

RESPONSE OF OIL PALM SEEDLINGS TO GRADED LEVELS OF NITROGEN

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ABSTRACT

A pot culture experiment was conducted with six month old oil palm seedlings for a duration of 18 months, to study their growth characteristics and the total nutrient contents with respect to graded levels of nitrogen (specific levels being: 0, 100, 200 and 400 ppm nitrogen per seedling per year). Increased levels of nitrogen significantly increased different growth parameters. The seedlings receiving no nitrogen (N_0 level) were found to manifest foliar yellowing and stunted growth. The percentage distribution of biomass at N_0 level showed that the root constituted about 45 per cent of the total biomass; while in the case of N_{100} , N_{200} and N_{400} levels, they were only 25.1, 2.8 and 20.2 per cent respectively. Distribution of total nitrogen content of the seedlings indicate that at all levels of nitrogen application, 53 to 60 per cent of its total content was locked up in leaf, 7 to 12 per cent in petiole, 12 to 16 per cent in stem, and 14 to 29 per cent in root. The total content of other nutrients increased significantly with increasing levels of nitrogen.

INTRODUCTION

There is considerable data on the dry matter production and its partitioning into different organs in the adult oil palm (Ng, 1970), and the nutrient contents and uptake by different oil palm organs have also been extensively investigated (Ng *et al.*, 1968). However, oil palm seedling did not receive the same attention, notwithstanding the fact that the perennial growth and productivity of the oil palm primarily depend on the initial growth performance and vigour of the seedlings. Thus, a sound nutrient management programme for the seedlings is a prerequisite for successful oil palm cultivation. Accordingly, a pot culture experiment was undertaken with oil palm seedlings to study their growth characteristics and total nutrient contents with respect to graded levels of nitrogen.

MATERIALS AND METHODS

Cement pots (50 cm diameter, 70 cm height) capable of accommodating the growth of oil palm seedlings for a period of two years without being pot-bound were used in the study. Each pot was filled with 100 kg of red sandy loam soil of Kasaragod. Six month old oil palm seedlings of *tenera* variety (11d x 32p) of almost uniform growth were transplanted into the pots after re-

moving the nuts from the bole portion of the seedlings. The seedlings were allowed to establish in the pots for two weeks before the treatments were imposed and the experiment continued for 18 months.

There were four treatments of nitrogen, with urea as the source - 0 (N_0), 100(N_{100}), 200(N_{200}) and 400(N_{400}) ppm per seedling per year. Each treatment had five replications.

Phosphorus and potassium at a constant rate of 100 ppm and 200 ppm respectively per year were applied to each seedling. Single dose of fertilizer for six months was applied initially and after the expiry of six months, another single dose for 12 months was applied at the rate mentioned above. Seedlings were irrigated uniformly as and when required.

The visual colour of the seedlings and the growth parameters such as height, girth of the seedlings at collar region and number of functional leaves were recorded periodically. The deficiency symptoms were also carefully recorded from time to time.

After 18 months, the seedlings were carefully uprooted using forced jet of water and the different parts *viz.*, leaves, petioles, stem and roots

were separated. Number of primary roots and their average girth were recorded. The dry biomass in respect of each part was also estimated. A total of 80 tissue samples, representative of the four organs of each seedling were collected and analysed for the major nutrients (Jackson, 1967). The results were statistically analysed.

RESULTS AND DISCUSSION

The morphological changes with respect to graded levels of nitrogen fertilization clearly indicate that the height of the seedlings, total number of leaves and girth at collar increased with increasing levels of nitrogen (Table I; Plates 1 and 2). Thus, nitrogen played a major role in controlling the growth of oil palm seedlings (Hartley, 1988).

