SOIL TEMPERATURE AND MOISTURE CHARACTERISTICS AS INFLUENCED BY INTER-CROPPING OF FODDER CROPS IN COCONUT GARDEN.

By

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THESIS

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TRIVANDRUM

1993

DECLARATION

I hereby declare that this thesis entitled "Soil temperatur and moisture characteristics as influenced by intercropping c fodder crops in coconut garden" is a bonafied record of researc work done by me during the course of research and that thi thesis has not previously formed the basis for the award to me c any degree, diploma, associateship, fellowship or other simila title of any other university or Society.

Vellayani
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Certified that this thesis entitled "Soil temperature an moisture characteristics as influenced by intercropping of fodde crops in coconut garden" is a record of research work don independently by Sri. ASOK P.I. under my guidance and supervisio and that it has not previously formed the basis for the award o any degree, fellowship or associateship to him.

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C O N T E N T S

INTRODUCTION

INTRODUCTION

Physical fertility of soil is of prime importance when we study the nutrient status and availability in a particular soil. By knowing the improtance of soil physical properties we have to further see that how these properties are influenced by various soil, plant and atmospheric factors.

Though the milk production in the state showed remarkable increase in the recent past, we have to depend upon the neighbouring states for the supply of essential inputs needed for milk production. As such the people do not show enthusiasm in maintaining cattle because of exorbitant price spiralling in cattle feeds. The fodder grasses have the qualities to increase production of milk without concentrates, reduce 50 percent feeding cost, limit the use of higher priced oil cakes and concentrates to a greater extent and to provide vitamins and minerals to cattle. So it is an imperative need to augment the production of fodder grasses. Hence we have to explore the possibilities to increase the production of fodder grasses, so that the milk producers will get sufficient quantity of forage with lesser cost. Thus the role of fodder grasses in the economical milk production need not be over emphasised.

Farmers and often intellectuals also are not fully aware of the benefits of grass feeding to lactating animals. Moreover farmers are generally under the impression that grass farming in coconut garden will reduce coconut production since the physical and chemical properties of soil will be deteriorated by the intercrop. This reduces the land availability for fodder cultivation.

It has been substantiated that in a systematically planted coconut garden the rooting pattern of coconut provides sufficient inter-space for intercropping without adversely affecting the main crop. (Pillai, 1986). The canopy of coconut tree also permits sufficient quantum of solar radiation to filter through it when the palms are grown up. The fodder crops, whose economic produce consist of vegetative tissue, can grow well under this partial shade. Studies at C.P.C.R.I. Kayamkulam have indicated that there was an increase in production of nuts from the area where fodder crop was intercultivated in coconut garden.

The important physical properties which influence the availability and uptake of nutrients and Plant growth are soil bulk density, particle density, porespace, waterholding capacity, porosity, hydraulic conductivity and soil temperature. All these properties affect plant growth and development directly or indirectly. The effect of soil temperature on various physico-chemical properties are manifold. Several vital processes like water transport, ion movement, denitrification and nitrification are affected by the soil thermal regime. In intensive cropping system the role of Nitrogen, Phosphorus, Potassium, Calcium and Magnesium is needless to emphasise.

Different moisture conditions present in the soil affect plant nutrient availability and uptake. Various soil physical properties are also influenced by the soil water. The nutrient movement in soil is greately controlled by soil water. Scientifically it has to be investigated, how far intercultivation of fodder grass influence the soil physical properties and fertility and yield of the main crop. With this background the present study was undertaken with following objectives :-

(1) To study the effect of fodder grasses grown as intercrop in coconut garden on various soil characteristics with special reference to soil temperature and moisture characteristics.

(2) To investigate the direct and indirect effect of soil temperature and soil moisture on the other soil physical properties when fodder grass is grown as intercrop in coconut garden continuously.

(3) To analyse the effect, if any on the soil physical characteristics as well on nutrient status, by continuous fodder cultivation in coconut garden.

REVIEW OF LITERATURE

An investigation was conducted during the period from June 1991 to May 1992, in fodder intercultivated coconut garden in the college of Agriculture Vellayani to find out the physical and chemical properties of soil due to grass cropping. The literature collected on the subject are reviewed hereunder. The plant growth and development is closely related with the soil conditions. The influence of various crop factors and soil factors on soil physical and chemical properties are also reviewed.

2.1 Influence of crops on soil physical properties

Cultivation of crops results in manifold changes in various physical properties of the soil.

2.1.1 Structural properties

2.1.1.1 Bulk density

A few reports are available on the effect of cultivation and cropping on bulk density of soil.

Page and Willard (1946) found that cultivation decreased porespace and correspondingly increased soil bulk density.

Pasture cultivation for eight years continously changed the bulk density of the cultivated soil (White et al 1976).

Anderson and Gantzer (1989) noticed the soil physical properties after 100 years of continuous cultivation of different crops. Their results indicated that annual additions of manure decreased bulk density by an average of 0.12 gm cm^{-3}

2.1.1.2 Porosity

Page and Willard (1946) found that cultivation brings change in porosity.

Lal and Greenland (1968) showed that root penetration brings out cleavages in soil and porosity is produced. The porosity resulted from old root channel is as high as in certain crops like sweet clover and alfalfa.

Skidmore et al (1974) reported that cropping system can alter the soil porosity which affects the water content and water transmission properties of soil.

2.1.1.3 Aggregation

Sahasranaman et al (1976) found that by intercropping fodder grass in coconut garden, there had been little effect on the size of the soil aggregates when observed after a period of 5 years.

2.1.2 Hydraulic characteristics

If the soil is made moist or if it is made compact, its conductivity is increased (Bridley, 1965).

2.1.2.1 Moisture content

Nako No (1983) demonstrated that shading of a bare soil with canopy can reduce evaporation considerably. Ravina (1983) has studied soil moisture changes in the bare field and in presence of vegetation. In bare field soils below the upper moist soil layer, which may dry up relatively fast, mositure may remain practically unchanged for a long time, shrinkage cracks do not form. Deep rooted plants can extract water from gradually increasing depth up to two to three metres. Moisture and volume changes are observed to depths of 1.5 to 2m, in cracked soils. In the presence of deep rooting crops, the time required to reach the maximum cracking volume is significantly shortened and the cracks are deeper and wider.

