# LEAF LITTER ADDITION AND NUTRIENT RECYCLING IN RUBBER (*HEVEA BRASILIENSIS* MUELL. ARG.) IN VELLANIKKARA ESTATE

By

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DEPARTMENT OF PLANTATION CROPS & SPICES
KERALA AGRICULTURAL UNIVERSITY
VELLANIKKARA

1992

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DISSERTATION SUBMITTED IN PARTIAL FULFILMENT
OF THE REQUIREMENT FOR THE
POST GRADUATE DIPLOMA IN NATURAL RUBBER PRODUCTION

FACULTY OF AGRICULTURE
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1992

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Vellanikkara,
11-12-1992.

M.K. GURUPRASAD

## DECLARATION

I hereby declare that this dissertation entitled "Leaf litter addition and nutrient recycling in rubber (*Hevea Brasiliensis* Muell.Arg.) in Vellanikkara Estate" and submitted in partial fulfilment of the course Post Graduate Diploma in Natural Rubber Production, of Kerala Agricultural University is a bonafide record of research work done by me and that the dissertation has not previously formed the basis of the award to me any degree, diploma, associateship, fellowship or other similar title of any University or Society.

Vellanikkara,
11-12-1992.

M.K. GURUPRASAD.

## CERTIFICATE

Certified that this dissertation entitled "leaf litter addition and nutrient recycling in rubber (Hevea brasiliensis Muell.Arg.) in Vellanikkara Estate" is a record of research work done by Sri. M.K.Guruprasad under our guidance and supervision and that it has not previously formed the basis for the award of any degree or diploma to him.

We, the undersigned members of the committee of Sri.M.K.Guruprasad, a candidate for the Post Graduate Diploma in Natural Rubber Production, agree that the dissertation entitled "Leaf litter addition and nutrient recycling in rubber (Hevea brasiliensis Muell.Arg.) in Vellanikara Estate" may be submitted by Sri.M.K.Guruprasad, in partial fulfilment of the requirement of the Diploma.

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# 1. INTRODUCTION

Para rubber tree Hevea brasiliensis is a perennial tree crop with an economic life span of over thirty years. Rubber is grown predominently in tropical belt, where the warm humid equatorial climate favour rapid degradation of soil fertility, especially the organic matter, through oxidation. Nevertheless, the rubber plantation offers a nearly 'closed' ecosystem during the entire cropping cycle from planting to replanting. The tillage operations are kept at a minimum in rubber plantation and this help in maintaining soil fertility at a relatively higher level. Moreover, there is a constant cycle of uptake and return of nutrients from and to the soil.

The growth period of rubber has two distinct stages. During the initial unproductive phase of nearly seven years, the trees grow very fast until the canopy is fully closed and tree trunk attains sufficient girth for exploitation. Ground covers, especially belonging to the leguminous species are grown in the interspaces in the initial years which accumulate a lot of biomass rich in nitrogen. Once the canopy of rubber closes, the undergrowths die back and add sufficient organic matter and nutrients apart from conserving the soil and improving the soil porosity. This is the first stage of organic recycling in the rubber plantations. Thereafter, as the trees come to dominate the situation, their roots exploit

the upper soil layers, taking up nutrients for immobilization within the biomass. (Watson 1989) Hevea is a deciduous tree which sheds the leaves well before summer months which is known as winter-ing. Thus rubber trees annually return organic matter to the soil through the leaves, petioles and twigs falling during the process of wintering. This constant cycling of nutrients in rubber plantation is akin to a forest ecosystem and rubber plantation presents an environmentally acceptable replacement for forest species from the point of forest flora.

Numerous studies have been made on litter productivity and nutrient cycling in natural forests and plantations from outside the country (Bray and Gorham, 1964; Duvigneaud and Smet, 1970; Walls and Jorgenson, 1976; Westmann, 1978; and Turner and Lambert, 1983) as well as from our country (Seth et al., 1963; Venkataramanan and Chinnamany, 1978; Singh, 1984; Singh et al., (1984); Negi and Sharma, 1984; Ram Prasad and Mishra, 1985; Durani et al, 1985; Malhotra et al., 1985; Malhotra et al., 1987; Pande et al., 1987; Tandon et al., 1991; George and Varghese, 1990 a,b; George and Varghese, 1991; and Negi et al. 1991.)

In rubber plantations, attempts have been made in Indonesia and Malaysia to estimate the quantity of leaf litter and the mineral nutrients added annually. (Schweizer, 1939; Penders, 1940; Shorrocks, 1965; and Watson, 1989.) However, no systematic investigation has been conducted in India on this aspect. Therefore the present study was taken up to quantify the annual leaf litter and nutrients added in Hevea.

Attempt is also made to estimate the approximate leaf area index as a supplementary information which will be of immense value in fundamendal studies on photosynthesis of Hevea.

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# REVIEW OF LITERATURE

# 2. REVIEW OF LITERATURE

## RUBBER

Nutrients are not only removed from the soil with the development of rubber plantation, but during their economic life cycle, the rubber trees themselves also return them to the soil by means of their shed leaves. (Dijkman 1951). It is also stated by him that in both Malaya and Jawa analysis have been made to obtain an idea of the amounts returned in this way under normal growth condition. Schweizer at the Besoeki Experiment Station, East Jawa, analysed leaves just before their abscission. (Schweizer, 1939). By this time the major portion of the nutrients in the leaves have been already translocated. From the analysis, Schweizer calculated that with 200 trees per ha, 140 kg N, 38 kg P and 40 kg K are returned to the ground each year by means of shed leaves.

A study on the growth and nutrient content of Hevea brasiliensis trees varying the age from one year to thirty years has been conducted by Shorrocks (1965 a) by weighing entire trees and analysing samples of roots, trunk, branches and leaves for both major and minor nutrients. Total dry weight of leaves (laminae and petioles) of eight year old RRIM 501 clone was reported to be 12.14 kg. It was quoted by Shorrocks (1965 a) that the leaf litter (laminae and petioles) collected under 4-5 year old trees of RRIM 603 was found by Wong(1964) to a total of 3610 kg/ha in one year.

The cumulative weight of leaf fall per ha has been calculated assuming that each year the tree sheds all its leaves. According to Shorrocks (1965 a) the weight of annual lamina and petiole fall in a mature plantation is likely to varry between 3700 kg and 7700 kg. per hectare, these being the amount of leaf found on the trees at any time.

