A PRELIMINARY STUDY ON THE RESPONSE OF TIMBER IN THE TRANSKEI TO FERTILIZATION

(Met opsomming in Afrikaans)

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Abstract

Fertilization trials on *Eucalyptys grandis* and *Pinus patula* first planting were laid down in the Transkei as part of an extensive research programme of Fedmis (Pty) Ltd on fertilization of timber in South Africa. Fertilizer was applied at planting in 1965.

Fertilized trees showed a dramatic response in height measurements within the first season. The volume of wood per tree of fertilized trees was significantly higher than that of unfertilized trees and this difference in volume seems to increase almost linearly each year. Furthermore, irrespective of the inherent growth rate of trees, pines and eucalypts being different, fertilization accelerated growth rate by approximately 30 per cent.

Introduction

The Transkei, in 1962, had 33 800 hectares (83 500 acres) under timber — its contribution being 3,6 per cent of the total timber area in South Africa. This is, however, 7 per cent of the total land area in Transkei compared to the one per cent timber area in South Africa. The value of timber felled during 1962 in the Transkei for different purposes, amounted to more than R190 000 of which 63 per cent was earned by the local inhabitants.

Thus it can be seen what important role Transkeian timber plays in the economic structure of that homeland. The Transkei with its congenial climate and topography, is an ideal timber-growing area with considerable possibilities for expansion. This can be achieved by enlarging the area under timber or by increasing the rate of tree growth in its rotation or alternatively, by reducing its rotation period. The object of this paper is to discuss the expansion of production by means of fertilization practices.

There is an ever increasing demand for timber all over the world. The demand for timber in the USA will exceed double the present demand by the end of this century, whilst total consumption in Europe increased by 59 per cent in the period 1950 — 1958 (Baule & Fricker, 1970). The current demand for timber in the Republic of South Africa, in terms of round wood equivalent, is 11 630 000m^3. This excludes firewood. Over the next 30 years this figure will rise to 32 650 000 m^3 in round wood equivalent. To supply the needs of the country's timber-using industries, the average planting rate of the past decade would have to be quadrupled, within the next generation (Timber Vol. 10, 1973).

Fertilization of timber became an integral part of the South African silvicultural practice over 40 years ago. Local research by Donald (1963) and Deetlefs & Dumont (1963) stimulated Fedmis (Pty) Ltd (then Fisons (Pty) Ltd) in 1964 under the supervision of H Wilhelmij, to conduct a long-term fertilization research programme throughout South Africa on physical growth responses of eucalypts, pines and poplars and on its economic implications. Preliminary reports on these trials were presented by Dicks, Jackson & Kirk (1965) and Möhr, Kirk & Dicks (1968). Two of these trials are dealt with in this paper.

Materials and methods

In co-operation with the foresters of the Transkeian Department of Agriculture and Forestry, a *Eucalyptus grandis* first-planting trial was laid out in the Mabeleni plantation and a *Pinus patula* first-planting trial in the Mhlahlane plantation, near Umtata.

The treatments of the trials are selected combinations of a 4^3 factorial with 2 replications. The selected combinations are those used in the San Cristobal design by Rojas (1962). Additional NPK combinations have been added. The fertilizer levels were as follows:

1 Eucalypt trial

Source	*Nutrient*	*kg per hectare of nutrient*			
LAN (26% N)	N	0	22	44	66
Superphosphate (8,3% P)	P	0	17	34	51
KCl (50% K)	K	0	28	56	84

2 Pine Trial

Source	*Nutrient*	*kg per hectare of nutrient*			
LAN (26% N)	N	0	11	22	33
Superphosphate (8,3% P)	P	0	17	34	51
KCl (50% K)	K	0	22	44	66

Except for 'controls', all plots received a basal dressing of 11 kg P/ha at planting.

Analytical results of soil samples taken before fertilization, are presented in Table 1.

TABLE 1 Analytical results of soil samples taken before fertilization

Location	pH		Parts per million				Conductivity	CEC me %
	H_2O	KCl	P	K	Ca	Mg		
E. grandis	5,2	4,0	13	300	550	70	70	18,4
P. patula	5,1	4,0	6	125	240	115	34	18,3

Soil texture: *E. grandis* — sandy clay loam to sandy loam.
P. patula — sandy loam.

Soils on both locations were low in phosphorus with calcium and magnesium medium to low. The potassium content of the eucalypt soil was high, whilst medium low in the pine soil. The soil in both trials was very acid.

Nursery seedlings selected for uniformity of height and vigor, were planted in June, 1965, and fertilized in January, 1966. The nett plots sizes were 20 trees spaced 2,75 x 2,75m for eucalypts, and 42 trees spaced 2,4m x 2,4m for pines. The first measurements were taken in April, 1966.

Height and diameter breast height (DBH) measurements have been recorded for both trials since 1968/1969. Since 1972 for pines and 1973 for eucalypts, trees have grown to the extent where accurate height measurements of individual trees are practically impossible. Final measurements will thus be taken after completion of the rotation cycle when the trees are felled.