The oil palm seedlings, which did not receive any nitrogen fertilizer (N_0 level), showed stunted growth with typical nitrogen deficiency symptoms, namely yellow colour in older leaves

Table I. Effect of graded levels of nitrogen on the growth parameters and primary roots after 18 months of growth of oil palm seedlings (Mean of five replications)

Treatments	Height (cm)	Total No. of leaves	Girth (cm)	Total No. of primary roots	Average girth of primary roots (cm)
N_0	94.1	10.9	22.5	20.1	1.4
N_{100}	178.0	14.1	30.2	34.2	2.1
N_{200}	226.2	16.0	35.1	37.5	2.4
N_{400}	260.6	16.9	37.0	40.2	2.5
CD (5% level)	27.5	0.9	2.3	5.7	0.3

Table II. Effect of graded levels of nitrogen on the dry matter content of different organs of oil palm seedlings* (Mean of five replications, in g/seedling)

Treatments	Leaf	Petiole	Stem	Root	Total
N_0 (23.2)	55.9 (13.6)	32.8 (18.8)	45.3 (44.5)	107.3	241.3
N_{100} (24.6)	166.9 (23.1)	156.9 (27.2)	185.0 (25.1)	170.5	679.3
N_{200} (25.6)	237.3 (22.6)	210.0 (29.0)	269.2 (22.8)	211.7	928.2
N_{400} (23.3)	269.0 (28.8)	332.1 (27.7)	320.0 (20.2)	232.8	1153.9
C.D. (5% level)	25.4	44.8	45.9	19.6	182.5

* Figures in parentheses show the percentage of dry matter content.

which progressively engulfed younger leaves with the advancement of symptoms (Fig. 3). The nitrogen deficiency symptoms intensified further upto 18 months. Around 12 months, the entire plant showed yellowing followed by stunted growth, shortening of petioles, leaflets and partial marginal necrosis in the older leaves. These symptoms are in agreement with the nitrogen deficiency symptoms described by Bull (1961) for oil palm seedlings.

As reflected in the general appearance of the seedlings, the root growth also markedly increased with increasing levels of nitrogen (Fig. 4). The total number of primary roots and average girth of primary roots progressively increased with graded levels of nitrogen (Table I). Agamuthu and Broughton (1986) also noted that increased soil nitrogen levels strongly induced the development of the oil palm rooting system.

The partitioning of biomass into leaf, petiole, stem and root indicates that the biomass of all organs progressively increased with increasing levels of nitrogen (Table II). Nitrogen is said to, (a) produce bigger cells (factories) and (b) increase the efficiency of photosynthesis, and thus, this would result in higher biomass production at its higher levels. The percentage distribution of biomass at N_0 level shows that the root constituted about 45 per cent of the total biomass; while in the case of N_{100} , N_{200} and N_{400} levels they were only 25.1, 22.8 and 20.2 per cent respectively (Table III). Thus, at low nitrogen management the productivity of above-ground parts of the seedlings was very much restricted in proportion

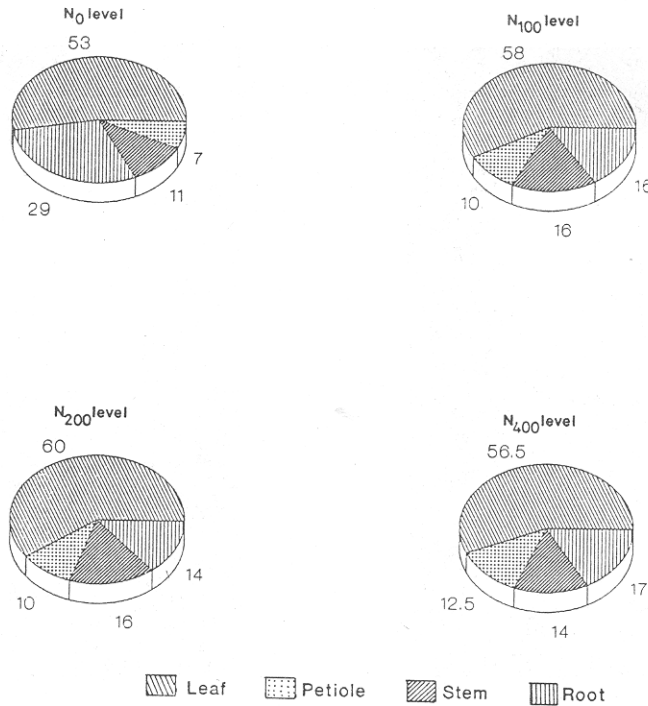


Fig. 1. Partitioning of total nitrogen content (%) of oil palm seedlings with respect to graded levels of nitrogen