The estimated nutrient return through leaf litter annually is as follows.(Shorrocks 1965 b).

| | |
|---|---|
| Nitrogen | : 45 - 90 Kg/ha. |
| Phosphorous | : 3-7 Kg/ha. |
| Pottassium | : 10-20 Kg/ha. |
| Magnesium | : 9-18 Kg/ha. |
| Calcium | : 60-120 Kg/ha. |

In another study Tan (1975) has reported that leaf litter fall of a well manured mature rubber plantation could return 53 Kg/ha. of organic leaf litter nitrogen annually to the soil. In a detailed study on mineralisation of leaf litter nitrogen and its availability to rubber seedling, Tan and Pushparajah (1985) found that leaf litter of Hevea brasiliensis is having comparatively high C/N ratio (33) and low nitrogen content (1.36%).

According to Watson(1989), rubber plantation presents an environmentally acceptable replacement for the native forest, being a 'closed' ecosystem with constant cycle of uptake and

return of nutrients from and to the soil.

## NATURAL FORESTS AND OTHER PLANTATIONS

The results of Belgian research on mineral cycling in deciduous forests (principally oakwoods) are summarised by Duvigneaud and Smet(1970), who reported that the young leaves are always richer in N,P and K and poorer in ca than mature leaves. During active growth, N,P and K content steadily decreas but remain constant when leaves are completely developed. During autumnal yellowing N,P and K content decrease (leaching,return to the tree branches, bole and roots), but Ca content increases. Throughout the leaf development, Mg level remains constant. The biomass of living leaves (3.5 metric tons/ha) was estimated from the biomass of fresh leaf litter, in the above study.

Preliminary studies on the chemical composition and total quantity of the leaf litter in the wet (montane) temporate evergreen forests (locally called as Sholas) of the Nilgiris in Tamil Nadu has been attempted by Venkataramanan and Chinnamany (1978) According to the study, Shola forests of Nilgiris annually add 2121 kg/ha of litter which by way of nutrients works out to 23.1 Kg N, 1.3 Kg P, 11 Kg K, 34 Kg Ca and 5 Kg Mg per ha.

Investigation was conducted by singh(1984) for nutrient cycle in five to nine years old Eucalyptus tereticornis grown by

Forest Department of Meerut Forest Division, U.P. along the main Ganga canal sides. Annual release of nutrients through leaf litter in 8 year old plants was found to be 26.60 Kg N, 17.48 Kg P and 190.00 Kg/ca per ha.

Studies on litter production and release of nutrients in coniferous forests of Himachal Pradesh, conducted by Singh *et al* (1984), recorded 3.03 tons to 7.02 tons per hectare of leaf litter annually. Annual nutrients released through litter fall (Kg/ha/year) in four coniferous species are as follows.

| SPECIES | N | K | P | Ca | Na |
|---|---|---|---|---|---|
| *Cedrus deodara* | 47.78 | 16.86 | 28.81 | 70.97 | 4.07 |
| *Picea Smithiana* | 46.53 | 13.61 | 10.21 | 56.17 | 3.00 |
| *Pinus Wallichiana* | 24.45 | 6.03 | 7.93 | 34.93 | 1.65 |
| *Abies Pindraw* | 44.59 | 9.70 | 15.16 | 52.78 | 2.42 |

Ram Prased and Mishra (1985) conducted studies on the litter productivity of natural dry deciduous teak forest of sugar (M.P) and has reported that total annual leaf litter production in these forests works out to be 4.959 tons/ha.

Durani *et al*., (1985) conducted preliminary observation on pattern of litter fall and the contribution of the various tree elements of the secondary forest in the Khandagiri hill in Orissa. Significant variation was observed with respect to pattern of litter fall through different months. Rate of

litter fall was almost uniform from September to November. A three fold increase was observed in January followed by marked decrease in February. Average leaf litter fall of 8.03 ton/ha/year was observed in this study.

George and Varghese (1991) has recorded litter production of 8492 Kg/ha/year in Eucalyptus globulus plantation of 10 year old, grown in the Nilgiri South Forest Division of Tamil Nadu. Out of this, leaf litter contribution is 3402 Kg/ha. Contribution of twig is 3187 Kg/ha, and that of bark is 1903 Kg/ha. Nutrients returned through leaf litter annually are N:28 Kg/ha, P:2.7 Kg/ha and K:20.0 Kg/ha.

Organic productivity and mineral cycling in poplar plantation (Populus deltoides) in Tarai region of U.P. was studied by Tandon et al., (1991). In their studies annual leaf litter production from a plantation of 9 years old is reported to be 1719 Kg/ha and the nutrient content in leaf litter for N, P, K, Ca and Mg are 20.28 Kg/ha, 0.57 Kg/ha, 5.50 Kg/ha, 31.11 Kg/ha and 1.89 Kg/ha respectively.

*******

# MATERIALS AND METHODS

# 3. MATERIALS AND METHODS

The study was taken up with an aim to quantify leaf litter addition, nutrient recycling and to compute the approximate leaf area index in an eight year old rubber plantation.

The entire leaf litter from the selected three rubber trees were collected during the wintering period at fortnightly intervals. Detailed methodology followed for the study was as follows.

## SELECTION OF TREES.

Three rubber trees of the clone RRII 105 planted in 1983, of Vellanikkara Estate of Kerala Agricultural University was selected for the study. The experiment site was one of the plots of a trial on clone cum density of Rubber Research Instituten of India, with normal spacing of 4.85m x 4.85m. All the three trees were of almost uniform girth and canopy development. The plot under study is almost flat. By the time the study was started, the canopy of the trees had fully overlapped with practically no undergrowths, except thin growth of grasses and remnants of Pueraria. The trees under study had a height of about 10 - 11 metres.

## PROTECTION FOR DRIFT OF LEAF LITTER

All the four sides of the selected plot with three trees were protected by closely woven nylon net upto a height of 12

metres to prevent the fallen leaves being blown away by wind, and also to prevent falling of leaves from the nearby trees to the experiment site. The net was provided on 11th November, 1991, sufficiently early to the probable date of commencement of wintering.

## COLLECTION OF LITTER

After fixing the net, the whole land inside the net enclosure was cleared off the grasses, left over leaf litter and big pebbles. The collection started from 25th November, 1991 and continued at fortnightly intervals till 2nd March, 1992.

