply 25 kg P/ha as GPR	34
Application	65
40 g DAP/seedling @ 1500/ha	36
Application	40
	175

Age 4	
Apply 200 kg urea/ha	80
Application	65
Apply 200 kg KCl/ha	60
Application	65
	270

$$\text{Present value} = 175(1.1)^{0} + 270(1.1)^{4}$$

$$= \$\ 355$$

The GPR strategy is 0.82 the cost of the soluble fertiliser strategy. GPR is recommended rather than a PAPR product because initial P availability does not appear to be a problem.

CONCLUSION

On Te Hapua fine sandy loam soil N and P limit the early growth of radiata pine. Application of GRP will solve the P deficiency, but cannot compensate for the N deficiency until at least age 2 when tree root systems are developing. DAP is essential at establishment to ensure N is non-limiting.

REFERENCES

HUNTER I.R. and SKINNER M.F. Establishing radiata pine on the North Auckland podzols. N.Z. Forestry 31 (3):17-23. 1986.

INTRODUCTION

Ground phosphate rock (GPR) applied as a broadcast fertiliser to radiata pine,at time-of-planting can maintain foliar P at or above 0.11% for at least the first 6 years (Hunter and Skinner, 1986) as shown by the early series of GPR trials. In that series of experiments the application rate was 145 kg P/ha. This rate may have been excessive. A series of trials across a range of soil types was set up to determine the optimum rates of GPR for radiata pine.

MATERIALS AND METHODS

A. Sites

Six sites were chosen over a range of soil types from Northland to Westland. This report covers Ak925/1 in Northland on Aupouri Peninsula at Parengarenga (Te Kao) on Carter Holt Harvey land.

B. Soils

The soil type is Hurewai/Te Hapua fine sandy loam. Its characteristics are as follows:

Total N	0.06%
Total P	42 ppm
Bray P	0.9 ppm
Bray Ca	0.87 meq %
Bray Mg	0.67 meq %
Bray K	0.07 meq %

Soil values for N, Bray- P and K are extremely low.

C. Fertiliser treatments

The GPR source was Christmas A/Nauru A mix (1:1 w/w) at 14.5 % P. The treatments are:

No	Rate Kg P/ha
1	0
2	25
3	56
4	125
5	280
6	Current fertiliser prescription (soluble N and P) approximating 15g P, 15g N/seedling.

Each treatment was replicated eight times to allow for refertilising of half the trial at age 3.

Table 1. The effect of fertiliser treatment on the growth of radiata pine.

	Fertiliser treatment					
	Rockphosphate (kg P/ha)					DAP (80 g/tree)
	0	25	56	125	280	
Age 1						
Ht (cm)	46	51	52	53	47	70
Dia(mm)	11	12	12	12	11	20
	LSD P.05 Ht=8; Dia=2					
Age 2						
Ht (cm)	95	116	120	113	112	169
Dia(mm)	26	27	31	29	28	44
	LSD P.05 Ht=22; Dia=8					
Age 3						
Ht (cm)	159	197	201	179	182	248
Dia(mm)	38	48	50	45	43	59
	LSD P.05 Ht=29; Dia=8					

Table 2. The effect of fertiliser treatment on foliar nutrients at age 3.

Foliar nutrient (%)	Treatment (kg P/ha)					DAP
	0	25	56	125	280	
Age 1						
N	1.48	1.53	1.52	1.68	1.53	1.78
P	0.12	0.12	0.15	0.18	0.19	0.22
K	1.12	1.14	1.20	1.30	1.25	1.02
Age 2						
N	1.51	1.40	1.38	1.38	1.38	1.39
P	0.10	0.11	0.14	0.15	0.16	0.13
K	0.80	0.62	0.60	0.71	0.72	0.65
Age 3						
N	1.42	1.39	1.45	1.38	1.46	1.44
P	0.08	0.12	0.14	0.15	0.16	0.13
K	0.51	0.46	0.42	0.42	0.46	0.47