Bhagat and Acharya (1988) reported that water uptake by crop roots boundary were moderated under different management practices like mulching and deep ploughing. It is not only moderated the soil rhizosphere and produced higher grain yield in wheat, but also improved the water economy during dry periods by permitting less downward movement across root boundary.

2.1.2.2. Infiltration

Lal et al (1978) indicated that maximum infiltration rate on soil was under Brachiaria grass.

Fahad et al (1982) studied infiltration rate in a four year cropping sequence. The cropping system included soyabean, sorghum, corn and fallow in various sequential cropping combinations. Cumulative infiltration rate after four hours of water application was 6, 13, 29 and 41 cm hr^{-1} for continuous soybean, sorghum after soybean, fallow after soybean and corn after sorghum cultivation respectively. The low infiltration was associated with low macroporosity and decreased aggregate stability. Both Kostiakov's and Philip's equation fitted the infiltration data reasonably well, but Kostiakov equation was a better fit for the early and late stages of infiltration.

2.1.2.3 Hydraulic conductivity

Bhatia and Sri vastava (1982) observed that hydraulic conductivity of the surface soil was lowest (0.82 cm hr^{-1}) in the uncultivated soil and highest in grass land (2.5 cm hr^{-1}).

Anderson et al (1989) found that 100 years of continous cultivation increased the saturated hydraulic conductivity about nine times because of the annual additions of manure.

2.1.3 Soil temperature

Soil temperature profoundly influence the various soil physical properties and crop growth from seed to harvest.

2.1.3.1 Porosity

Investigations by Smith and Bayer (1938) showed that thermal conductivity of the soil constituent with possible exception of organic matter varies little from one soil to another. Their expression shows that conductivity of soil decreases as the porosity increases.

2.1.3.2 Infiltration

Soil temperature accelerates the infiltration rate. Infiltration studies conducted by Moore (1940) revealed that maximum water content in the wetted layer decreased, while infiltration rate increased with increasing soil temperature.

2.1.3.3 Bridley et al (1965) observed an increased thermal conductivity when the soil is moist and compact.

2.1.3.4. Effect of crops on soil temperature

Baver (1983) reported a steady rise in soil temperature at depths of five and ten cm in uncropped soil whereas under a crop stand there was a tendency towards a lowering of soil temperature during the course of a day.

Naka No et al (1983) observed that shading of a bare soil with a canopy can reduce the soil temperature and evaporation considerably. Rodskjer et al (1989) compared the soil temperature under a bare soil surface to that under stands of winter wheat, spring barley and ley. In summer soil temperature, under bare soil was considerably higher, than under crop stand.

2.2 Influence of crops on chemical properties of soil

It is observed that the nutrient movement and availability depend to some extent on the cropping systems and the crop stand.

2.2.1 Soil Nitrogen

Figwan (1963) reported that continuous cultivation in soil did not bring any change in total Nitrogen.

Sahasranaman *et al* (1976) reported that no significant change in available Nitrogen content when the fodder grasses were grown in coconut stand for a period of five years.

According to White *et al* (1976) the pasture cultivation for eight years continuously, changed the total Nitrogen content of the soil.

Mandal *et al* (1982) reported that after five years of sequential cropping with jute, rice and wheat about 80 per cent of Nitrogen was lost. Studies on Alpine soils showed that the total Nitrogen was more in the surface horizon and decreased with depth (Snedown et al 1982).

Decka and Singh (1984) showed that total Nitrogen and Organic matter contents increased under all crop rotations, except in pure cereals-rice-wheat.

Choudhari and Veehmi (1985) and Prasad and Palaniappan (1987) reported that total Nitrogen content of the soil remain unchanged after continuous cultivation of rice.

Noshita and Hang (1986) studied the distribution of different forms of Nitrogen in the desert soils at Nevada test site, and found that the amount of total Nitrogen was greater in the surface layer and usually decreased very sharply with depth.

2.2.2 Soil Phosphorus

Ghosh and Kanzaria (1964) obtained a higher status of available Phosphorus under continuous cropping systems, in plots which received superphosphate.

Koshy and Britomuthunayagam (1965) from their study on Kerala soils reported that the level of total Phosphorus varied from 0.024 to 0.0250 percentage. The phosphorus fixing capacity also varied widely in acid soils with high sesqui-oxides having high fixation capacity.

Chibba and Sekhon (1973) observed that phosphorus availability did not show any definite trend of increase or decrease with depth in soil, eventhough it was higher in surface soils of the two profiles studied. It varied from 3.9 to 85.1 kg ha^{-1}. Sahasranaman *et al* (1976) found that available phosphorus increases in soil at depth 0 to 50 cm and 50 to 100cm, due to continuous cultivation of fodder in coconut garden.

Subha Rao and Ghosh (1981) reported that intensive cropping affect the depletion of inorganic phosphorus than the depletion of organic phosphorus in soils. Mandal *et al* (1982) noticed that due to continuous cropping and manuring in a jute-rice-wheat rotation an appreciable build up of available phosphorus in the soil has occured.

Varma *et al* (1986) reported that continuous cropping increased the phosphorus status over the initial value, when phosphorus was applied in the cropping sequence.

2.2.3 Soil Potassium

Sturgis (1934) reported a reduction in exchangable potassium content of the soil due to continuous cultivation of rice. An increase in the total potassium content with increase in depth was reported by Balaguru (1970) in red and alluvial soils of Tamil Nadu.

Lal (1973) reported that available potassium decreased by increasing the cropping intensity.

Clark and Mack (1974) found that exchangable potassium decreased under continuous cropping for four years with fertilizer application.

Sahasranaman *et al* (1976) found an increase in the available potassium content at 50 cm depth and 100 cm depths of soil where fodder crops were grown in coconut garden. Ganesh and Biswas (1985) reported that continuous cropping did not affect the exchangable potassium content of the soil.