In this study, the response to fertilization on height, DBH and consequent under bark (UB) volume per tree will be compared with unfertilized trees. The treatment of 44kg N + 34kg P per hectare will be used as the fertilization treatment in the case of *E. grandis,* whilst the treatment of 22kg N + 62kg P + 44kg K per hectare will be used in the case of *P. patula* respectively for a basis of comparison.

Results

The effect of fertilization on tree heights

The effect of fertilization on the annual tree height of *E. grandis,* is given in Table 2.

TABLE 2 Eucalyptus grandis: *Effect of fertilization on the annual height increments per tree (in metres)*

Treatment	Year						
	1966	1967	1968	1969+	1970	1971	1972
Unfertilized trees	0,36	1,68	4,18	6,71	12,19	14,48	16,76
Fertilized trees	0,85	3,54	6,92	7,59	13,72	16,31	18,75
Difference	0,49	1,86	2,74*	0,88*	1,53*	1,83*	1,99*

* Difference is significant at the 5% level. Statistical anylyses of the results were not done before 1968.

+ The trees were pruned to half their height during January, 1969.
Measurements taken in September, 1969.

A dramatic response was observed within the first year — an increase of more than 136% due to fertilization. Mahandrappa, Salonius & Calvert (1967) observed a similar response on *Eucalyptus saligna* in Canada at the same fertilization levels.

With the maturing of the trees, there is a gradual reduction in the rate of height increase, which is to be expected, but what is more interesting, is the fact that the annual height increments of the fertilized trees are increasing each year over the control trees. This effect would have been more impressive, had the pruning in 1969 not affected the fertilized trees so adversely.

The effect of fertilization on the annual tree height of *P. patula*, is given in Table 3.

The same tendency was observed as with the eucalypt response, although not so dramatically, as pines are slow growers. It would appear that the growth rate of fertilized trees was boosted in the first two years, but then slowed down to the normal annual growth rate of unfertilized trees, thus maintaining the height difference obtained from that early fertilizer booster.

The effect of fertilization on DBH

The effect of fertilization on the annual DBH increments of *E. grandis*, is given in Table 4.

Without the initial DBH measurements after fertilization, it is rather difficult to observe any fertilizer response. Measurements taken two years after fertilization show no increasing difference in growth rate due to fertilization, neither does the annual DBH increments show any consistent pattern. This could be due to fluctuating climatic conditions. Pruning, however, seems to have adversely affected fertilized trees more than unfertilized trees.

TABLE 3 Pinus patula: *Effect of fertilization on the annual height increments per tree (in metres)*

Treatment	Year					
	1966	1967	1968	1969+	1970	1971
Unfertilized trees	0,49	1,52	3,32	5,33	8,07	9,75
Fertilized trees	0,73	2,13	4,11	6,40	9,14	10,67
Difference	0,24	0,61	0,79*	1,07*	1,07*	0,92*

* Difference is significant at the 5% level. Statistical analyses of the results were not done before 1968.

\+ All the stems were pruned to 1, 5m during September, 1969.
Measurements taken immediately thereafter.

TABLE 4 Eucalyptus grandis: *Effect of fertilization on the annual DBH increments per tree (cm)*

Treatment	Year				
	1968	1969	1970	1971	1972
Unfertilized trees	6,10	6,98	10,16	11,43	14,10
Fertilized trees	8,89	9,78	11,81	13,33	15,88
Difference	2,79*	2,80*	1,65*	1,90*	1,78*

* Difference is significant at the 5% level. No DBH measurements were taken before 1968.

The effect of fertilization on the annual DBH increments of *P. patula,* is given in Table 5.

Measurements taken two years after fertilization show a response tendency to fertilization up to 1969.

From 1970 onwards, the annual rate of growth seems to be the same for fertilized and unfertilized trees. The difference in DBH can be attributed on the initial fertili[zer] boost.

The effect of fertilization on tree volume

The effect of fertilization on the annual UB volume [per] tree of *E. grandis* and *P. patula* is given in Tables 6 and [7] respectively.

TABLE 5 Pinus patula: *Effect of fertilization on the annual DBH increments per tree (cm)*

Treatment	Year			
	1968	1969	1970	1971
Unfertilized trees	3,30	6,98	11,81	14,22
Fertilized trees	4,06	8,13	13,21	15,49
Difference	0,76*	1,15	1,40	1,27

* Difference is significant at the 5% level.

TABLE 6 Eucalyptus grandis: *Effect of fertilization on the aanual UB volume per tree (m^3)*

Treatment	Year			
	1969	1970	1971	1972
Unfertilized trees	0,009	0,038	0,055	0,095
Fertilized trees	0,021	0,055	0,085	0,133
Difference	0,012*	0,017*	0,030*	0,038*

* Difference is significant at the 5% level.