The collected leaf litter was weighed and sundried. Samples were drawn for estimation of moisture percentage, based on which dry matter was computed. From the samples, relative proportion of leaf lamina and petiole was found out and used for working out the quantities of leaf lamina and petiole seperately. The total litter addition per ha was worked out and expressed as Kg/ha, taking into consideration the actual density of the trees 366/ha, in the experimental plot.

## CHEMICAL ANALYSIS OF LEAF LITTER

In order to find out the quantities of mineral nutrients added through leaf litter, samples from all the collections were analysed for N, P, K, Ca and Mg, in the Rubber Research

Institute of India. N, P and K were analysed using Auto analyser and Ca and Mg using Atomic Absorption Spectro Photometer, following the procedures prescribed in the Laboratory Manual of Rubber Research Institute of India, compiled by Karthikakutty Amma (R.R.I.I. 1989).

**LEAF AREA INDEX**

Dry weight of 50 leaves was found out, and the leaf area of these leaves was calculated using leaf area meter in the Rubber Research Institute of India. Leaf area index was computed by these values.

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# RESULTS AND DISCUSSION

## 4. RESULTS AND DISCUSSION

The result of this study comprises of the pattern of wintering, quantity of leaf litter addition, mineral nutrients added to the soil through leaf litter, soil fertility as influenced by leaf litter and the leaf area index.

### a) PATTERN OF WINTERING

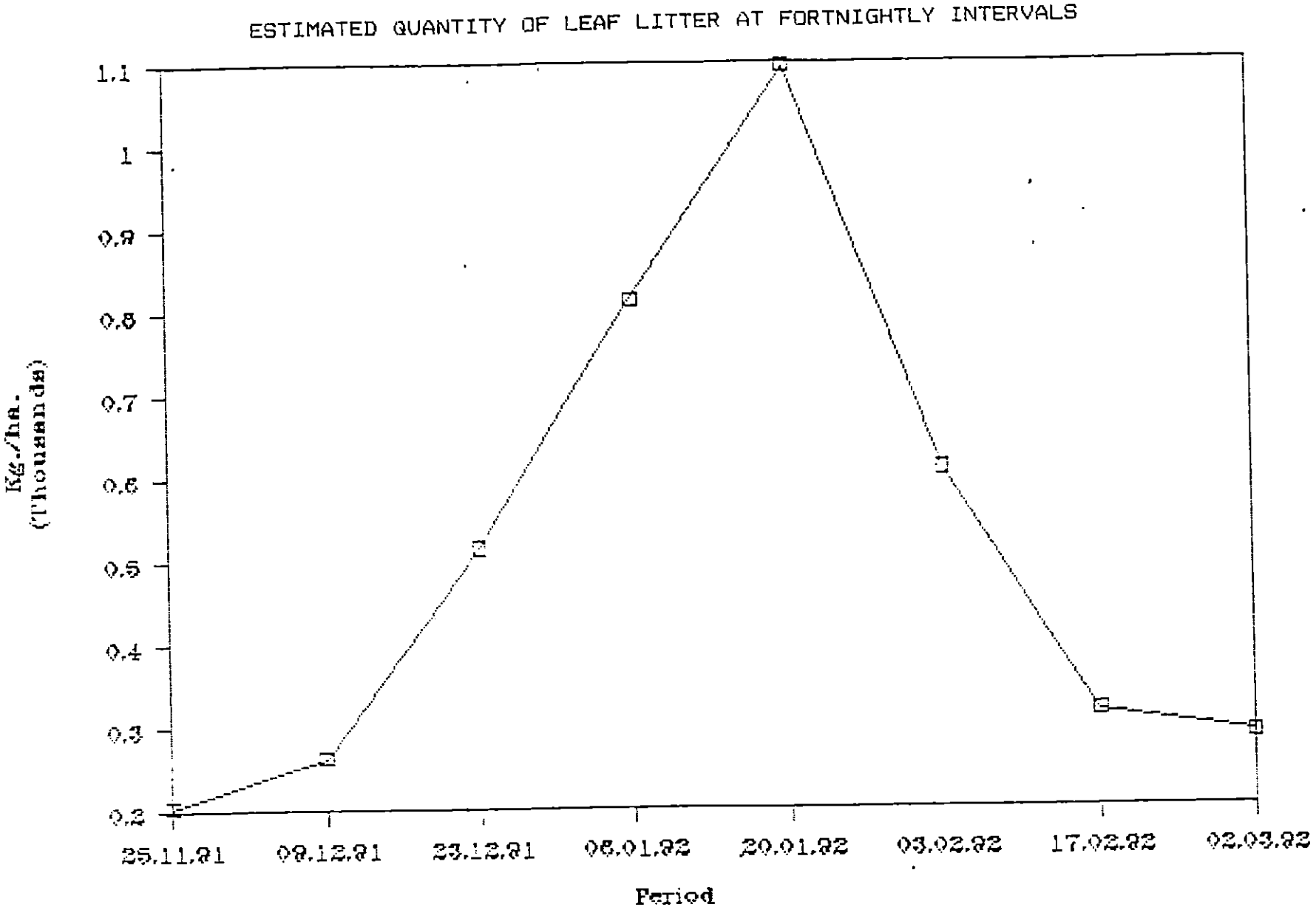
During the year under study the wintering started by 14th December and continued till 2nd March, 1992. (Table 1, Fig 1) However, green leaves were also found fallen due to heavy wind prevailing in the locality during November and December months. The rate of leaf litter fall gradually increased from the last week of December and reached the peak by the third week of January. Thereafter the quantity of litter addition decreased gradually and wintering was almost complete by 2nd March, 1992. However a few leaves didnot fall and was found to be retained in the trees. The mean leaf fall observed in January accounts for nearly one third of the total annual leaf fall.

Annual leaf fall in rubber in South India has been reported to commence during December - January . (RRII 1980) However, wide variation has been observed in wintering depending upon the clone, age of the trees, seasonal factors, location where grown etc. (George et al., 1967) The observations revealed in this study are in agreement with the pattern of litter fall reported earlier.

Table 1
Quantity of leaf litter at fortnightly interval from three selected trees

| Date of collection | Dry weight of leaf litter (Kg) | | |
|---|---|---|---|
| | Lamina | Petiole | Total |
| 25.11.91 | 1.445 | 0.239 | 1.684 |
| 09.12.91 | 1.856 | 0.306 | 2.162 |
| 23.12.91 | 3.626 | 0.603 | 4.229 |
| 06.01.92 | 5.733 | 0.944 | 6.677 |
| 20.01.92 | 7.727 | 1.266 | 8.993 |
| 03.02.92 | 4.284 | 0.716 | 5.000 |
| 17.02.92 | 2.232 | 0.363 | 2.595 |
| 02.03.92 | 2.029 | 0.336 | 2.365 |
| | 28.932 | 4.773 | 33.705 |

Fig. 1.