2.2.4 Soil Calcium

Alway (1960) in his studies on Nebraska loess soil found negative correlation between annual precipitation and hydrochloric acid soluble as well as insoluble calcium.

Sahasranaman et al (1976) reported increase in calcium content in the soil due to intercropping of fodder crops in coconut garden.

2.2.5 Soil Magnesium

The level of Magnesium in soils depends to a large extend on soil type, rainfall, elevation, particle size distribution and organic matter content.

Sahasranaman et al (1976) reported an increase in Magnesium content of the soil due to the intercropping of fodder crops in coconut garden.

2.2.6 Soil reaction

Kanwar and Prihar (1962) reported that continuous cultivation of crop that use Ammonium, results in lowering of soil pH Moore (1972) observed that nutrient absorption by plants is maximum at pH 5 to 7.

Lal (1973) reported that soil pH decreased with increasing crop intensity from 100 to 400 percentage.

Juo and Lal (1975) reported that continuous cropping for three years resulted in decreasing soil pH. Sahasranaman et al (1976) observed no change in soil reaction after five years of intercropping of fodder crops in coconut garden.

2.3 Effect of soil temperature on physical and chemical properties of soil

Soil temperature affects the various physical properties and the nutrient availability.

2.3.1 The infiltration rate increased with increase in soil temperature and the maximum water content in the wetted layer decreased as reported by Moore (1940).

2.3.2 Mackey and Barber (1984) noted that the temperature affects each of the mechanisms involved in phosphorus uptake by corn. Norstadt and Porter (1984) found that soil Nitrogen content was negatively correlated with soil temperature.

2.4. Soil moisture conditions in relation to physical properties of soil

The hydraulic characteristics influence both physical and chemical properties of soil. The moisture conditions existing in the soil have vital role in deciding physical properties of soil. soil mechanical properties, aeration and thermal properties profusely depend on soil water and moisture conditions.

Choudhari (1964) found that moisture equivalent and water holding capacity were significantly correlated to water stable aggregates.

Ghildyal and Tripathi (1971) observed that thermal conductivity increased exponentially with the increase in degree of saturation. Volumetric heat capacity showed parabolic relationship with degree of saturation.

A high significant positive correlation between clay content and moisture constants was observed by Velayudhan and Roy (1971).

Acharya and Gupta (1975) found that thermal diffusivity value increased with moisture contents up to a particular wetness of soil and then the rate of increase decreased with further increase in moisture. Kamper and Rosenew (1984) reported that cohesion increased for several months after disruption in moist soils. Rate at which cohesion increased was slower in air dry soil, but continued for years. Bulk density increased with depth and decreased with increasing water content (Oilver _et al_ 1986).

Ploughing the soil at high moisture content caused a resistance for penetration and a decrease of macropores as well as in oxygen concentration in the top soil and tillage pan (Maidl and Fischbeck, 1987).

2.4.2 Soil moisture conditions in repation to chemical properties of soil

Since nutrient movement and availability to plant is attained through soil solution, soil moisture conditions have definite influence on chemical properties of soil.

Vyas and Motiramani (1971) reported that at the same phosphorus level, higher moisture percentage increased the availability of phosphorus. Minimum fixation was found at 60 percent moisture level and maximum at 10 percent moisture level.

Hira and Singh (1979) noticed that phosphrous diffusion increased from 9.47×10^{-7} to 23.72×10^{-7} $cm^2 sec^{-1}$ neither increase in soil water content from 7 to 18 percent.

Casmann and Munns (1980) showed that Nitrogen mineralisation declined linearly with water content.

Schaff and Skogley (1982) reported that soil moisture contents of 10, 17 and 20 percent, significantly influenced the diffusion of potassium, calcium and magnesium. The temperature and moisture interaction was significant for all the three cations.

2.5 Yield of coconut due to intercropping of fodder crops in coconut garden

In the root area a 28 percentage increase in nut yield was obtained by adopting mixed farming practices over a period of 5 years. (Sahasranaman *et al* 1976))

Pillai (1986) observed an increase in coconut yield to the tune of 20.5 percent by fodder intercropping for a period of 5 years.

MATERIALS AND METHODS

The experiment was carried out with five varieties of grasses in the farm area at the college of Agriculture, Vellayani during June 1991 to May 1992.

3.1 Climatic conditions

Vellayani is situated at a latitude of 8.5^{o} N, longitude of 76.9^{o} E and at an altitude of 29 mtrs from M.S.L. During the period of investigation there was an average rainfall of 272 mm in the rainy season namely July and 20mm in December, ie in the winter season and there was no rain fall on the month of March, the summer season. The mean maximum and mean minimum temperature are 29.4^{o} C and 23.47^{o} C for rainy season, for the summer it is 32.5^{o} C and 23.4^{o} C and for winter it is 30.4^{o} C and 21.9^{o} C respectively.

3.2 Preliminary analysis

Soils samples were collected from the plots before planting the grasses were analysied for physico-chemical properties. The results are given in table - I

PRELIMINARY ANALYSIS

Preliminary Analysis was done on 1988 in control plot

Table No. 1

Physical properties of the soil	W.H.C. (in%)	M.C (in%)	B.D gm/cc	P.D gm/cc
	33.14	7.11	1.22	2.0

Table No. 2

Chemical properties of the Soil	Total Nitrogen kg/ha	Available P2O5 kg/ha	Available K20 kg/ha
	1300.2	90.57	37.98

3.3 Field experiment

From the already laid out plots the samples are collected. The date of planting was on 27-6-87. The fertilisers were applied to the plot at the rate of 150:30:90 Kg N.P.K ha^{-1}.