FIGURE 1

THE EFFECT OF FERTILISER TREATMENT ON HEIGHT GROWTH

TRIAL AK925/1

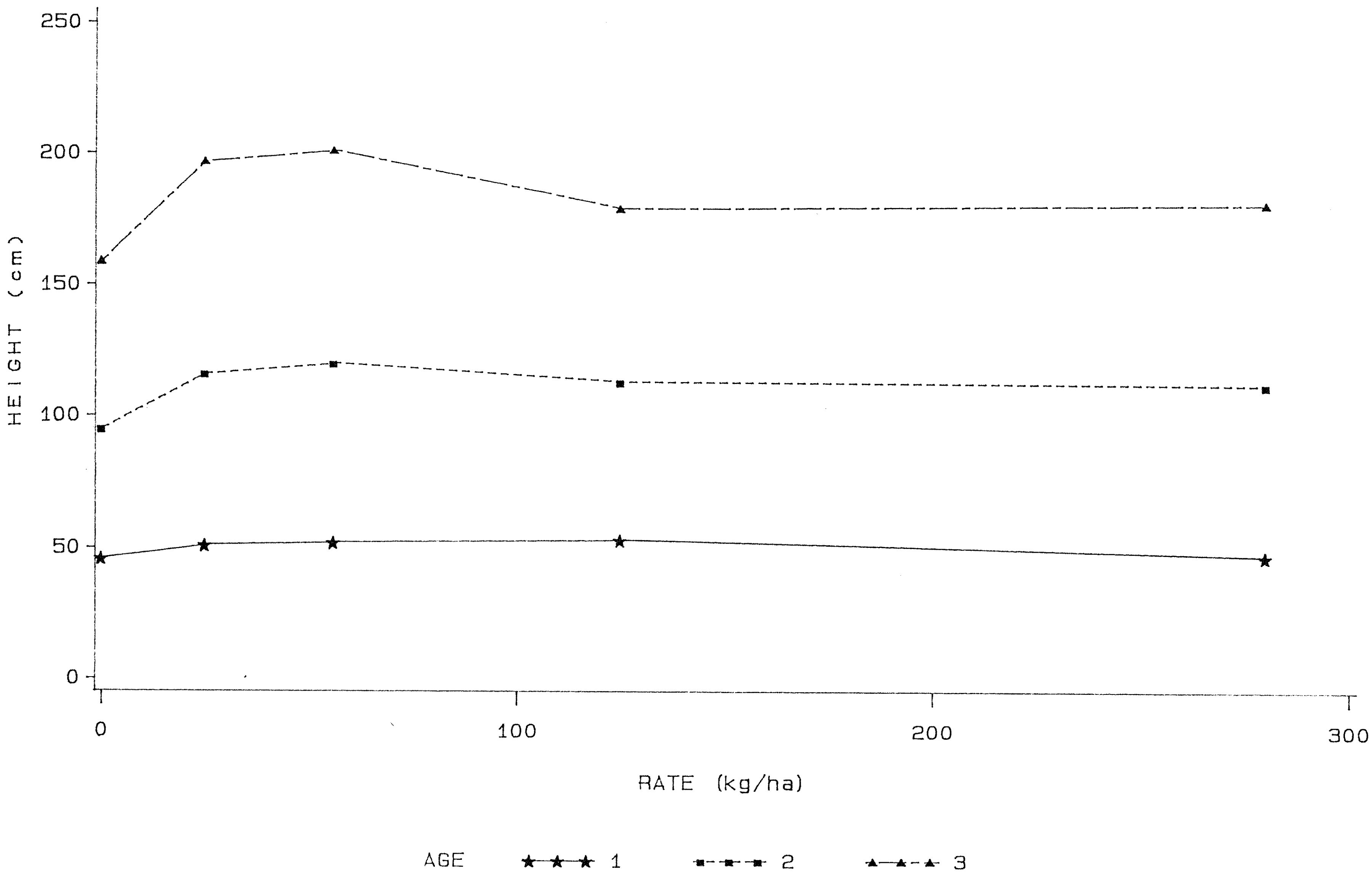


FIGURE 2

THE EFFECT OF FERTILISER TREATMENT ON DIAMETER GROWTH

TRIAL AK925/1

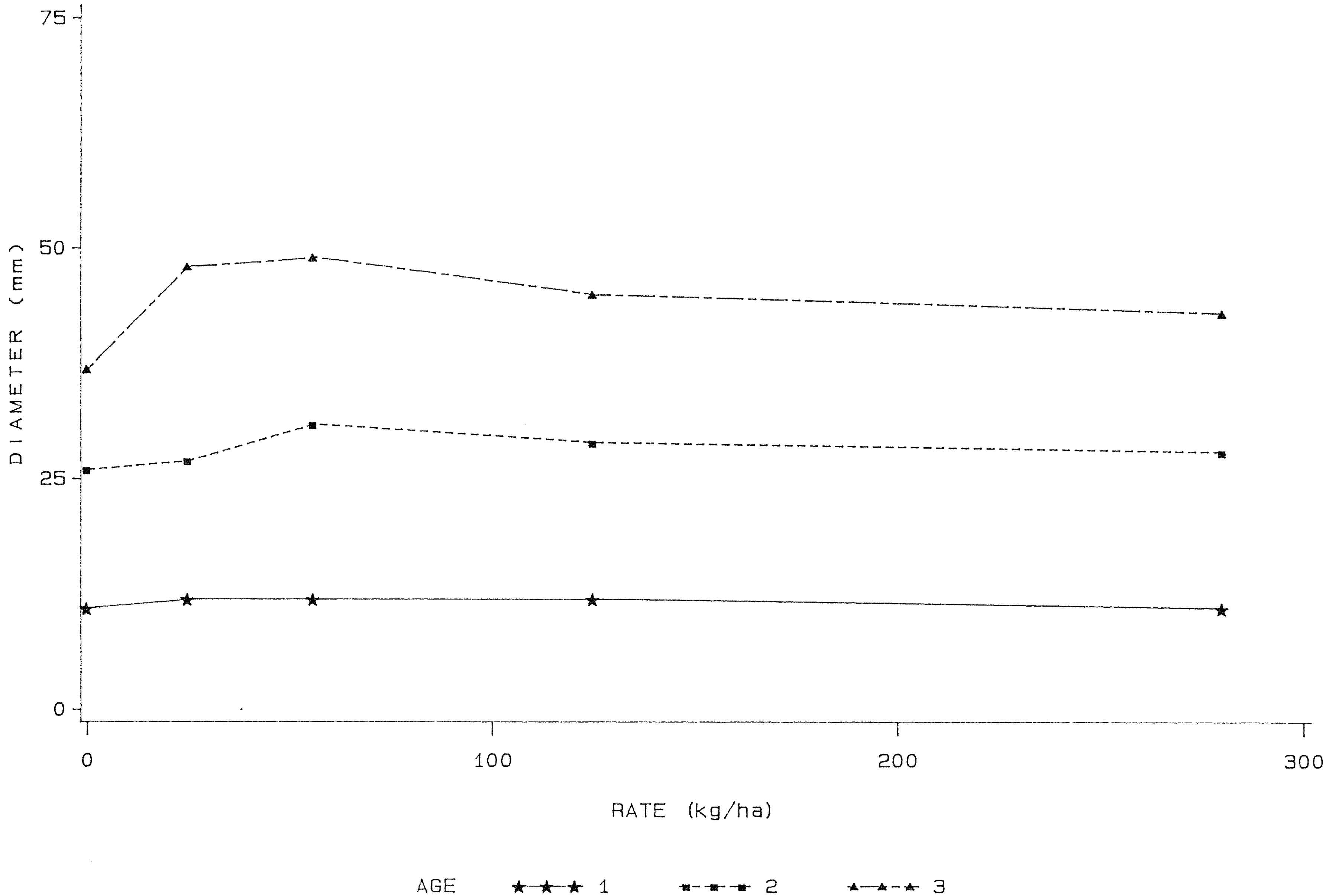


FIGURE 3

THE EFFECT OF FERTILISER TREATMENT ON FOLIAR P

TRIAL AK925/1

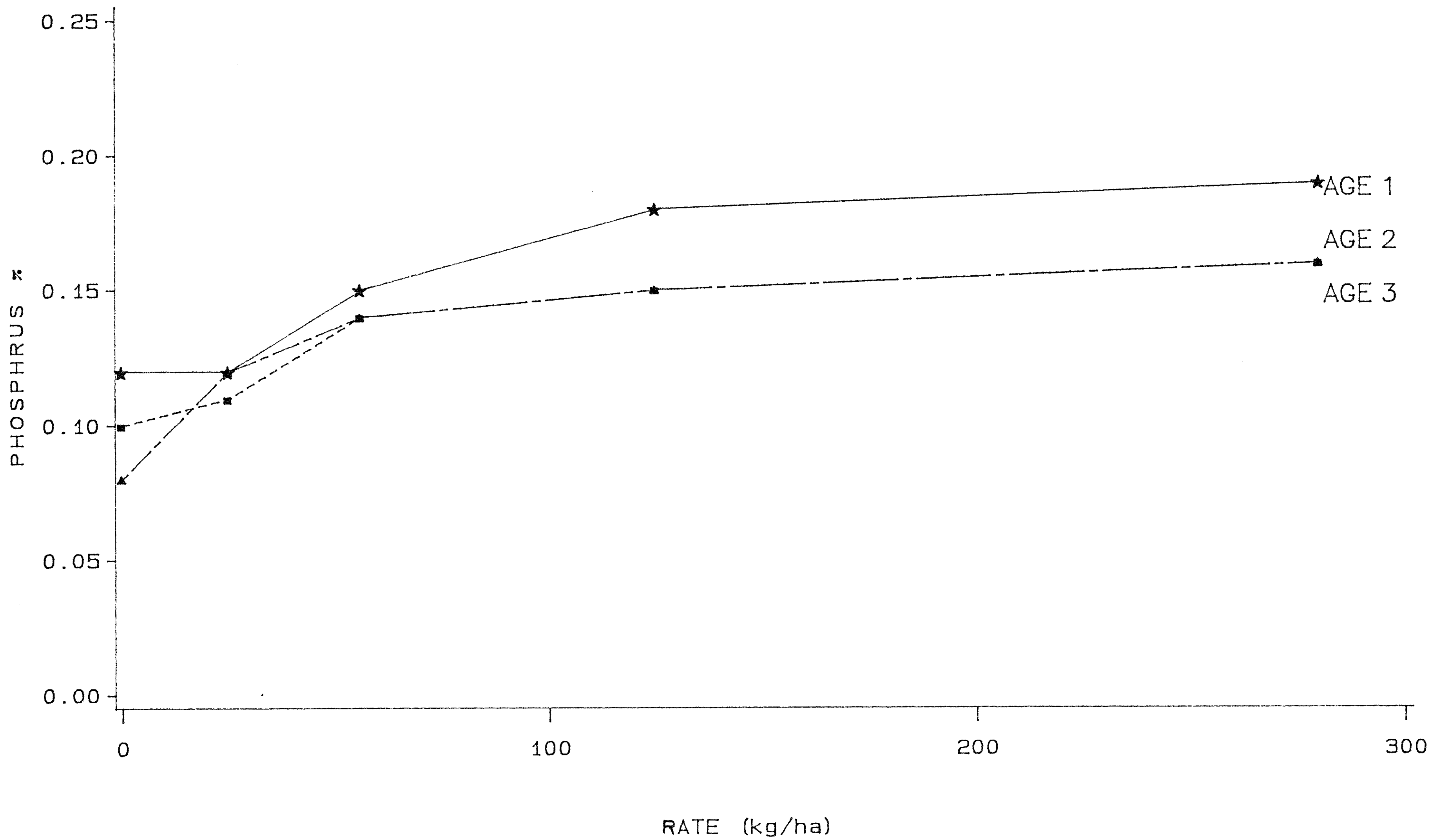


FIGURE 4

THE EFFECT OF FERTILISER TREATMENT ON FOLIAR N

TRIAL AK925/1

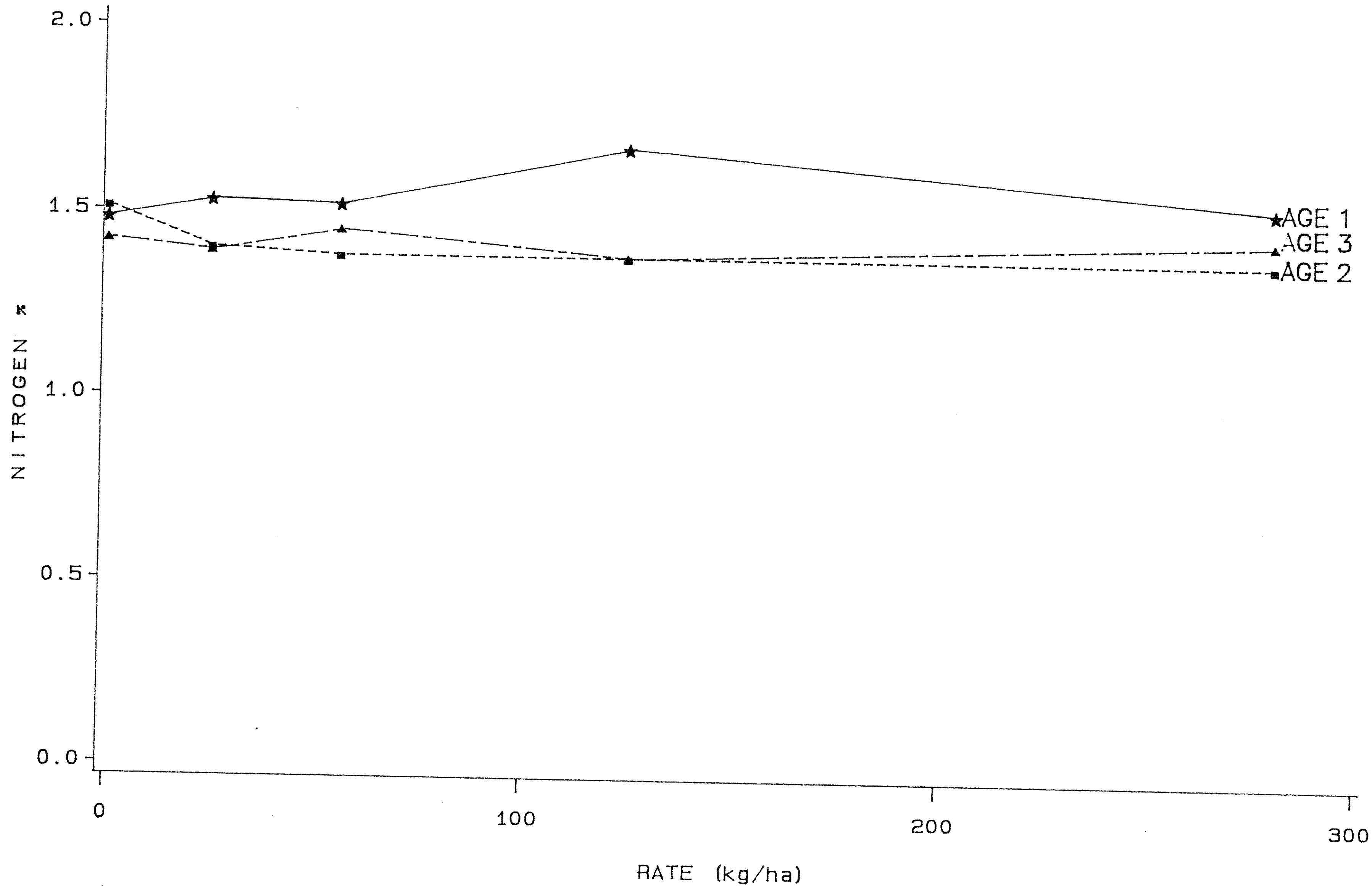
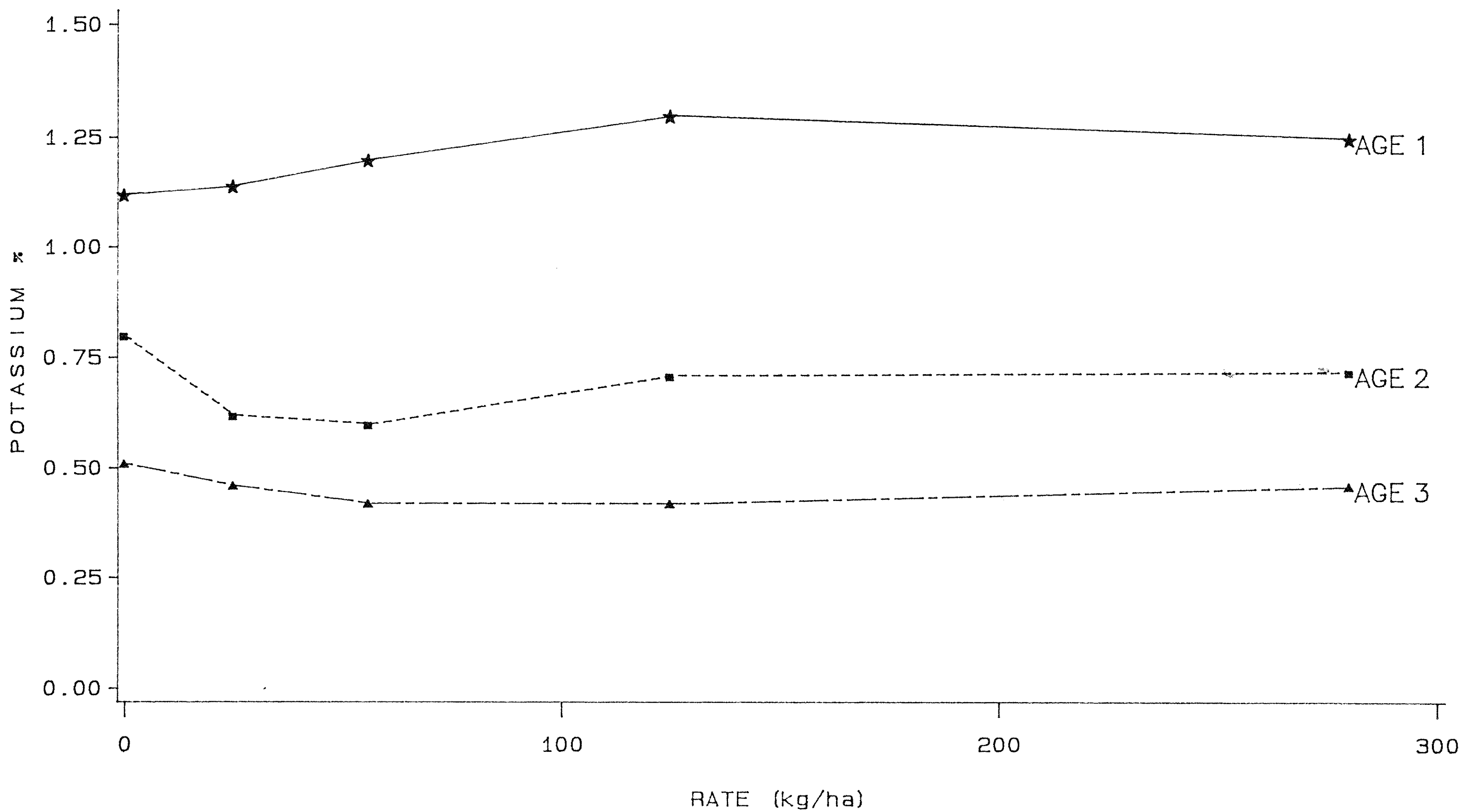


FIGURE 5

THE EFFECT OF FERTILISER TREATMENT ON FOLIAR K

TRIAL AK925/1



REFINING THE PHOSPHATE ROCK STRATEGY, RATES OF PHOSPHATE ROCK AT ESTABLISHMENT

TRIAL AK925/2

M.F. Skinner

E.D. Robertson

A confidential report prepared for
Northern Pulp Ltd

April 1987

Soils and Site Amendment Section
Forest Management and Resouces Division
Ministry of Forestry
Forest Research Institute

MANAGEMENT SUMMARY

1. WITH THE GRP STRATEGY, 125 KG P/HA APPEARS TO BE THE OPTIMUM RATE (AS ASSESSED AT AGE 3)
2. WITH THE DAP OPTION, REFERTILISATION MUST BE UNDERTAKEN AGE 2 TO ENSURE TREES DO NOT BECOME P DEFICIENT.

INTRODUCTION

Ground phosphate rock (GPR) applied as a broadcast fertiliser to radiata pine, at time-of-planting can maintain foliar P at or above 0.11% for at least the first 6 years (Hunter and Skinner, 1986) as shown by the early series of GPR trials. In that series of experiments the application rate was 145 kg P/ha. This rate may have been excessive. A rates by Soil Type Series of trials was designed to determine the optimum rate of GPR for the early growth of radiata pine.

MATERIALS AND METHODS

A. Sites

Six sites were chosen over a range of soil types from Northland to Westland. This report covers Ak925/2 on Karikari Peninsula near Kaitaia (Northern Pulp Ltd).

B. Soils

The soil type is Pukenamu silt loam. Its characteristics are as follows:

Total N	0.13
Total P	44 ppm
Bray P	1.8 ppm
Bray Ca	1.1 meq %
Bray Mg	1.1 meq %
Bray K	0.06 meq %

Soil values for N are low. The values of P and K are extremely low.