ESTIMATED QUANTITY OF LEAF LITTER AT FORTNIGHTLY INTERVALS
Kg./ha.
(Thousands)
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
25.11.91
09.12.91
23.12.91
06.01.92
20.01.92
03.02.92
17.02.92
02.03.92
Period

**b) QUANTITY OF LEAF LITTER ADDITION**

The leaf litter addition at fortnightly intervals during the defoliation period is presented in table 1, table 2 and in figure 1. The cumulative addition is presented in table 3 and figure 2.

The dry matter and air dried weight followed the same pattern, since the moisture content was almost same throughout the period. The average litter fall per tree was 11.235 Kg (Oven dry weight). When computed this work out to 4.112 ton/ha, considering the actual stand of 366 trees per ha. Of this the leaf laminae constitute 3.530 ton/ha and petioles 0.582 ton/ha (Table 2) The leaf lamina constitute to nearly 86% of the total leaf litter addition. Shorrocks (1965 a) found that the petioles contribute to 15 to 19% of the total leaf weight and dry weight of leaves from 8 yaar old RRIM 501 clone was 12.14 Kg/tree/year. The present observation of annual productivity of leaf litter per tree and petiole lamina ratio in dry weight are comparable with the observations of Shorrocks.

There was not much variations between the moisture content in lamina and petiole. In the litter collected on 06-01-1992, presence of tender leaves fallen due to attack of Oidium heveae was noticed.

Table 2.

Estimated Quantity of leaf litter at fortnightly intervals per ha.

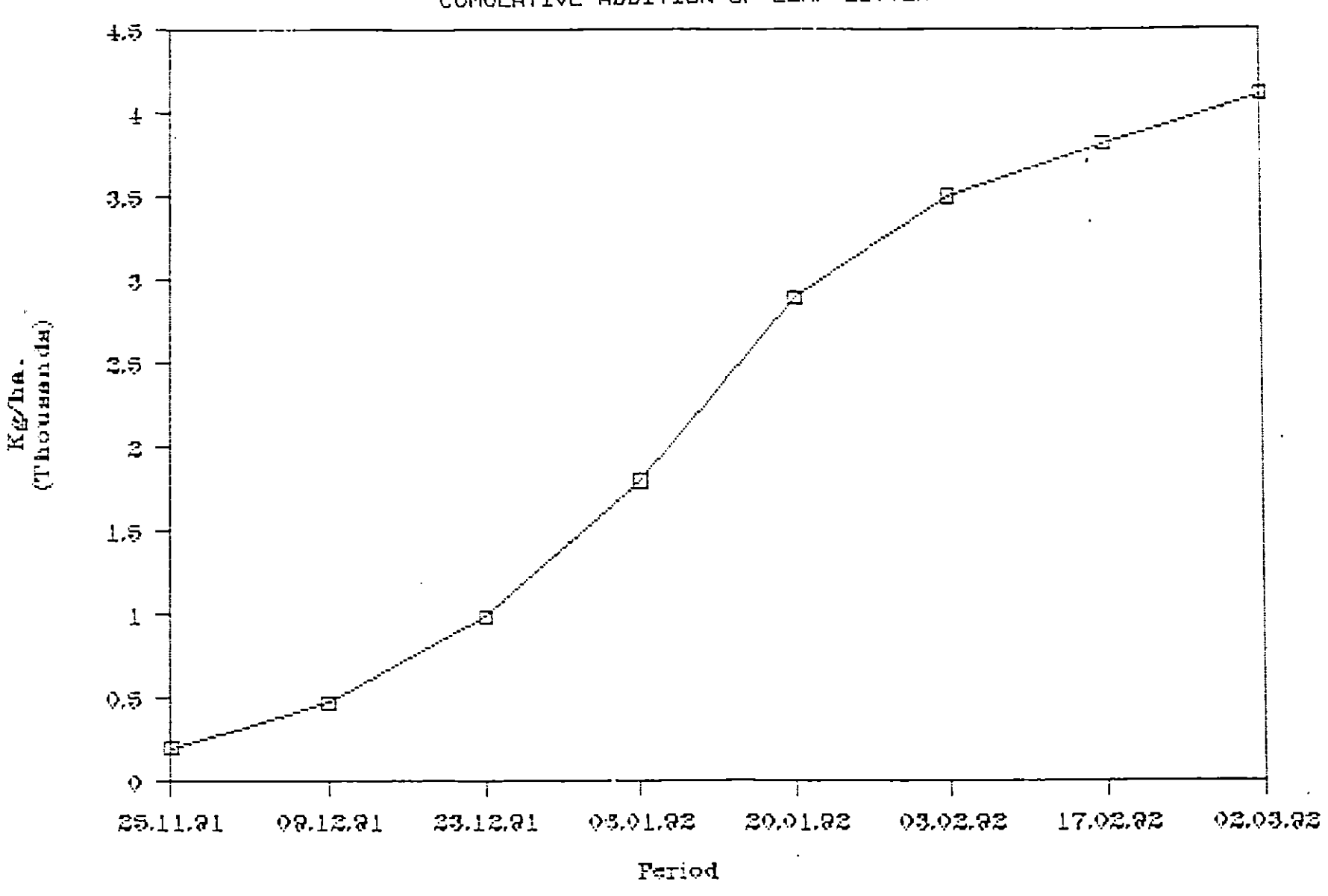
| DATE | Air dried Weight | | | Dry Weight (Kg.) | | |
|---|---|---|---|---|---|---|
| | LAMINA | PETIOLE | TOTAL | LAMINA | PETIOLE | TOTAL |
| 25.11.91 | 203.130 | 33.550 | 236.680 | 176.290 | 29.158 | 205.448 |
| 09.12.91 | 259.738 | 42.822 | 302.560 | 226.432 | 37.332 | 263.764 |
| 23.12.91 | 495.076 | 81.984 | 577.060 | 442.372 | 73.566 | 515.938 |
| 06.01.92 | 777.750 | 127.490 | 905.240 | 699.426 | 115.168 | 814.594 |
| 20.01.92 | 1034.682 | 168.238 | 1202.920 | 942.694 | 154.452 | 1097.146 |
| 03.02.92 | 579.622 | 96.258 | 675.880 | 522.648 | 87.352 | 610.000 |
| 17.02.92 | 302.438 | 48.922 | 351.360 | 272.304 | 44.286 | 316.590 |
| 02.03.92 | 275.354 | 45.506 | 320.860 | 247.538 | 40.992 | 288.530 |
| Total | 3927.79 | 644.77 | 4572.56 | 3529.704 | 582.306 | 4112.01 |

Table 3.