	South west monsoon	North West monsoo
Urea per plot	200 Gm	200Gm
Mussori phos	180 Gm	-
MOP	180 Gm	-

3.3.1 Design and Treatments

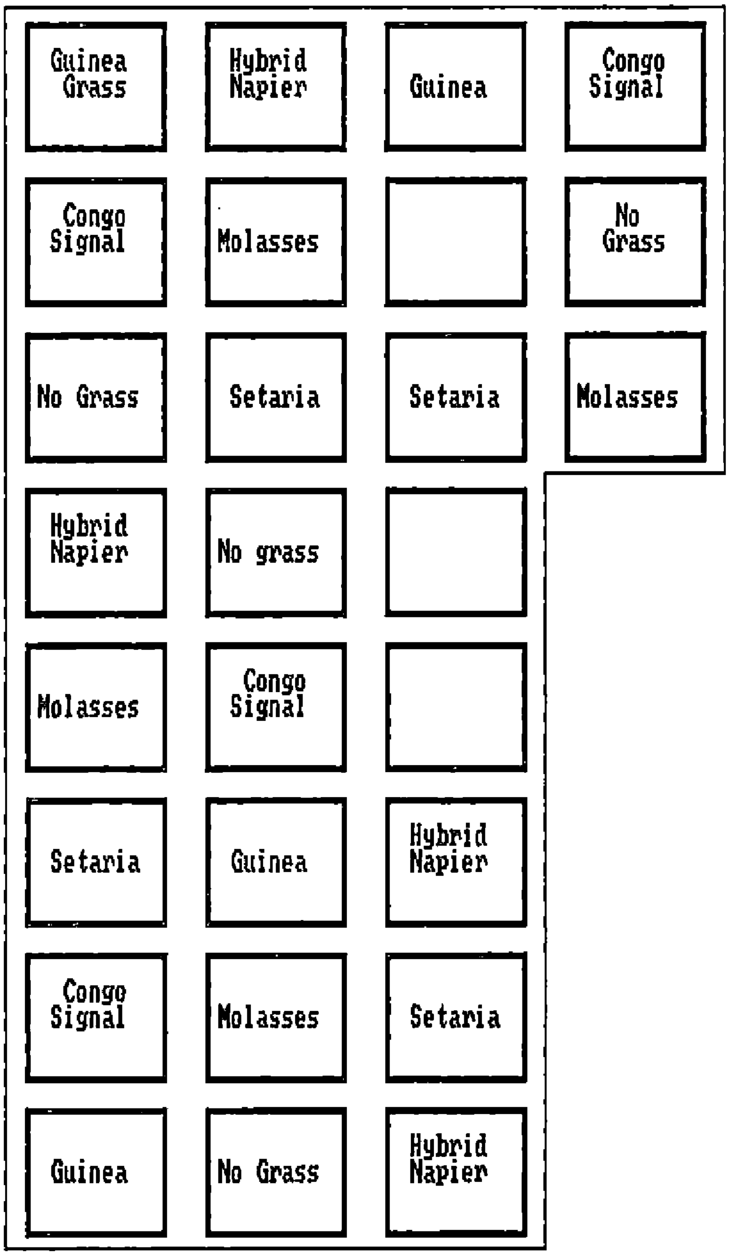
The experiment was laid out in randomised block design with five varieties of grasses and fallow. Fig No. 1 shows the lay out of the experiement. The treatments include :-

1. Guinea grass
2. Congo Signal grass
3. Setaria grass
4. Molasses grass
5. Hybrid Napier grass
6. Control plot without fodder

Layout of the Experiement

Fig. 1

North ←



Area of single plot 3 x 3 m2

Plate 3 Guinea Grass

Plate 4 Congo Signal Grass

Plate 5 Setaria Grass

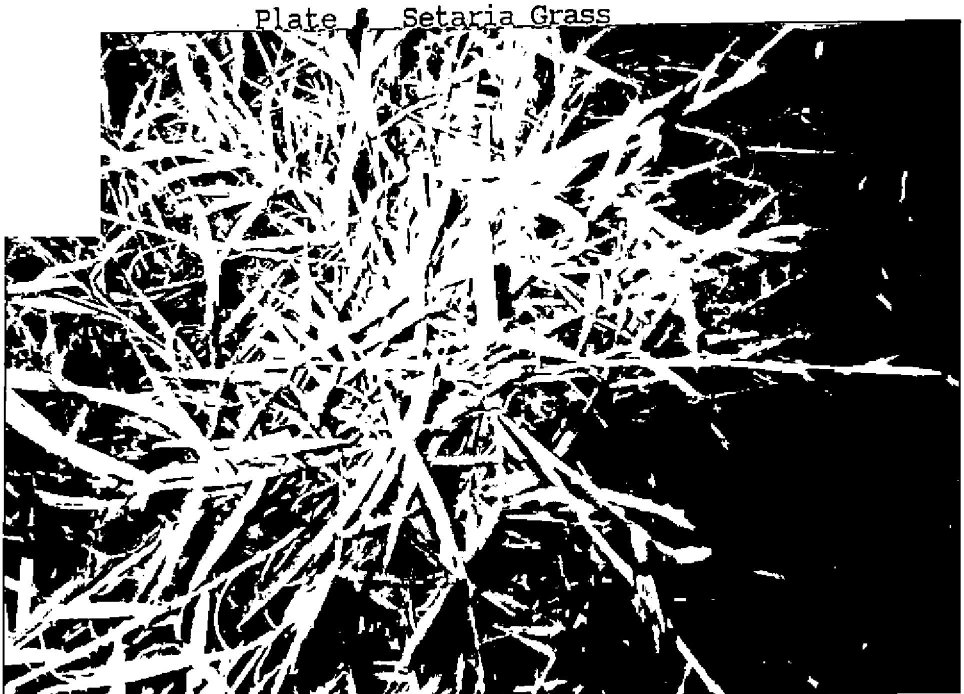


Plate 6 Molasses Grass

Plate 5 Hybrid Napier Grass

Samples were taken from two depths

1. 15cm from the surface
2. 30cm from the surface

Total treatments were 6x2 = 12 and the replications were four in number. Samples were collected in April, July and December to study the seasonal effects of fodder grasses on soil properties.

3.4 Observations

Observations on soil temperature, moisture and physico-chemical properties were recorded.

3.4.1 Physical properties of soil

Soil samples are collected for different seasons were analysed for following properties.

3.4.1.2 Soil temperature

Soil temperature at 15cm and 30cm depth were recorded at 07.30 and 14.30 hours thrice in a week.