C. Fertiliser treatments

The GPR source was Christmas A/Nauru A mix (1:1 w/w) at 14.5 % P. The treatments are:

No	Rate Kg P/ha
1	0
2	25
3	56
4	125
5	280
6	Current fertiliser prescription (soluble N and P) approximating 15g P, 15g N/seedling.

Each treatment was replicated eight times to allow for refertilising of half the trial at age 3.

RESULTS

Growth and Nutrition

All rates of GPR increased the growth of radiata pine at age 1. Height growth ranged from 0.4 metres (control) to 0.7 metres (280 kg P/ha) with DAP-treated trees at 0.6 metres (Table 1, Fig.1). All growth increases were significant (P.05) except at the lowest P rate (25 kg P/ha) where the 0.1 metre increase just failed to reach significance. Foliar P concentrations show a graded increase with increasing P rates to a maximum of 0.14%, the same as recorded with the DAP treatment. P concentrations at all other rates were less than the "0.11%" critical level.

By age 2 tree heights within the P rates were from 1.3 metres (25 kg P/ha) to 1.9 metres (280 kg P/ha). Controls were 0.5 metres and DAP-treated trees 1.5 metres, equivalent to the 56-125 kg P/ha rates.

Foliar P concentrations increased slightly for the 25 and 56 kg P/ha treatments between ages 1 and 2, remained constant for the 125 kg P/ha treatment and declined slightly for the 280 kg P/ha treatment (Table 2, Fig.2).

By age 3, the height response to P showed a strong plateau effect after the 56 kg P/ha treatment where trees averaged 2,9 metres height. The DAP-treated trees recorded 2.4 metres height.

By age 3 the DAP-treated trees were markedly P deficient at 0.07%. Even though the "plateau' effect for the P rates occured at about 56 kg P/ha, this treatment yielded foliar P at 0.09%. The critical level of 0.11% fell somewhere between the 125 and the 280 kg P/ha treatments.

Foliar N values (Fig.3) were more or less satisfactory; Foliar K values (Fig.4) indicate a possible K deficiency to be expected within the next 3 years

DISCUSSION

On Pukenamu silty clay loam, the response to P (as GRP) is marked. 125 kg P/ha appears to be the optimum rate through to age 3, although there are indications that this rate may need to be increased to maintain growth beyond age 3. DAP is satisfactory only for the very early growth of radiata. With DAP alone at establishment, refertilisation must be undertaken by age 2 if foliar P is to be maintained above the 0.11% level.

The economics of phosphate rock

Strategy A

At establishment

Apply 80 g DAP.seedling @ 1500/ha	72
Application	40
	112

Age 2

Apply 500 kg DAP/ha	280
Application	65
	245

$$\text{Present value} = 112(1.1)^{0} + 245)1.1)^{2}$$

$$= \$\ 314$$

Strategy B

At establishment

Apply 125 kg P/ha	$ 172
Application	65
	237

The GPR strategy is 0.75 the cost of the soluble fertiliser strategy taken to age 3 only.

CONCLUSION

P deficiency symptoms are extreme for radiata on this soil type. DAP is effective for less than 2 years, and GRP appears to have difficulty in supplying available P unless the rates are in excess of 125 kg P/ha. Nitrogen values are less than 1.5% by age 3, and N deficiency is likely to be a problem between ages 4 and 6. Potassium concentrations are currently adequate.

REFERENCES

HUNTER I.R. and SKINNER M.F. Establishing radiata pine on the North Auckland podzols. N.Z. Forestry 31 (3):17-23. 1986.

Table 1. The effect of fertiliser treatment on the growth of radiata pine.

	Fertiliser treatment					
	Rockphosphate (kg P/ha)					DAP (80 g/tree)
	0	25	56	125	280	
Age 1						
Ht (cm)	38	49	57	62	69	63
Dia(mm)	12	14	18	19	24	22
	LSD P.05 Ht=11; Dia=5					
Age 2						
Ht (cm)	54	126	170	181	193	151
Dia(mm)	18	38	57	56	62	51
	LSD P.05 Ht=33; Dia=11					
Age 3						
Ht (cm)	96	220	288	305	307	244
Dia(mm)	28	65	87	85	89	72
	LSD P.05 Ht=42; Dia=12					

Table 2. The effect of fertiliser treatment on foliar nutrients to age 3.

Foliar nutrient (%)	Treatment (kg P/ha)					DAP
	0	25	56	125	280	
Age 1						
N	1.75	1.56	1.68	1.59	1.67	1.97
P	0.06	0.07	0.08	0.10	0.14	0.14
K	0.79	0.81	0.79	0.83	0.83	0.90
Age 2						
N	2.10	1.61	1.54	1.49	1.39	1.45
P	0.06	0.08	0.10	0.11	0.13	0.08
K	0.72	0.65	0.66	0.63	0.43	0.74
Age 3						
N	2.12	1.51	1.40	1.34	1.32	1.55
P	0.06	0.09	0.09	0.10	0.12	0.07
K	0.71	0.71	0.59	0.46	0.41	0.66