Cumulative addition of leaf litter at fortnightly intervals

| Date of Collection | Dry Wt. of leaf litter From selected 3 trees (Kg) | Dry Wt. of leaf litter Kg. Per ha.(Estimated) |
|---|---|---|
| 25.11.91 | 1.684 | 205.448 |
| 09.12.91 | 3.846 | 469.212 |
| 23.12.91 | 8.075 | 985.150 |
| 06.01.92 | 14.752 | 1799.744 |
| 20.01.92 | 23.745 | 2896.890 |
| 03.02.92 | 28.745 | 3506.890 |
| 17.02.92 | 31.340 | 3823.480 |
| 02.03.92 | 33.705 | 4112.010 |

Fig. 2.


CUMULATIVE ADDITION OF LEAF LITTER
Kg/ha.
(Thousands)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
25.11.91
09.12.91
23.12.91
05.01.92
20.01.92
03.02.92
17.02.92
02.03.92
Period

The graph depicting cumulative accumulation of dry matter through leaf litter (Fig.2) reveals a sharp increase in January which is the peak defoliation period.

Wong(1964), quoted by Shorrocks(1965 a), reported that leaf litter (laminae and petioles) collected under four to five years old trees (RRIM 603) was 3.61 ton/ha in one year. In another study conducted in Malayasia it is estimated that the dry weight of leaves (laminae and Petioles) returned to to soil annually is 3.7 to 7.7 ton/ha. (RRIM 1972)

The present study was conducted in an eight year old plantation and the observation that it adds 4.112 ton/ha/year during wintering is in full confirmity with the earlier reports.

The amount of leaf litter addition observed in the present study in rubber is relatively lower when compared to Sal, Teak and Chir of 9500 Kg., 7700 Kg. and 8500 Kg. per ha respectively (Srivasthava et al.,1972). In Khandagiri Hills of Orissa, the annual leaf litter addition is estimated to be 8.03 ton/ha. (Durani et al., 1985) However, the rubber plantation under study is only 8 years old and the quantity of leaf litter is likely to be more as the trees grow.

Lower quantities of leaf litter than rubber as revealed from the present study are reported in Oakwood in Belgium, (Duvigneaud and Smet, 1970), in Shola forests of Nilgiris (Venkataramanan and Chinnamany 1978), in Eucalyptus globulus plantation of Nilgiri South Forest Division (George and Varghese, 1991) and in Populus deltoides (9 years old) of Tarai region of U.P. (Tendon et al., 1991).

The Present estimate of leaf litter for rubber compares well with Shorea robusta : 5.9 ton/ha/year (Puri 1953) and Tectona grandis : 5.3 ton/ha/year (Seth et al., 1963) in the New Forest, Dehradun. The estimate is also within the range of 1.01 to 6.21 ton/ha/yr reported by Singh (1968), in the deciduous forest of Varanasi and Udaipur. The estimate of 4.04 ton/ha/yr in the same forest by Garg and Vyas (1975) is almost same as the present observation for rubber. Ram Prasad and Mishra(1985) estimated 4.95 ton/ha/year of leaf litter in the forests of Sagar, M.P., Which is also comparable to the present estimation.

**c) NUTRIENT ADDITION THROUGH LEAF LITTER.**

The chemical composition of N,P,K,Ca and Mg in the leaf litter collected at fortnightly interval is given in Table 4. The change in the percentage content of the above nutrients in the different collections is depicted in Fig. 3 and Fig. 4. The percentage composition of N,P,K,Ca and Mg in leaves prior to wintering was 2.85, 0.16, 1.24, 0.75 and 0.19 respectively

Table 4

Chemical composition of leaf litter

| Date of Collection | N% | | P% | | K% | | Ca% | | Mg% | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Lamina | Petiole | Lamina | Petiole | Lamina | Petiole | Lamina | Petiole | Lamina | Petiole |
| 25.11.91 | 2.25 | 1.20 | 0.130 | 0.09 | 0.98 | 1.62 | 1.08 | 1.39 | 0.22 | 0.21 |
| 09.12.91 | 2.45 | 1.31 | 0.130 | 0.10 | 1.24 | 2.00 | 0.82 | 1.09 | 0.21 | 0.17 |
| 23.12.91 | 1.45 | 0.77 | 0.065 | 0.04 | 1.08 | 1.69 | 0.96 | 1.05 | 0.20 | 0.15 |
| 06.01.92 | 2.10 | 1.09 | 0.085 | 0.07 | 1.16 | 1.79 | 0.94 | 1.17 | 0.23 | 0.18 |
| 20.01.92 | 1.45 | 0.74 | 0.045 | 0.03 | 0.76 | 0.98 | 0.99 | 1.25 | 0.20 | 0.14 |
| 03.02.92 | 1.40 | 0.72 | 0.055 | 0.05 | 1.08 | 1.41 | 1.09 | 1.38 | 0.23 | 0.20 |
| 17.02.92 | 1.33 | 0.67 | 0.045 | 0.04 | 1.03 | 1.66 | 1.07 | 1.34 | 0.26 | 0.23 |
| 02.03.92 | 1.25 | 0.61 | 0.040 | 0.04 | 0.98 | 1.29 | 1.05 | 1.31 | 0.29 | 0.26 |
| Average | 1.71 | 0.89 | 0.07 | 0.06 | 1.04 | 1.56 | 1.00 | 1.25 | 0.23 | 0.19 |

Table 5

Chemical composition of leaf samples

| Date of Collection | Description of Leaf sample | Percentage of nutrients in lamina | | | | |
|---|---|---|---|---|---|---|
| | | N | P | K | Ca | Mg |
| 25.11.91 | Sample collected on the same date of first collection of leaf litter. | 2.85 | 0.16 | 1.24 | 0.75 | 0.19 |
| 02.03.92 | Sample collected from the leaves retained on the trees after completion of wintering. | 2.55 | 0.14 | 0.74 | 1.52 | 0.38 |

Fig. 3.