TABLE 7 Pinus patula: *Effect of fertilizarion on the annual UB volume per tree (m^3)*

Treatment	Year			
	1968	1969	1970	1971
Unfertilized trees	0,001	0,010	0,035	0,058
Fertilized trees	0,002	0,015	0,048	0,076
Difference	0,001*	0,005*	0,013*	0,018*

* Difference is significant at the 5% level.

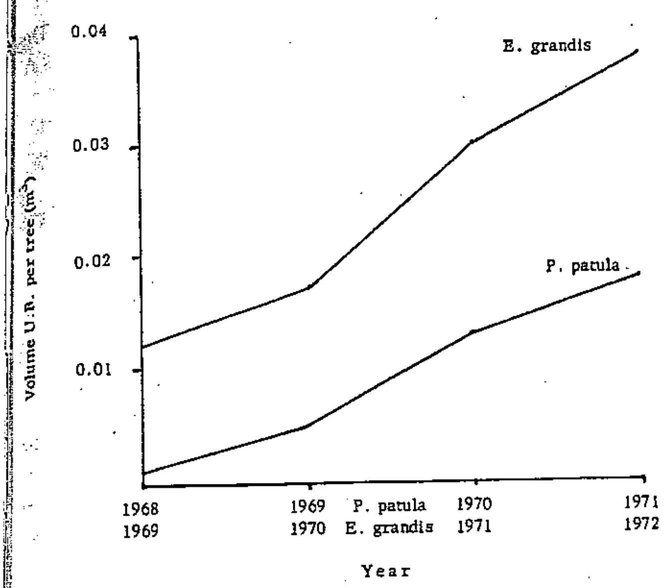

Figure 1 The accelerating effect of fertilization on the growth rate of E. grandis *and* P. patula.

Note: X – axis represents the unfertilized control for both species.

The significant effect of fertilization can be seen in Tables 6 and 7. More prominently though, is the accelerating increase in wood volume each season, due to fertilization when comparing the volume difference of fertilized trees with unfertilized trees each season in Tables 6 and 7. Figure 1 illustrates this.

More interesting though, is the fact that the annual volume UB per tree increments of the fertilized trees are increasing almost linearly each year over the control trees. Figure 1 illustrates it more clearly.

The different growth rates of *E. grandis* and *P. patula* can be seen from the above figure. Fertilization, however, accelerates the growth almost at the same rate in both species.

The effect of fertilization on growth rate

The average growth rate, expressed as mean annual increments (MAI), for *E. grandis* trees over its whole rotation period, is given as 31,5m^3/ha/annum and 24,5m^3/ha/annum for *P. patula*.

The periodical annual increment (PAI) for fertilized, *E. grandis* trees for the period 1969–1972, is 49,9m^3/ha/annum compared to the 38,0m^3/ha/annum of unfertilized trees – an increase of ca 30 per cent in growth rate due to fertilization.

The PAI for fertilized *P. patula* trees for the period 1968–1971, is 41,1m^3/ha/annum compared to the 31,9m^3/ha/annum of unfertilized trees – also an increase of ca 30% in growth rate due to fertilization. These results are very similar to those found in Europe (Baule & Fricker, 1970).

Fertilized *E. grandis* and *P. patula* trees have approximately one year's and two-thirds of a year's volume growth advantage, respectively, over unfertilized trees, at this stage.

Discussion

Heinsdorf (1964), Junack (1956) and Hausser (1956) and other researchers in Europe noted the considerable response fertilization had on annual volume increments of young and old pines and spruce (Baule & Fricker, 1970). Similar responses were found in the Transkei. However, what is significant from the results, is that irrespective of the inherent growth rate of trees, pines and eucalypts being different, the response of the periodical annual increment to fertilization, is the same, namely an increase of ca 30 per cent for the seven year old first plantings, for Transkei.

There is every reason to believe that this increase will have a marked effect on the reduction of the rotation age of timber trees. Rough extrapolation indicates a reduction of two to four years in the rotation irrespective of the species of tree, but depending on the rotation period.

With regards to the effect of fertilization on quality of timber, very little is known under local conditions. It is known that the climatic characteristics of South Africa, with its long hours of sunshine, cause timber to grow at an incredible speed, compared to timber producing countries of northern Europe and America, but this tends to have an adverse effect on its fibre characteristics. W Taylor (1973), Professor in Timber Science at the Mississippi State University in the USA, presently in South Africa and working in the CSIR's Timber Research Unit in Pretoria, found that growth rate has no significant effect on mass of the wood within individual trees *(Eucalyptus grandis / saligna).* This seems to indicate that fast-grown trees are not less dense than slow-grown trees of the same age. G S Klem (1968) found that fertilization increases the number of cells produced and has a slight change in the spring-wood: summer-wood ratio in pine trees. Fertilization will reduce specific gravity by approximately five per cent but this reduction, however, will be more than compensated for by the increase in volume production. The reduced variation in wood characteristics, together with the reduction in the amount of heart-wood, will facilitate pulp production and increase the homogeneity of the pulp.

Our own conclusions on the above and on the economic implications of fertilization, can only be confirmed and evaluated after completion of the rotation period and felling of the trees.

Acknowledgement

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