Table III. Effect of graded levels of nitrogen on nutrient concentrations of different organs of oil palm seedlings (Mean of five replications, as % of dry matter)

Nutrients		Treatments				C. D. (5% level)
		N_0	N_{100}	N_{200}	N_{400}	
Nitrogen	Leaf	1.638	1.832	1.918	2.772	0.074
	Petiole	0.350	0.360	0.364	0.490	0.112
	Stem	0.448	0.450	0.462	0.574	0.101
	Root	0.462	0.488	0.490	0.981	0.021
Phosphorus	Leaf	0.197	0.149	0.156	0.183	0.024
	Petiole	0.409	0.118	0.154	0.118	0.174
	Stem	0.222	0.112	0.145	0.138	0.107
	Root	0.162	0.081	0.083	0.073	0.076
Potassium	Leaf	1.40	1.40	1.45	1.50	NS
	Petiole	1.75	1.40	1.50	1.30	NS
	Stem	1.15	1.95	1.10	0.90	NS
	Root	1.50	1.70	1.55	1.15	NS
Calcium	Leaf	1.020	0.770	0.887	0.690	0.118
	Petiole	0.756	0.407	0.538	0.363	0.135
	Stem	0.378	0.349	0.509	0.363	NS
	Root	0.276	0.262	0.247	0.262	NS
Magnesium	Leaf	0.274	0.189	0.187	0.143	0.037
	Petiole	0.168	0.060	0.054	0.058	0.078
	Stem	0.182	0.090	0.095	0.043	0.039
	Root	0.164	0.119	0.114	0.120	0.035

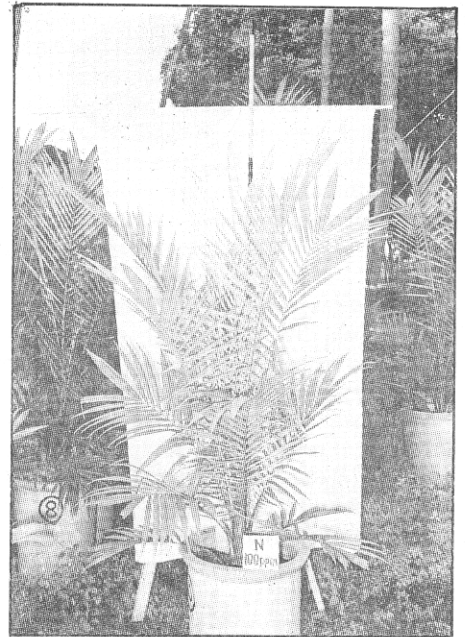


Fig. 2. Effect of N_0 and N_{100} levels on the growth of oil palm seedlings

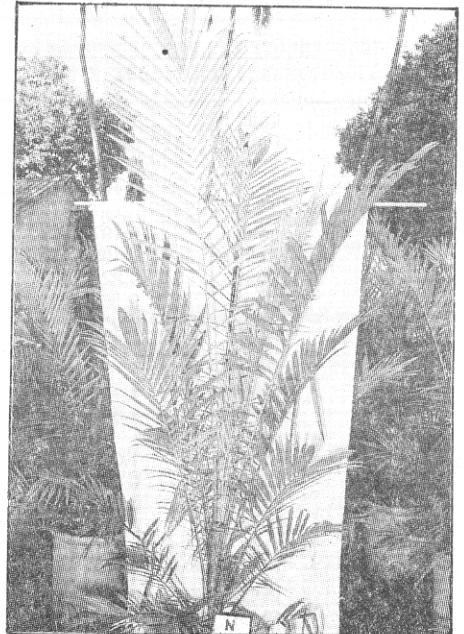
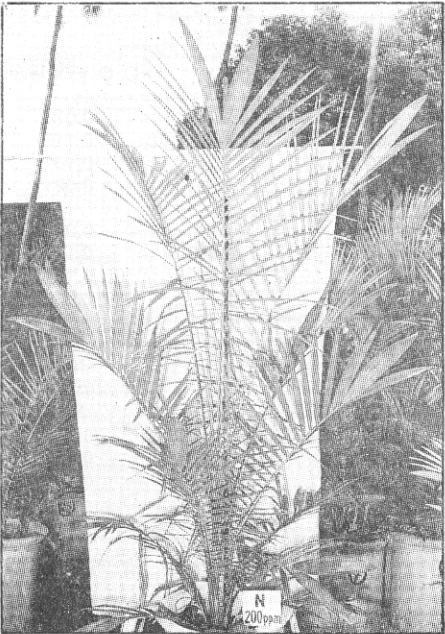