CHEMICAL COMPOSITION OF LEAF LITTER (LAMINA)

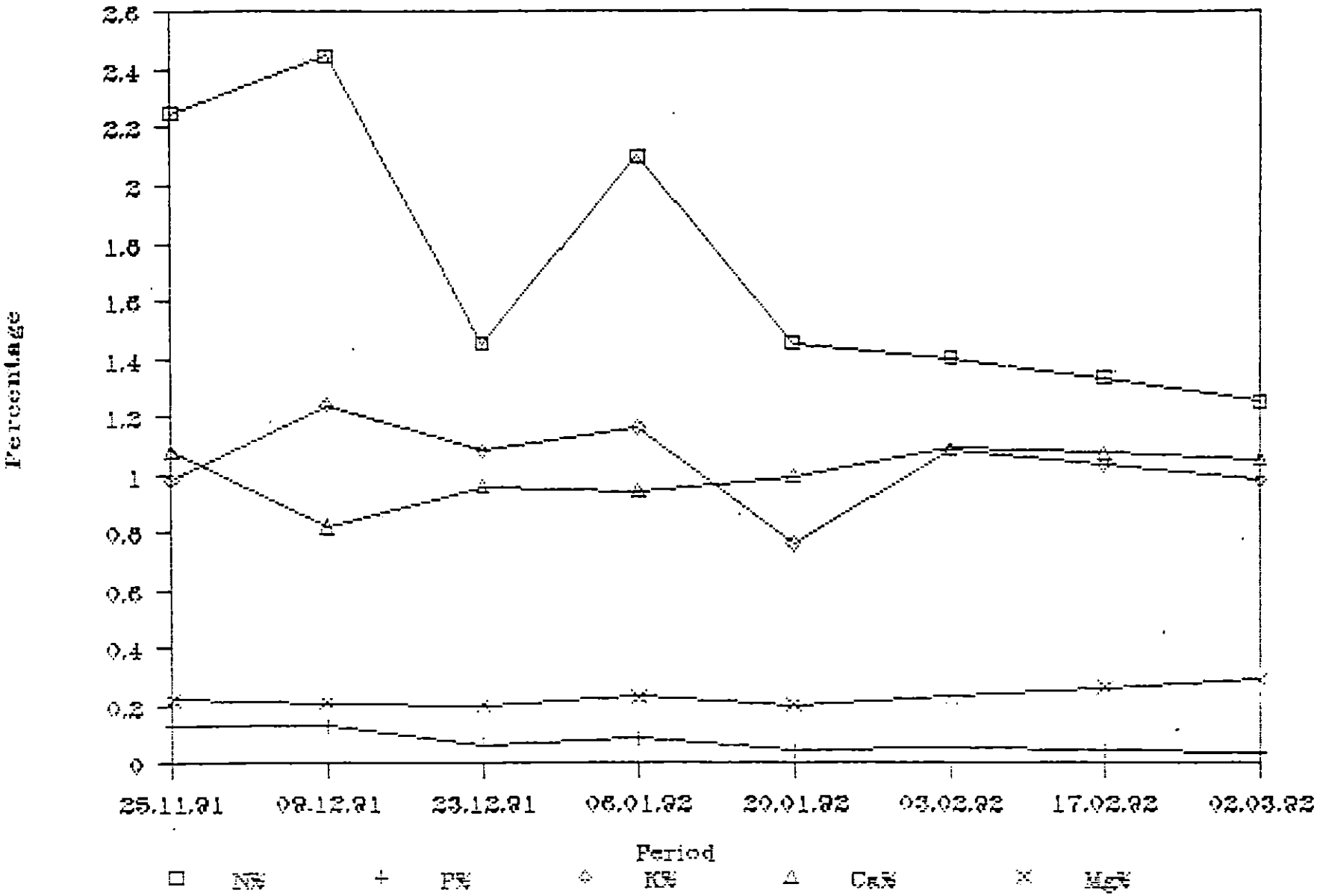
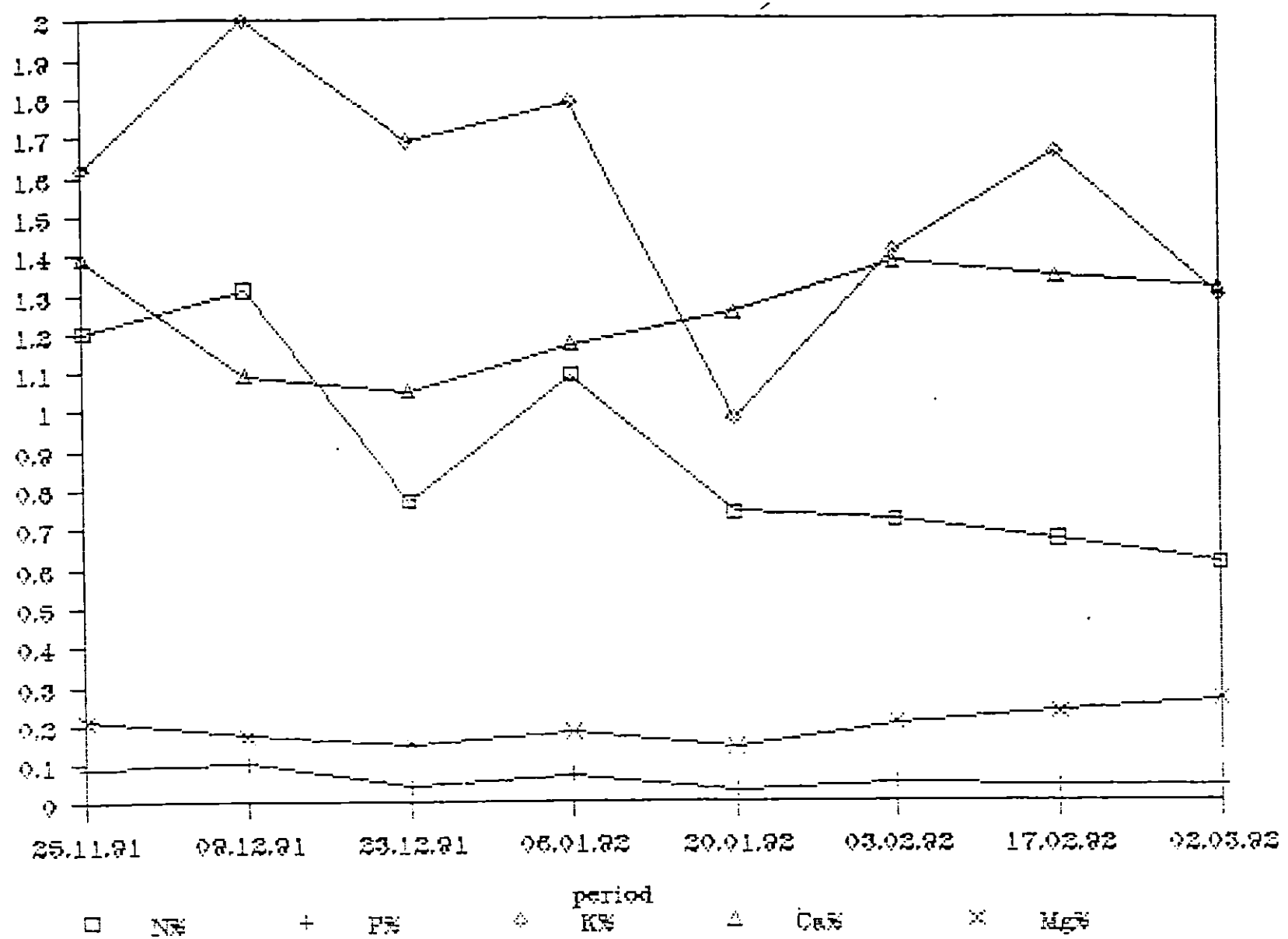