FIGURE 1

THE EFFECT OF FERTILISER TREATMENT ON HEIGHT GROWTH

TRIAL AK925/2

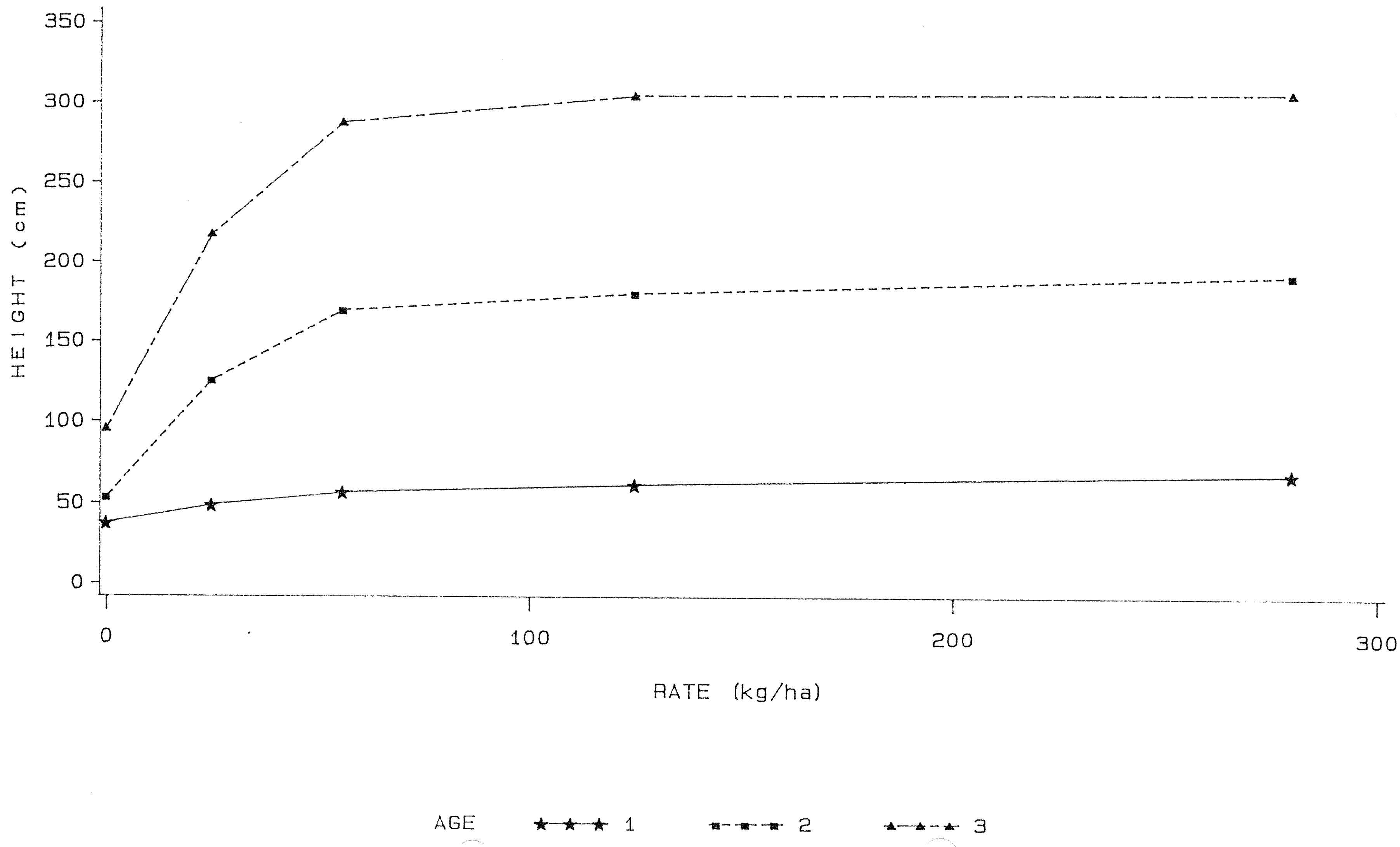


FIGURE 2

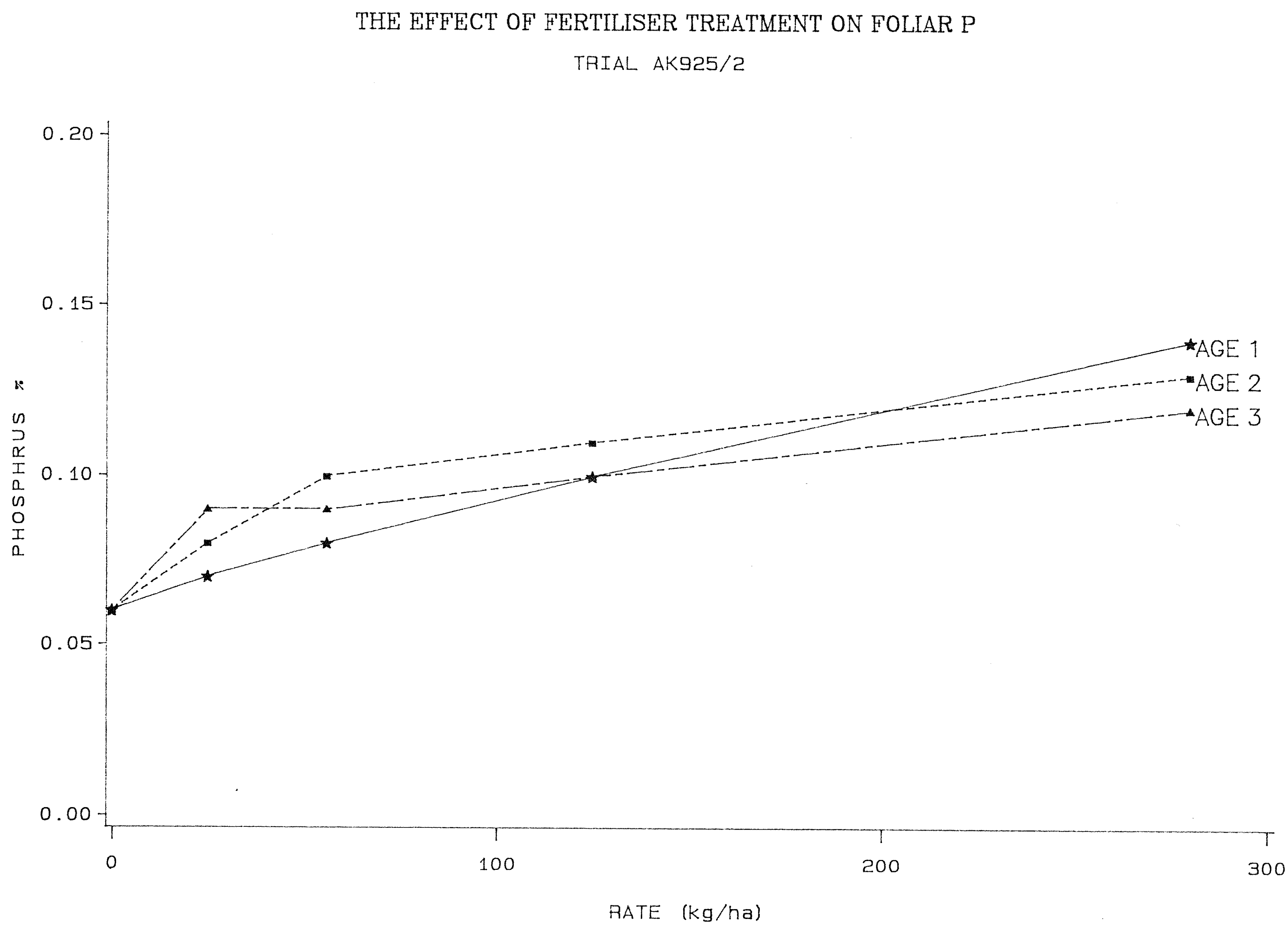

THE EFFECT OF FERTILISER TREATMENT ON FOLIAR P
TRIAL AK925/2
0.20
0.15
0.10
0.05
0.00
PHOSPHRUS %
AGE 1
AGE 2
AGE 3
0
100
200
300
RATE (kg/ha)