Fig. 3. Effect of N_{200} and N_{400} levels on the growth of oil palm seedlings.

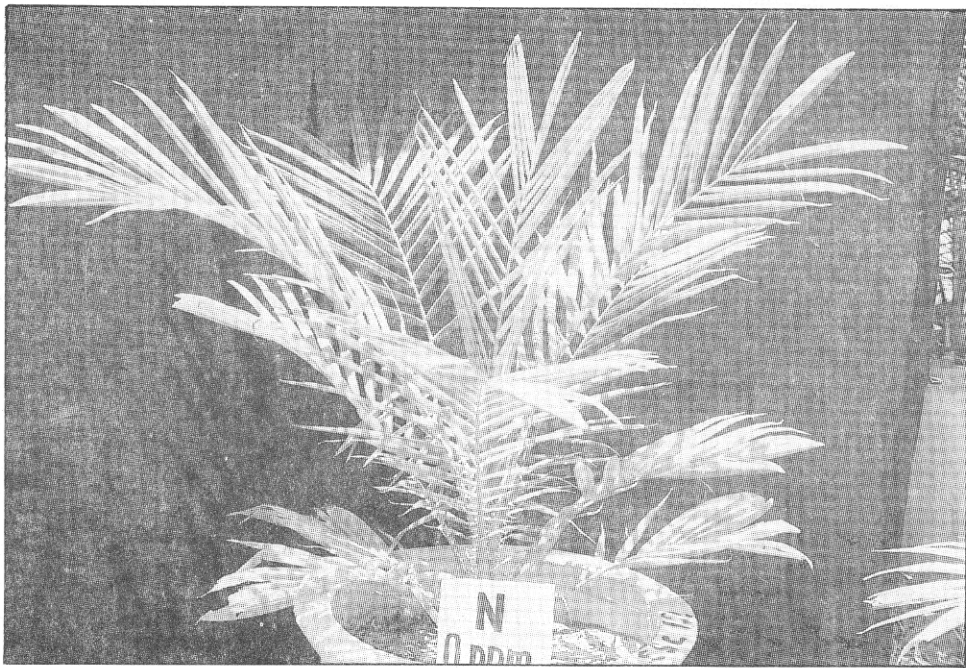


Fig. 4. Nitrogen deficiency symptoms in a 2 year old seedling.

to root growth.

The nutrient concentrations of different parts of oil palm seedlings indicate that the nitrogen content steadily increased with increasing levels of applied nitrogen (Table III). On the other hand, the phosphorus concentration of leaf, petiole, stem and root at N_0 level was higher as compared to that at N_{100} , N_{200} and N_{400} levels. This was probably due to the very low biomass production at N_0 level resulting in the accumulation of phosphorus, whereas at the other levels, the higher biomass production might have diluted the phosphorus content considerably. However, the phosphorus concentration of leaf among N_{100} , N_{200} and N_{400} levels showed an increasing trend with respect to graded levels of nitrogen. This action on the phosphorus content was probably due to the well-known physiological synergism of nitrogen and phosphorus in the plant. Ollagnier *et al.* (1970) noted an appreciable increase in leaf phosphorus along with the rise of leaf nitrogen status in the oil palm. Besides, increased nitrogen availability also leads to greater microbial activity which in

turn releases phosphorus from organic phosphorus sources and plants absorb more phosphorus.