Fig. 4.

CHEMICAL COMPOSITION OF LEAF LITTER (PETIOLE)



(Table 5). The Corresponding values in the leaves retained in the trees after completion of wintering was 2.55 0.14, 0.74, 1.52 and 0.38 respectively.

A close study of Table 4 and Figures 3 and 4 reveals that among the major five nutrients there is a gradual decrease in concentration in the case of N, P, and K as the leaf fall progresses. However in the collection made on 06-01-92, these values are marginally higher. In this collection there was a small percentage of young leaves fallen due to the attack of Oidium heveae. Possibly because of higher content of nutrient in such leaves the litter of this collection was marginally richer in N, P, and K.

The leaf litter contained a marginally higher percentage of Ca and Mg which could be because of no shift in these nutrients and the marginal increase is difficult to be explained. This observation is therefore to be confirmed in subsequent years of experimentation.

However, higher percentage of Ca in leaf litter was reported by Duvigneaud and Smet (1970) in oak forests of Belgium, Venkataramanan and Chinnamany (1978) in temperate ever green Shola forests of Nilgiris, Singh (1984) in Eucalyptus of Smith Plantations (U.P.), and Tandon et al.,(1991) in poplars of Tarai region of U.P.

Table 6

Addition of nutrients through leaf litter during wintering from 3 selected rubber trees

| Date of Collection | Nutrients released (gm.) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | N | | P | | K | | Ca | | Mg | |
| | Lamina | Petiole | Lamina | Petiole | Lamina | Petiole | Lamina | Petiole | Lamina | Petiole |
| 25.11.91 | 32.51 | 2.87 | 1.880 | 0.22 | 14.16 | 3.87 | 15.61 | 3.32 | 3.32 | 0.50 |
| 09.12.91 | 45.47 | 4.01 | 2.410 | 0.31 | 23.01 | 6.12 | 15.22 | 3.34 | 3.90 | 0.52 |
| 23.12.91 | 52.58 | 4.64 | 2.360 | 0.24 | 39.16 | 10.19 | 34.80 | 6.33 | 7.25 | 0.90 |
| 06.01.92 | 120.39 | 10.29 | 4.870 | 0.66 | 66.50 | 16.90 | 53.89 | 11.04 | 13.19 | 1.70 |
| 20.01.92 | 112.04 | 9.37 | 3.480 | 0.38 | 58.73 | 12.41 | 76.50 | 15.83 | 15.45 | 1.77 |
| 03.02.92 | 59.98 | 5.16 | 2.360 | 0.36 | 46.27 | 10.10 | 46.70 | 9.88 | 9.85 | 1.43 |
| 17.02.92 | 29.69 | 2.43 | 1.000 | 0.15 | 22.99 | 6.03 | 23.88 | 4.86 | 5.80 | 0.83 |
| 02.03.92 | 25.36 | 2.05 | 0.810 | 0.13 | 19.88 | 4.33 | 21.30 | 4.40 | 5.88 | 0.87 |
| Total | 478.02 | 40.82 | 19.17 | 2.45 | 290.70 | 69.95 | 287.90 | 59.00 | 64.64 | 8.52 |
| Grand Total | | 518.84 | | 21.62 | | 360.65 | | 346.9 | | 73.16 |

Table 7

Addition of nutrients through leaf litter during the 'Wintering'