FIGURE 3

THE EFFECT OF FERTILISER TREATMENT ON FOLIAR N

TRIAL AK925/2

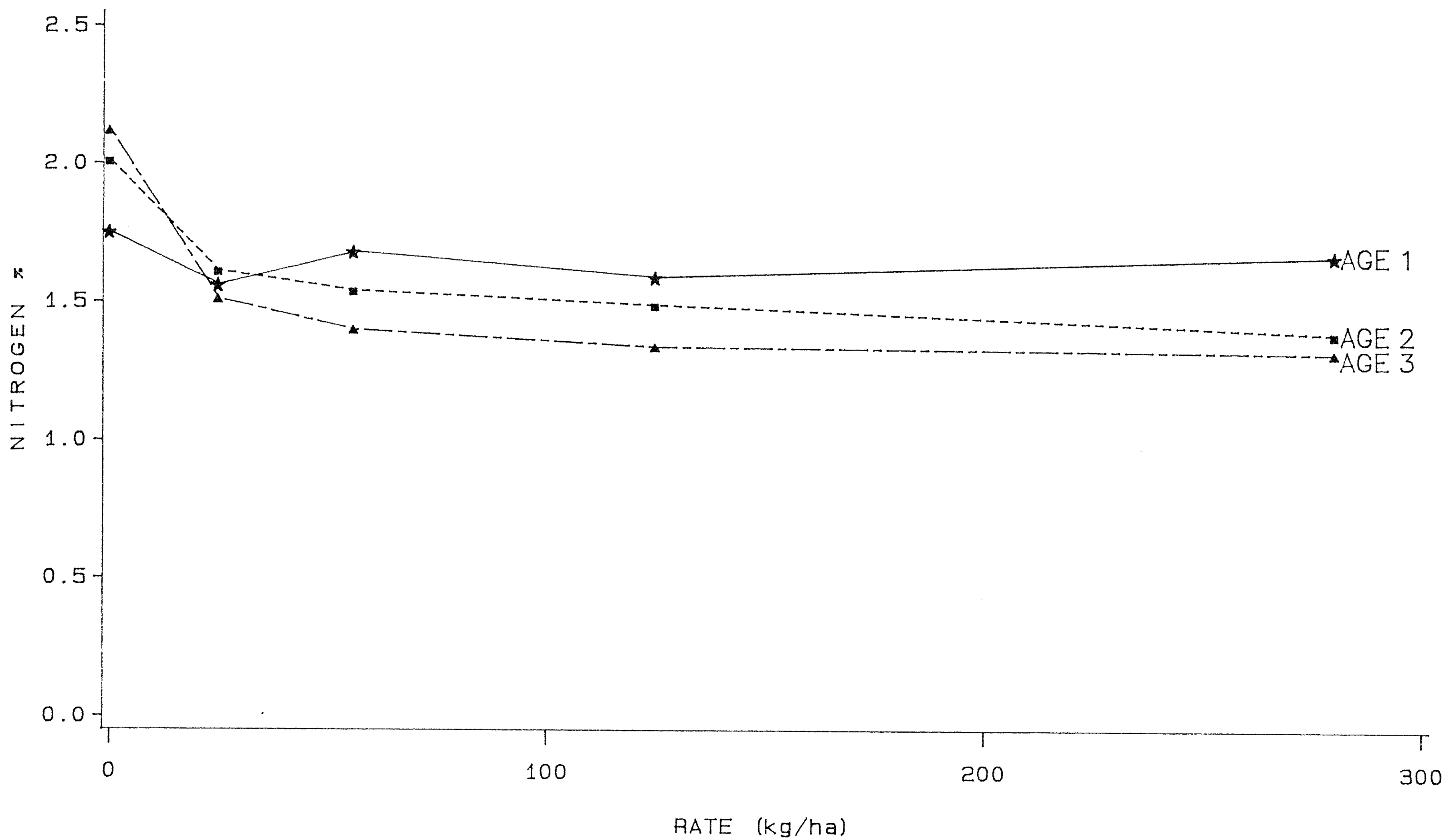
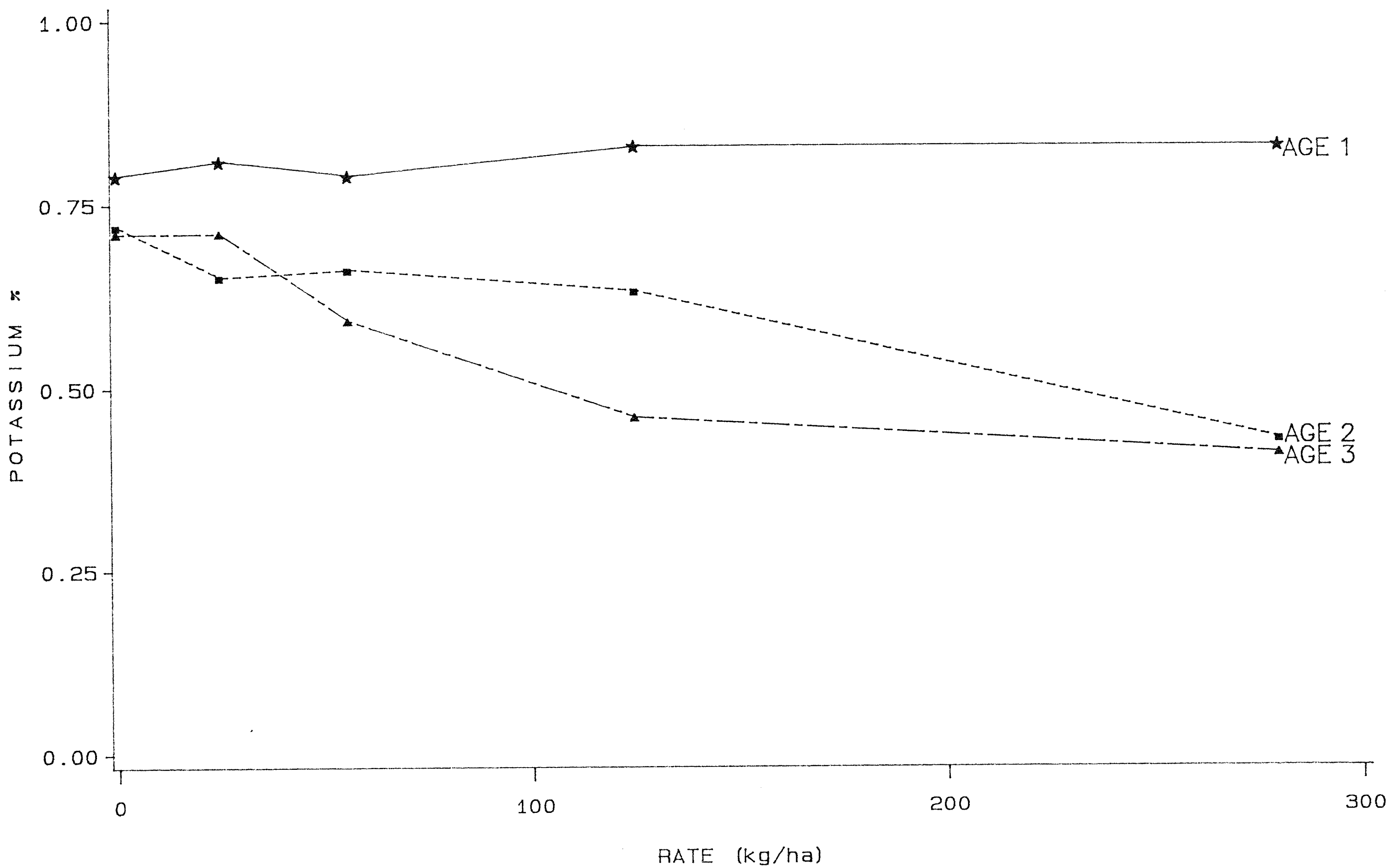


FIGURE 4

THE EFFECT OF FERTILISER TREATMENT ON FOLIAR K

TRIAL AK925/2



REFINING THE PHOSPHATE ROCK STRATEGY, RATES OF PHOSPHATE ROCK AT ESTABLISHMENT

TRIAL AK925/3

M.F. Skinner
E.D. Robertson

A confidential report prepared for
New Zealand Forest Products Ltd

April 1987

Soils and Site Amendment Section
Forest Management and Resouces Division
Ministry of Forestry
Forest Research Institute

MANAGEMENT SUMMARY

WAIMATENUI CLAY REQUIRES NO FERTILISER AMENDMENT

FOR THE EARLY GROWTH OF RADIATA PINE

INTRODUCTION

Ground phosphate rock (GPR) applied as a broadcast fertiliser to radiata pine, at time-of-planting can maintain foliar P at or above 0.11% for at least the first 6 years (Hunter and Skinner,1986) as shown by the early series of GPR trials. In that series of experiments the application rate was 145 kg P/ha. This rate may have been excessive. A Rates by Soil Type Series of trials was designed to determine the optimum rate of GPR for the early growth of radiata pine.

MATERIALS AND METHODS

A. Sites

Six sites were chosen over a range of soil types from Northland to Westland. This report covers A925/3 in Northland at Opeteke West (north of Dargaville) on New Zealand Forest Products land.

B. Soils

The soil type is Waimatenui silty clay. Its characteristics are as follows:

Total N	0.71
Total P	888 ppm
Bray P	5.3 ppm
Bray Ca	4.6 meq %
Bray Mg	1.7 meq %
Bray K	0.45 meq %

Soil N is adequate; Bray-P indicates a P deficient soil; other nutrients are adequate.

C. Fertiliser treatments

The GPR source was Christmas A/Nauru A mix (1:1 w/w) at 14.5 % P. The treatments are:

No	Rate Kg P/ha
1	0
2	25
3	56
4	125
5	280
6	Current fertiliser prescription (soluble N and P) approximating 15g P, 15g N/seedling.

Each treatment was replicated eight times to allow for refertilising of half the trial at age 3.

RESULTS

Growth and Nutrition

No statistically significant effects of fertiliser treatment on height or diameter growth could be detected at either age 1 or 2 years. However, trends were evident. Unfertilised trees by age 1 were 60 cm in height and 13 mm in diameter; gains of up to 8 cm in height were achieved with GRP at 280 kg P/ha and 10 cm with DAP (Table 1, Fig.1). By age 2 the trends were still apparent. Control trees were 1 metre in height and 30 mm in diameter; GRP at the highest rate produced a 22 cm gain in height, comparable with the DAP treatment.

Between ages 1 and 2 foliar P levels were never less than 0.13% (Table 2, Fig.2); trees fertilised with GRP showed increased foliar P levels with increasing rates of P.

By age 3 there were marginal gains to P at and above the 25 kg P/ha rate (controls at 1.5 metres; GRP treatments at about 1.7 metres and DAP at 1.8 metres). Foliar P levels in the controls were at 0.12% and at or in excess of 0.13% in all other treatments. Foliar N (Fig.3) and K (Fig.4) values were satisfactory.

DISCUSSION

On Waimatenui clay, there was little response to any of the fertiliser treatments, even though the Bray-P test indicated P deficiency. The gains to fertiliser (either DAP or GRP at the 25 kg P/ha rate) were about 25 cm over the unfertilised controls. The test for the effectiveness of the fertiliser will occur between ages 4 and 6 when the trees begin to make their greatest demands on the soil for nutrients. If P deficiency does develop in the controls, the GRP treatment is likely to be effective is preventing deficiency. The DAP effect will have been long since over.

CONCLUSION

The growth of radiata pine in the first three years from establishment on Waimatenui clay appears to be adequate without fertiliser. P deficiency may still be a problem between ages 4 and 6.

REFERENCES

Hunter I.R and Skinner M.F. Establishing radiata pine on the North Auckland podzols. N.Z. Journal of Forestry 31 (3):17-23, 1986.

Table 1. The effect of fertiliser treatment on the growth of radiata pine.

	Fertiliser treatment					
	Rockphosphate (kg P/ha)					DAP (80 g/tree)
	0	25	56	125	280	
Age 1						
Ht (cm)	60	66	62	66	68	70
Dia(mm)	13	13	12	13	13	15
	LSD P.05 Ht=10; Dia=3					
Age 2						
Ht (cm)	101	104	107	119	122	123
Dia(mm)	30	35	30	36	38	40
	LSD P.05 Ht=22; Dia=8					
Age 3						
Ht (cm)	148	173	166	172	170	184
Dia(mm)	50	61	56	58	63	63
	LSD P.05 Ht=36; Dia=13					

Table 2. The effect of fertiliser treatment on foliar nutrients at age 3.