The potassium content of different parts of oil palm seedlings did not reveal any significant variations in relation to graded levels of nitrogen. Nair and Shreedharan (1983) reported an increase of leaf potassium content in the oil palm followed by nitrogen application. However, such results were not reflected in the present investigation.

As far as calcium and magnesium of different parts of oil palm seedlings are concerned, in general, their concentrations decreased with increasing levels of nitrogen. This could be explained by the dilution effect due to the increased biomass production at higher levels of nitrogen application. Mendham (1971) also reported an interaction between applied nitrogen and leaf magnesium content for the oil palm nursery seedlings.

The total nitrogen content of different vegetative parts of oil palm seedlings increased

Table IV. Effect of graded levels of nitrogen on the total nitrogen content of different organs of oil palm seedlings (Mean of five replications, in mg/seedling)

Treatments	Leaf	Petiole	Stem	Root	Total
N ₀	916	115	203	496	1730
N ₁₀₀	3057	565	833	832	5287
N ₂₀₀	4551	764	1244	1037	7596
N ₄₀₀	7457	1627	1837	2284	13205
C. D. (5% level)	997	192	314	201	1710

Table V. Effect of graded levels of nitrogen on the total nutrient contents of oil palm seedlings (Mean of five replications, in mg/seedling)

Treatments	Phosphorus	Potassium	Calcium	Magnesium
N ₀	519	3488	1285	467
N ₁₀₀	779	9191	3017	730
N ₂₀₀	1259	12833	5128	1054
N ₄₀₀	1496	13909	4834	995
C. D. (5% level)	210	1007	357	118

**Fig. 5.** Effect of graded levels of nitrogen on the root growth of oil palm seedling.

with increasing levels of nitrogen (Table IV). Distribution of the total nitrogen content of the seedlings indicates that irrespective of the levels of nitrogen application, 53 to 60 per cent of its

total content was locked up in leaf, 7 to 12 per cent in petiole, 12 and 16 per cent in stem and 14 to 29 per cent in root (Fig. 1). This suggests a rapid translocation of the absorbed nutrient into leaf for various bio-synthetic activities. The total content of all other major nutrients increased with increasing levels of nitrogen (Table V), which may be attributed to increased net assimilation rate as suggested by Corley and Mok (1972), thereby favouring the absorption of all nutrients by the seedlings.

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DISCUSSION

D.P. VERMA : The partitioning of biomass at N_0 level is highest in the root but root density is low. How do you explain?

A. MURALEEDHARAN : It only means that at N_0 level, the productivity of above-ground parts of the seedlings was very much restricted compared to root growth.

P.R.V. SUBRAMANIA IYER : In your data, you mentioned that P content is more at N_0 level because of d.m. effect. But data gives concentration and not uptake.

A. MURALEEDHARAN : The very low biomass production at N_0 level resulted in the accumulation of phosphorus, whereas at the other levels, the higher biomass production might have diluted the phosphorus concentration considerably.

K.R. VIJAYAKUMAR : What was the nutrient status of the soil and what was the quantity of the soil used?

A. MURALEEDHARAN : Soil available nitrogen of red sandy loam soil of Kasaragod is 82.2 ppm. Quantity of soil used was 100 kg/pot.

L. MANIVEL : How often was the N applied, and when were the tissues sampled?

N. MURALEEDHARAN : The fertilizer was applied initially at 6th month and another dose at 12th month. After 18 months, the tissues were sampled.

A.Y.S. REDDY : What graded level do you fix for the optimum biomass production in seedling growth and what is the periodicity of application for the seedlings?

A. MURALEEDHARAN : In the present study maximum biomass was obtained at N_{400} level. Had I used still higher levels, greater biomass production would have been obtained. Thus I could not fix an optimum level for higher biomass production. As regards periodicity, the application was done twice at 6th and 12th month.

K.U.K. NAMPOOTHIRI : Is it not more advisable to add Farm Yard Manure to the potting mixture so that the quality of fertiliser required is reduced especially in view of the increase in cost of fertilizers?

A. MURALEEDHARAN : I agree with the opinion and I hope studies employing FYM will be taken up in the future course of research plan.