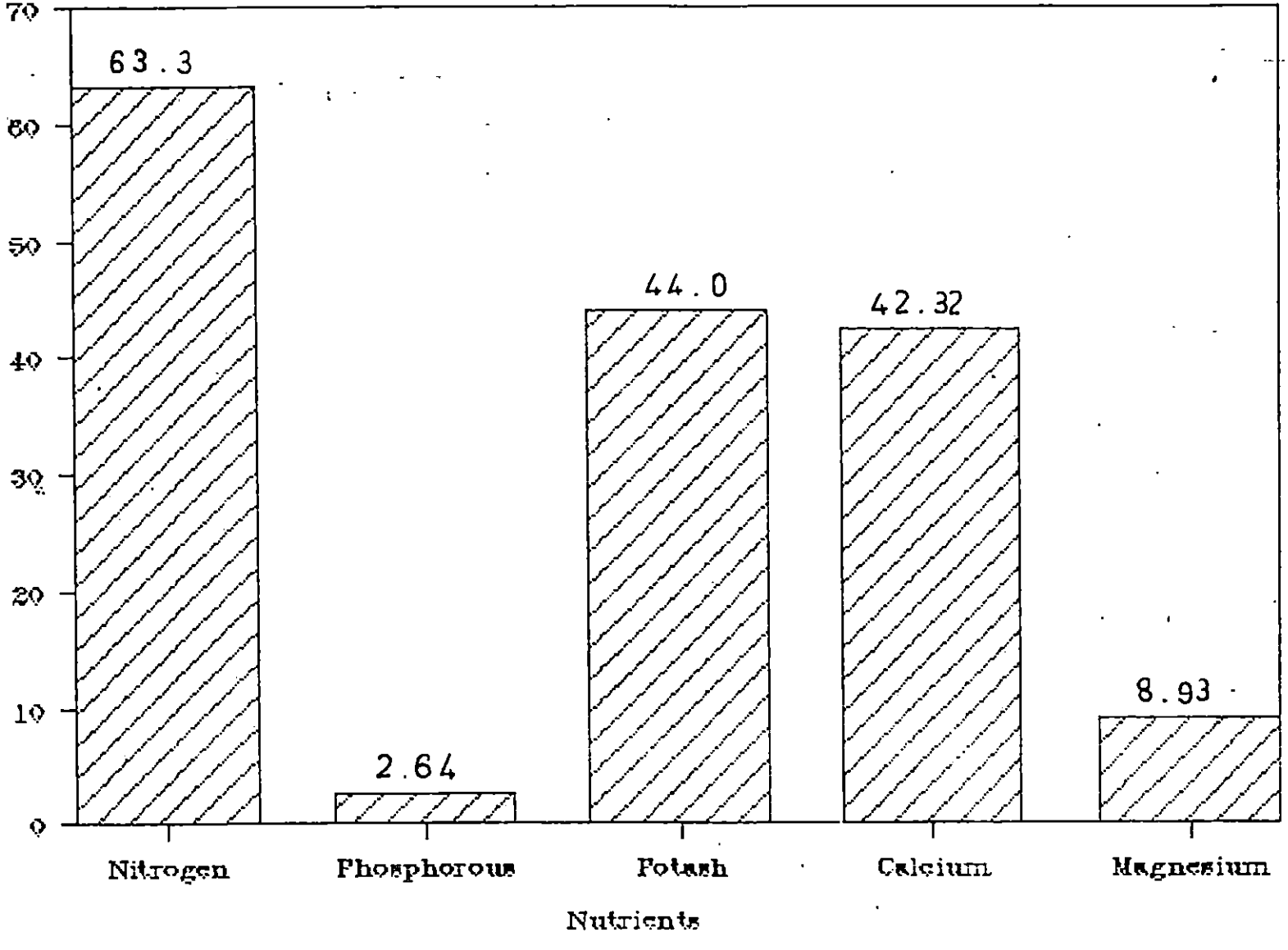
| Nutrient | Quantity (Kg/ha.) | | |
|---|---|---|---|
| | Lamina | Petiole | Total |
| Nitrogen | 58.32 | 4.98 | 63.30 |
| Phosphorous | 2.34 | 0.30 | 2.64 |
| Potash | 35.47 | 8.53 | 44.00 |
| Calcium | 35.12 | 7.20 | 42.32 |
| Magnesium | 7.89 | 1.04 | 8.93 |

Stand of rubber trees : 366/ha.

Fig. 5

# Addition of nutrients

**through leaf litter during wintering**



Thus it is seen that the estimate of mineral nutrient cycling revealed in the present study compares well with the earlier reports in Malayasia and the variations can be attributed to factors like differences in clone, soil fertility, climate, age of the trees studied, stand per ha etc.

Comparison of mineral nutrients released annually through leaf litter in rubber plantation as per present study, with that of other woody species reveal that the leaf litter of rubber adds more quantity of nitrogen.

**d) SOIL FERTILITY AS INFLUENCED BY LEAF LITTER**

Three Samples of top soil were collected on 17-3-92 each from the litter plot and from the adjoining plots. The results of the soil chemical analysis is expressed in Table 8. Comparison of the results of the soil chemical analysis in subsequent years is necessary in order to find out the fertility status as influenced by the leaf litter.

**e) LEAF AREA INDEX**

Fifty leaves with dry weight of 29.08 gm had leaf area of 3512.86 sq. cm. and thus leaf area per gram dry weight of laminae is found to be 120.80 sq. cm. Total leaf area offered by one tree is estimated to be 116.5 sq. metre, and leaf area per ha is 42639 Sq. Metre. Thus leaf area index is 4.26.

TABLE 8

DATA OF SOIL CHEMICAL ANALYSIS

| soil sample no. | Description | %O.C | Av.P * | Av.K * | Av.Mg * | pH |
|---|---|---|---|---|---|---|
| 1 | Top soil sample from experiment site (litter plot) | 1.22 | 0.42 | 3.75 | 3.18 | 5.3 |
| 2 | " | 1.58 | 0.42 | 4.75 | 2.72 | 4.8 |
| 3 | " | 1.37 | 0.92 | 4.12 | 2.09 | 4.8 |
| | Average values for soil samples from the experiment plot | 1.39 | 0.59 | 4.21 | 2.66 | 5.0 |
| 4 | Top soil sample from outside the litter plot | 1.30 | 0.67 | 4.87 | 4.63 | 5.0 |
| 5 | " | 1.15 | 0.50 | 5.12 | 3.99 | 5.1 |
| 6 | " | 1.19 | 0.42 | 4.62 | 4.27 | 5.0 |
| | Average values for soil from outside the litter plot | 1.21 | 0.53 | 4.87 | 4.30 | 5.0 |

* 'Available' P,K and Mg expressed as mg/100gm soil

O.C - Organic Carbon

The leaf area index was found to increase from 0.11 in the one year-old trees to maximum of 14.03 in the ten-year old trees and to decline thereafter to 5.4 in the thirty-three year old trees. (Shorrocks, 1965 a) The leaf area index for the eight-year old RRII 105 clone estimated in the present study is less when compared to the same year old RRIM 501 clone estimated to be 5.26 by shorrocks.

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# SUMMARY

## 5. SUMMARY

Preliminary studies on the total quantity of the leaf litter, chemical composition of leaf litter and the nutrients released through leaf litter for recycling, in an eight year old rubber plantation of Vellanikkara Estate of Kerala Agricultural University have been attempted.

During the year under study, wintering Started by 14th December, 1991 and Continued till 2nd March, 1992, the peak being the third week of January, 1992. During annual defoliation period total leaf litter production (dry weight) was estimated to be 4112 Kg/ha, the contribution of which works out to annual addition of 63.3 Kg N, 2.64 Kg P, 44.0 Kg K, 42.32 Kg Ca and 8.93 Kg Mg. During wintering, there is a gradual decline in the levels of nitrogen, phosphorus and potassium in leaves due to the shift of these nutrients to trunk. This shift was not observed in the case of calcium and magnesium.

Approximate leaf area index was also worked out and is found to be 4.26.

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