3.4.1.3 Physical constants

Bulk density, particle density water holding capacity and porosity for undisturbed soil samples were determined for all the three seasons as described by Gupta and Dhakshinamoorthi (1980).

3.4.1.4 Hydraulic conductivity

Using the Jodpur constant head permeameter, hydraulic conductivity for the final season samples were determined (Gupta and Dhakshinamoorthy, 1980). Plate No. 1 shows the equipment for the determination of Hydraulic conductivity. Hydraulic conductivity 'K' was calculated using Darcy's equation as follows.

$$K = QL / dHAt$$

Where

K = Hydraulic conductivity ($Cm\ hr^{-1}$)

t = time in hour

Q = Amount of water collected in time 't' ($-Cm^{-3}$)

L = Length of soil colum in Cm

A = Area of cross section of core (Cm^{2})

H = Effective hydraulic head (Height from base of soi[l] column to the top of water level (-Cm)

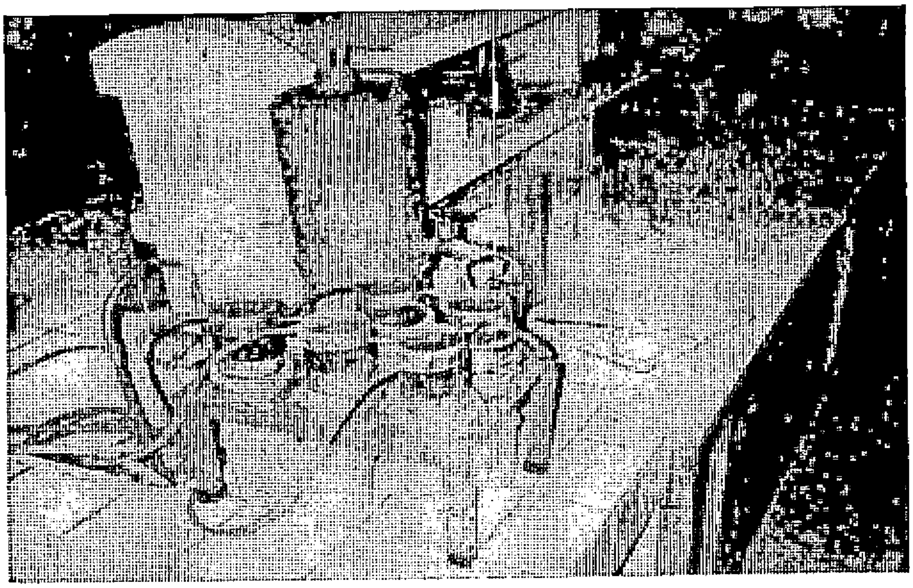


Plate 1 : Hydraulic Conductivity - Measurement

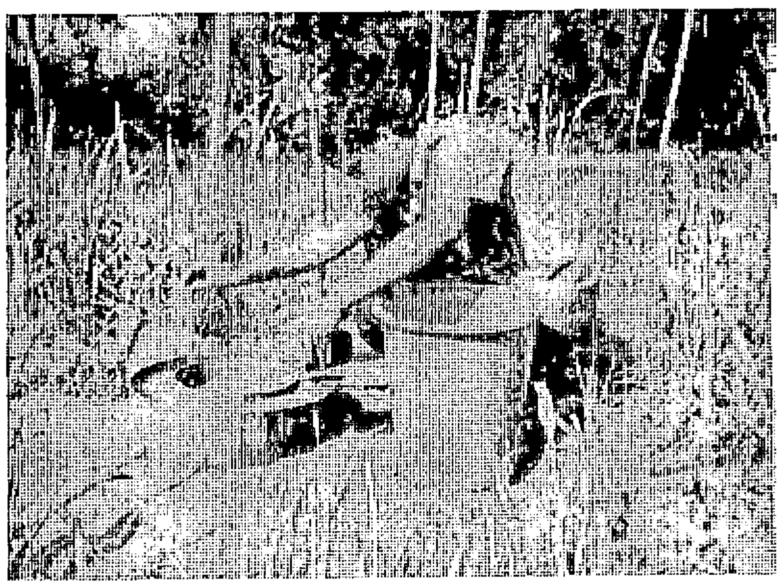


Plate 2 : Infiltration Rate - Measurement

3.4.1.5 Soil water status

Gravimetric soil water contents were recorded by collected soil samples from 15 and 30cm depths for the three seasons under study.

3.4.1.6 Infiltration rate

Infiltration rates were recorded using the double ring method (Gupta and Dhakshinamoorthy, 1980) by nullifying the angular effect. The observations were taken during the third season only. The equipment for infiltration rate measurement is shown in Plate No. 2.

3.4.2 Chemical analysis

Chemical analysis was done for all the soil samples as given below.

3.4.2.1 Available Nitrogen was estimated using the permanganate titration method by Subbiah and Asija (1956).

3.4.2.2 Available Phosphorus was estimated by Dickman and Brays Molybdenum blue method (Jackson, 1973).

3.4.2.3 Exchangable K, Ca and Mg were estimated using atomic absorption spectro photometer Model - PE - 3030 using ammonium acetate extract (Jackson, 1973).

Statistical Analysis

The data obtained under various observation were statistically analysed as RBD and the results were interpreted. Correlations were worked between soil temperature with other soil physical and chemical parameters and is given in table No. 30.

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

An investigation was conducted in the college of Agriculture Vellayani to study the effect of intercultivation of fodder grasses on the physico-chemical properties of the soil. The observations are statistically analysed. The mean values for all the observations for the three seasons are given in tables. No.3 to 27 and are graphically represented from figures No.2 to 28.

4.1. The physical parameters like moisture content Bulk density, particle density, water holding capacity, porosity and soil temperature for 15 cm and 30 cm depth are given in tables No. 3 to 16. The seasonal soil temperature represents the mean value of weekly soil temperature. The soil temperature values are recorded at 7.30 and 14.30 hours. The hydraulic characteristics such as infiltration rate, and hydraulic conductivity are determined at the close of the experiment, in the third season table No. 13.