Foliar nutrient (%)	Treatment (kg P/ha)					DAP
	0	25	56	125	280	
Age 1						
N	2.21	2.25	2.16	2.20	2.31	2.39
P	0.14	0.18	0.19	0.21	0.23	0.19
K	1.21	1.26	1.27	1.20	1.28	1.32
Age 2						
N	1.22	1.74	1.74	1.74	1.86	1.81
P	0.14	0.15	0.17	0.18	0.21	0.16
K	1.03	1.07	1.11	1.01	1.09	1.07
Age 3						
N	1.67	1.68	1.72	1.56	1.59	1.66
P	0.12	0.13	0.14	0.14	0.16	0.13
K	1.03	1.03	1.03	1.04	1.02	1.03

FIGURE 1

THE EFFECT OF FERTILISER TREATMENT ON HEIGHT GROWTH

TRIAL AK925/3

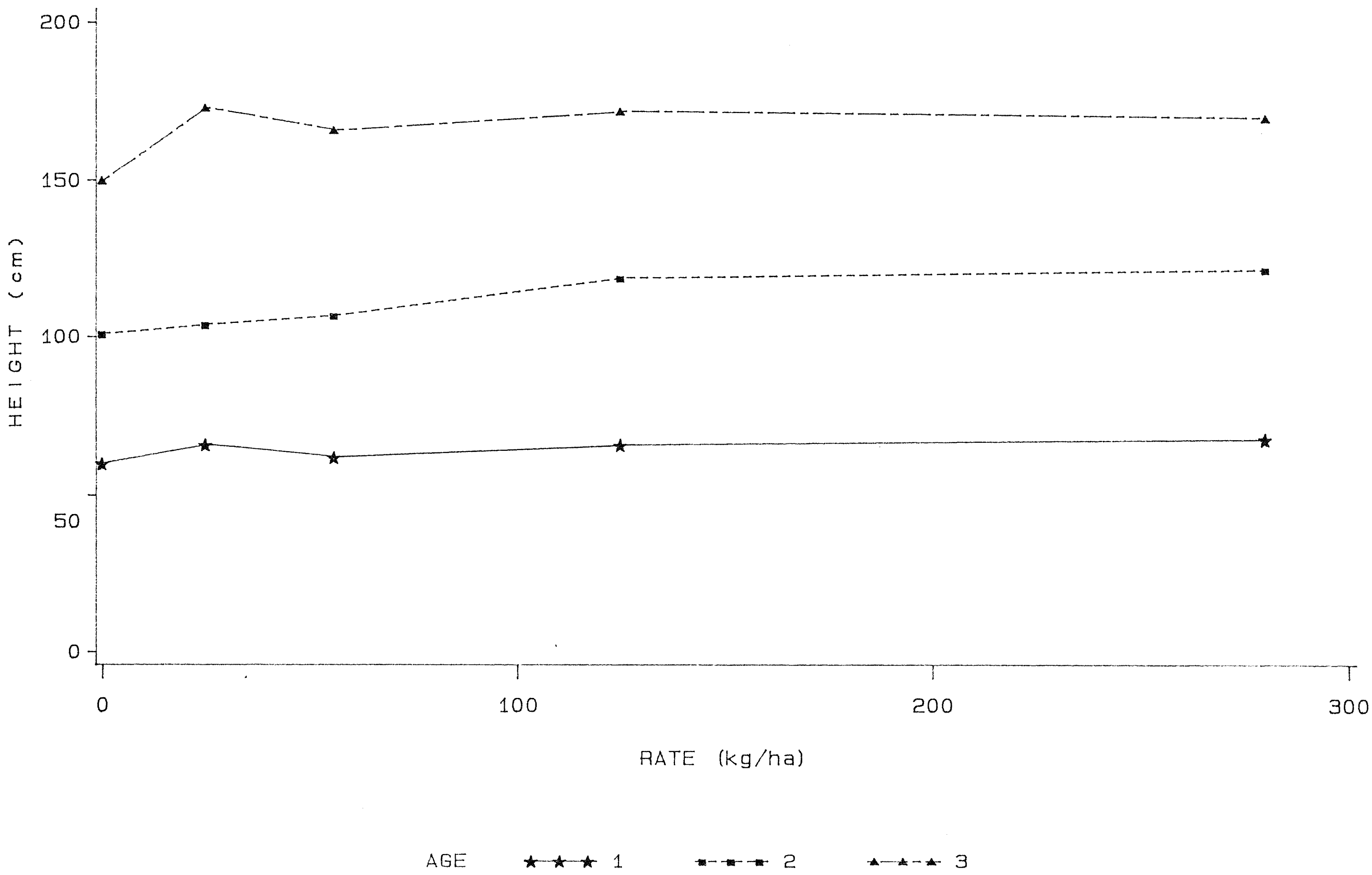


FIGURE 2

THE EFFECT OF FERTILISER TREATMENT ON FOLIAR P

TRIAL AK925/3

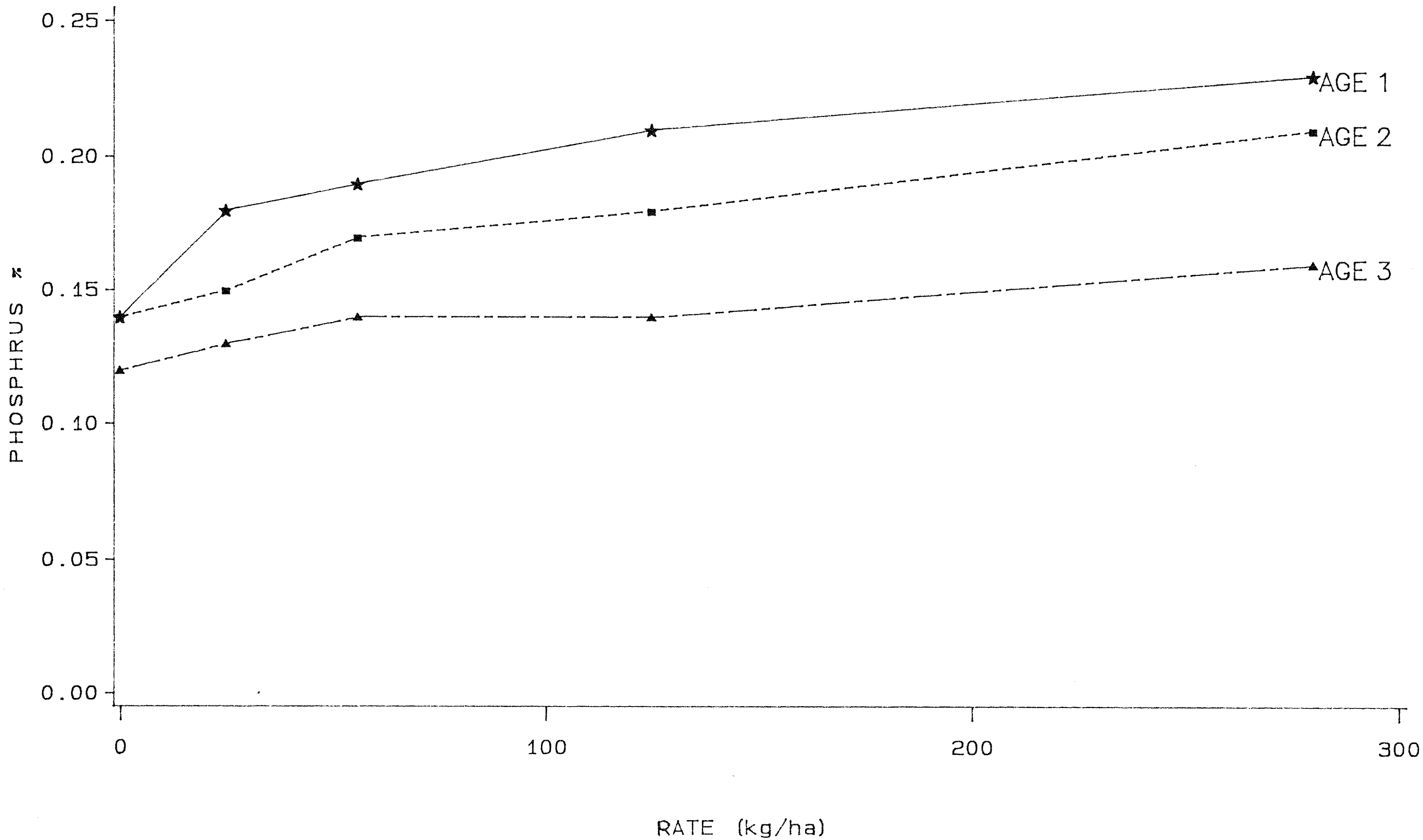


FIGURE 3

THE EFFECT OF FERTILISER TREATMENT ON FOLIAR N

TRIAL AK925/3

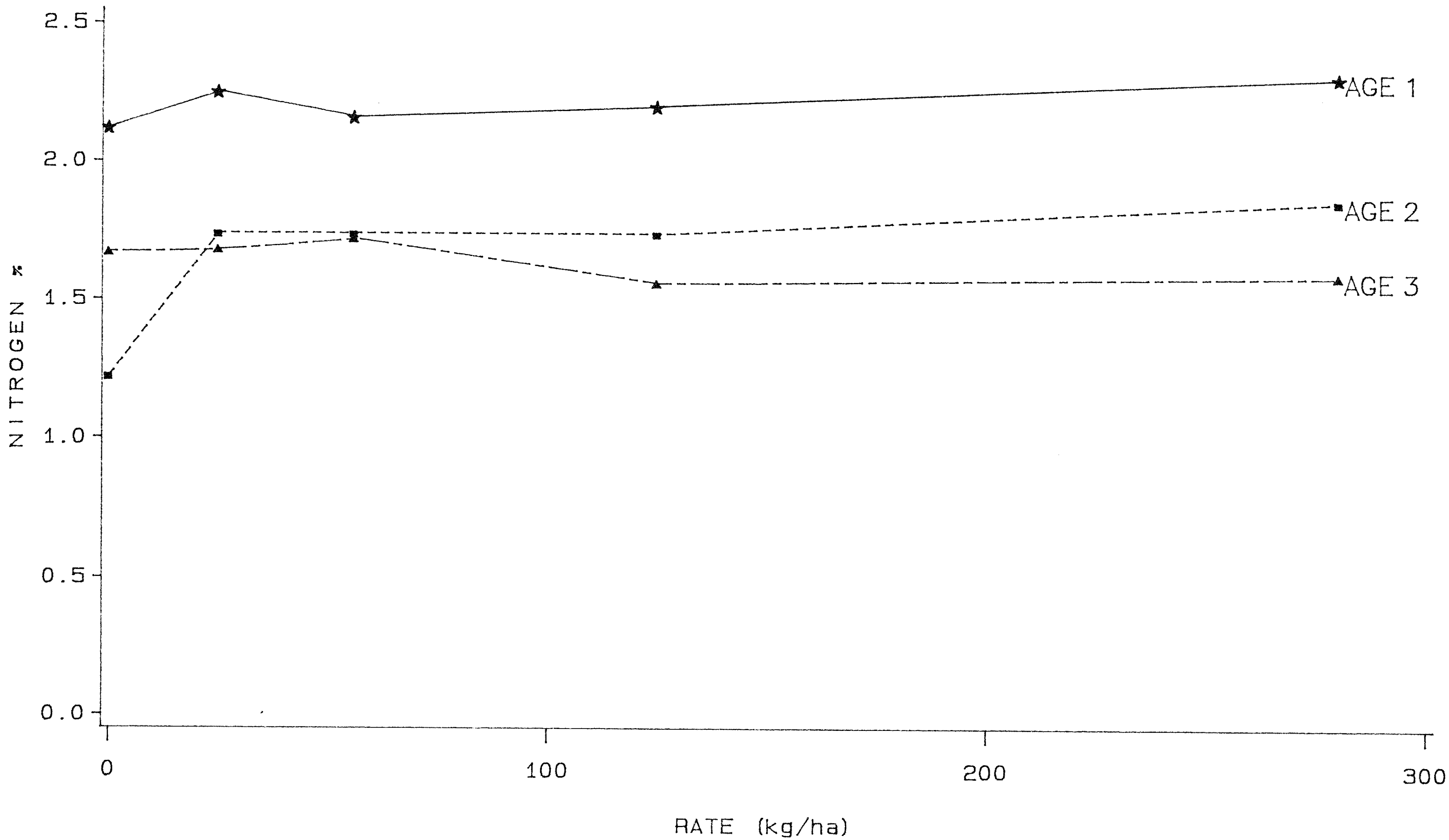
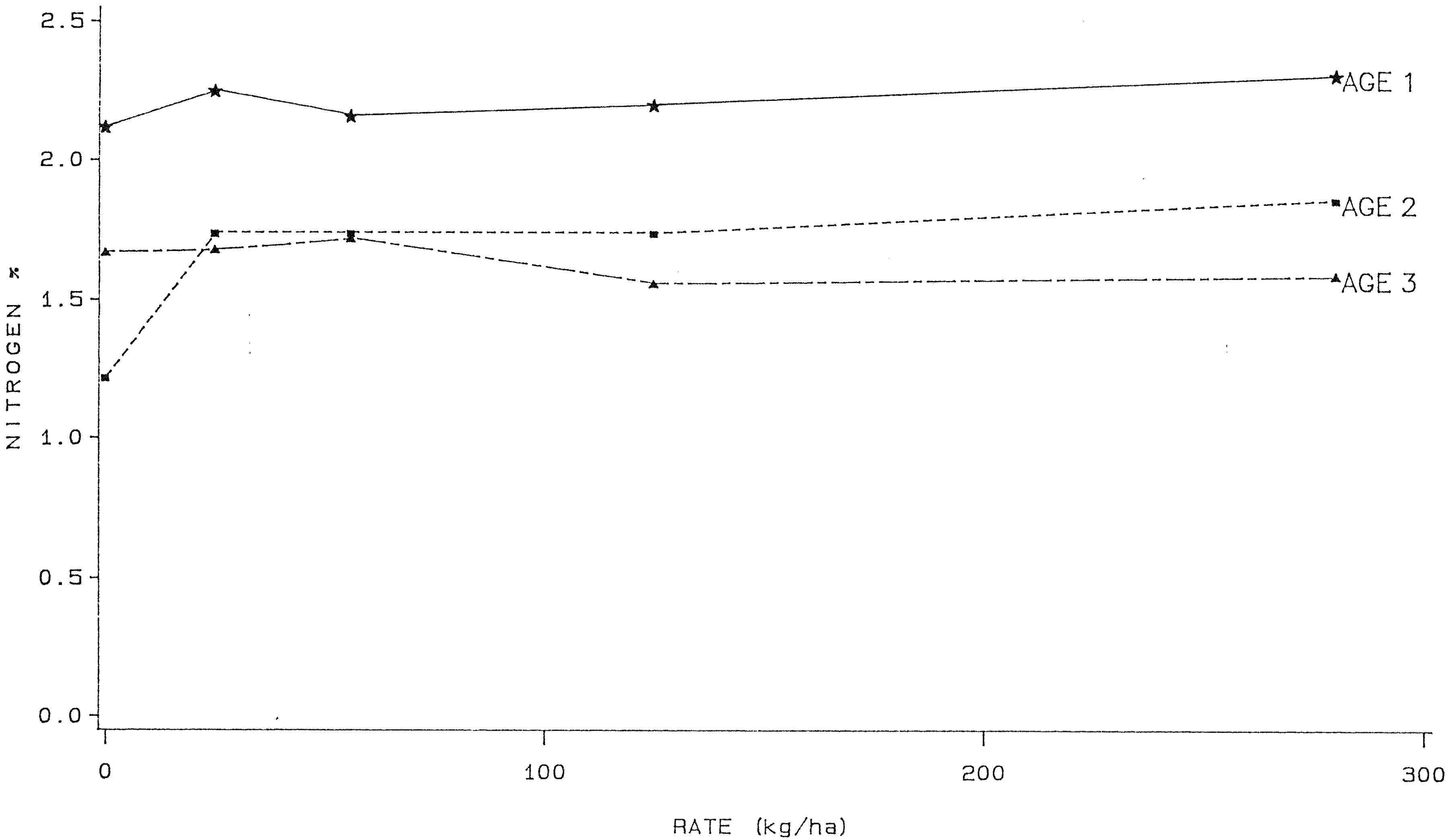


FIGURE 4

THE EFFECT OF FERTILISER TREATMENT ON FOLIAR N

TRIAL AK925/3



THE EFFECT OF FERTILISER TREATMENT ON FOLIAR K

TRIAL AK925/3