4.1.1 Moisture content

Table No.3 shows the mean values of soil moisture content at 15 cm depth for all the three seasons for the first season. Moisture percentage variations at 15cm depth is not significant among the treatments. The mean moisture percentage ranges from 7.15 percent in Molasses grass to 10.27 in congo signal grass, for the second season the treatment effects are found to be significant. The mean moisture contents range from 5.57 in control to 12.52 per cent in Guinea grass. It is also found that only Guinea grass showed a significant value over Molasses grass. Otherwise all treatments are on par except control which gives the lowest value of 5.57. For the third season the mean moisture per cent range from 7.10 in Hybrid Napier plot to 9.06 in control plot. Though the control plot shows the highest value it is on par with other treatments.

The result for the moisture content at 30cm depth for all the three seasons are given in table No.4. It is found that there is no significance for treatments in all the three seasons. For the first season the values range from 8.24 percent in Molasses grass to 11.28 in control. As seen from the table for the second season the mean values range from 5.51 for control to 11.30 percent in Congo signal grass. In the third season the mean values range from 6.79 per cent in Setaria grass to 8.58 in control plot.

From the results it can be seen that soil moisture content is not much affected by growing fodder crops. There is a decline of soil moisture in the surface layer of the soil only at 15cm depth of the soil. But there is not much variation in the sub surface soil. (fig 2 & 3). The root distribution of coconut is found to be 30-120 cm deeper from the surface. So that it is deeper than fodder grass. So the moisture stress may not be experienced by the coconut roots. A close correlation between root distribution and water extraction pattern has been reported by Chaudhary and Bhatnagar (1980) in the case of wheat crop. In the present study the fodder grass seem to utilize water mostly from the surface layer. The evaporation from surface layer is restricted by the presence of fodder canopy.

For both 15 and 30cm depth the control plot shows the highest moisture percentage value in the third season. This may be due to the high rainfall received during this season

Table 3. Moisture persentage at 15 cm depth for the three seasons.

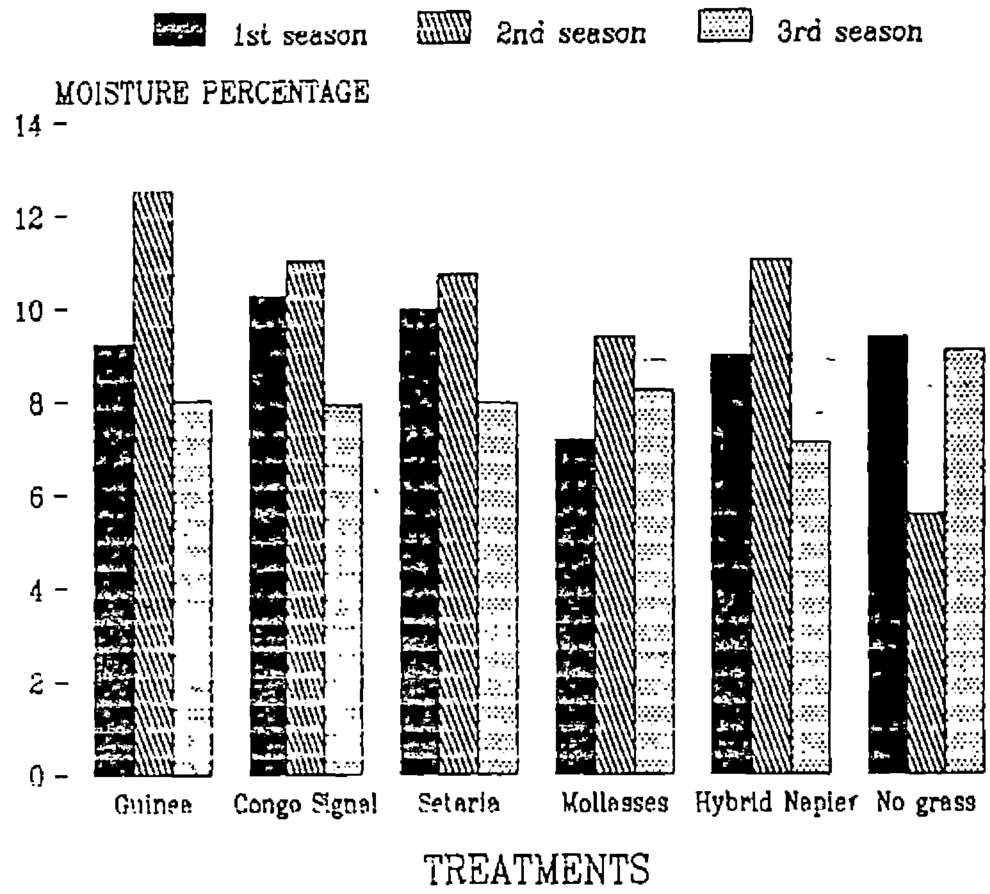
Treatments	Ist Season	IInd Season	IIIrd Season
Guinea grass	9.22	12.52	8.08
Congo signal grass	10.27	11.02	7.92
Setaria grass	9.95	10.73	7.78
Molasses grass	7.15	9.35	8.22
Hybrid Napier grass	8.94	11.02	7.10
No grass	9.33	5.57	9.06
C.D at 5% level	N.S.	3.01	N.S.

Table 4. Moisture percentage at 30 cm depth for the three seasons.

Treatments	Ist Season	IInd Season	IIIrd Season
Guinea grass	9.72	11.02	7.92
Congo signal grass	10.46	11.30	7.63
Setaria grass	11.17	11.08	6.79
Molasses grass	8.24	10.20	7.94
Hybrid Napier grass	10.83	9.39	7.39
No grass	11.28	5.51	8.58
C.D at 5% level	N.S	N.S	N.S

Figure 2

MOISTURE PERCENTAGE AT 15CM. DEPTH FOR THREE SEASONS



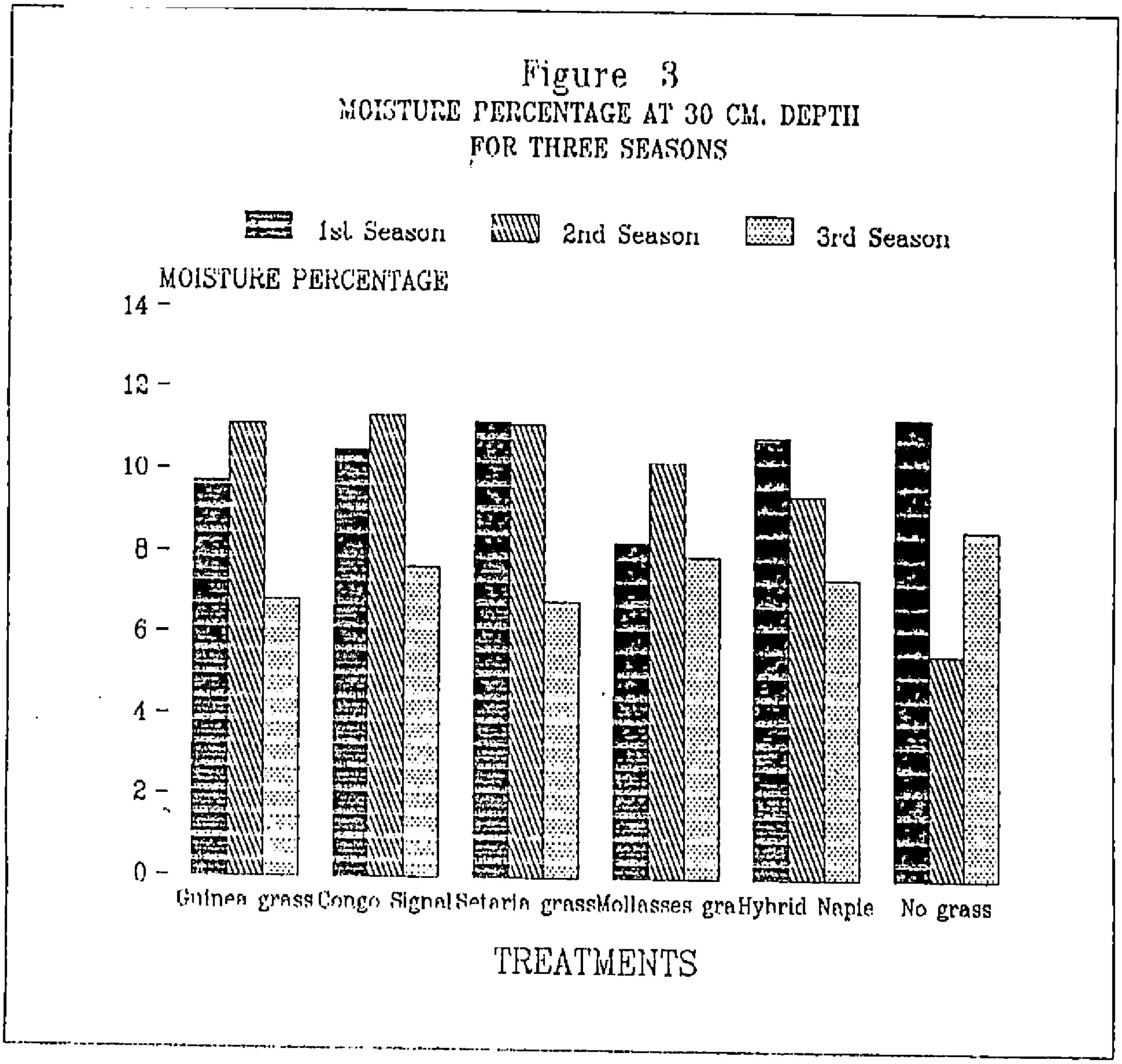


Figure 3
MOISTURE PERCENTAGE AT 30 CM. DEPTH
FOR THREE SEASONS
1st Season
2nd Season
3rd Season
MOISTURE PERCENTAGE
14
12
10
8
6
4
2
0
Guinea grass
Congo Signal
Setaria grass
Mollasses gra
Hybrid Naple
No grass
TREATMENTS

as shown in the appendix. The thick canopy cover of Guinea and Congo signal grass might be the reason for a higher moisture content in these plots for both the depths.

4.1.2. Bulk Density

The bulk density values on wet basis at 15cm depth for three seasons are depicted in Table No. 5. No significant difference is obtained for bulk density at 15 cm depth.

The highest value of 1.32 gm cm^{-3} is obtained for Molasses grass during the first season and lowest value of 1.11 gm cm^{-3} is shown by Guinea grass during the third season. The control records comparatively higher values for bulk density at 15cm depth for second and third seasons.

Table No. 6 shows the mean bulk density values at 30 cm depth for the three seasons. Treatment effects are significant only for the second season. The maximum value obtained is 1.41 gm cm^{-3} for Hybrid Napier in the first season and the minimum value is 1.08 gm cm^{-3} for the plot in which Setaria grass was grown. As in the case of 15 cm depth for the second and third seasons bulk density values are comparatively higher for the control plots than other

Table No 5. Bulk Density in gm cm^{-3} of soil at 30 cm depth fo[r] three seasons

Treatments	Ist Season	IInd Season	IIIrd Season
Guinea grass	1.26	1.11	1.11
Congo signal grass	1.31	1.17	1.16
Setaria grass	1.29	1.16	1.20
Molasses grass	1.32	1.12	1.16
Hybrid Napier grass	1.32	1.12	1.16
No grass	1.20	2.0	1.19
C.D at 5% level	N.S	N.S	N.S

Table No 6. Bulk density in gm cm^{-3} of soil at 30cm depth fo[r] three seasons

Treatments	Ist Season	IInd Season	IIIrd Season
Guinea grass	1.34	1.11	1.11
Congo signal grass	1.33	1.10	1.19
Setaria grass	1.34	1.08	1.24
Molasses grass	1.32	1.10	1.28
Hybrid Napier grass	1.41	1.12	1.22
No grass	1.23	1.21	1.17
C.D at 5% level	N.S	N.S	N.S

Figure 4
BULK DENSITY OF SOIL AT 15 CM. DEPTH
FOR THREE SEASONS

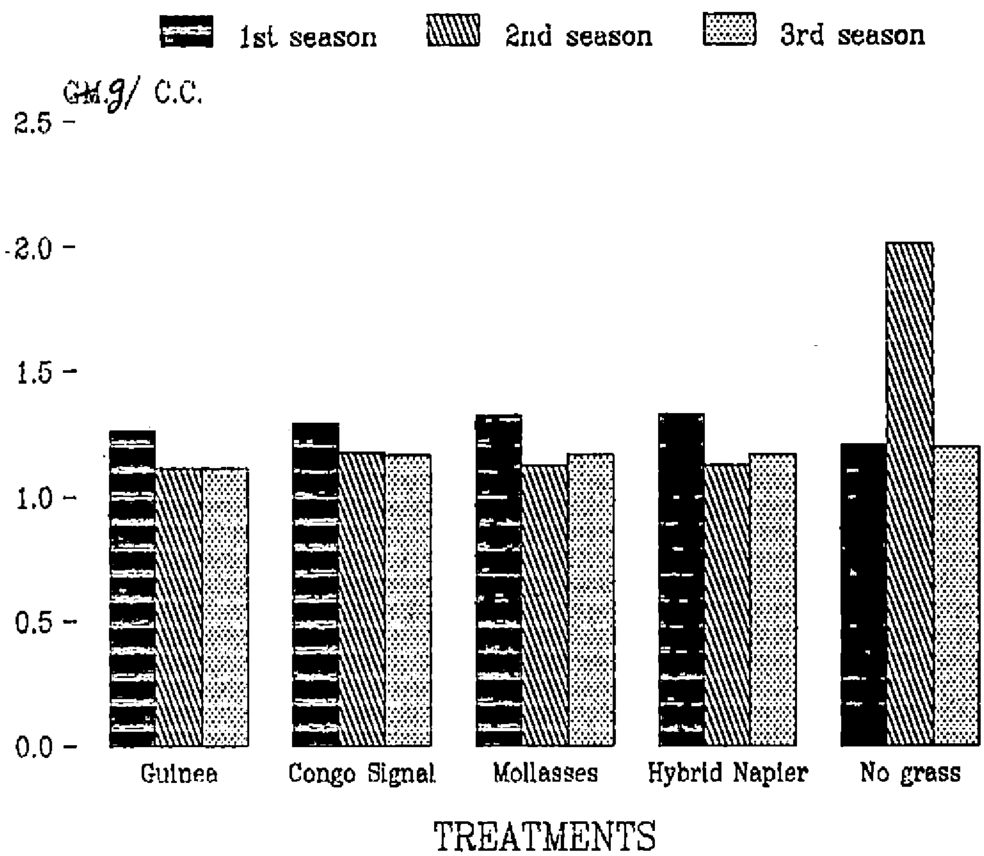
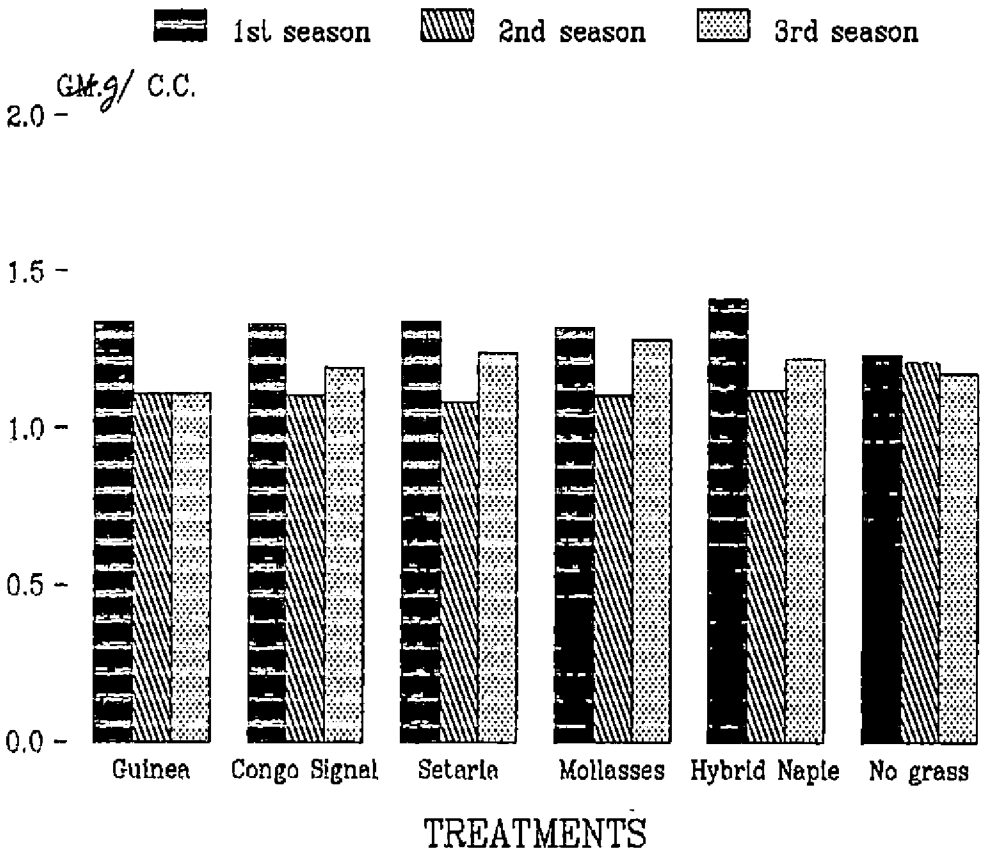


Figure 5
BULK DENSITY OF SOIL AT 30 CM. DEPTH
FOR THREE SEASONS



treatments and it is significantly different in the second season.

Bulk density varies with moisture content. When the moisture content decreases compaction increases and this gives a higher value of bulk density during the first season that is in the dry spell. Relatively higher values of bulk density at the surface and sub surface layer during the first season is due to the dry spell of the summer season. During the season the distribution of the pores are more or less uniform in the cropped and control plots. During the second and third seasons a higher value of bulk density was observed for the control. The lower bulk density recorded at the surface layer during these sasons may be due to the presence of fodder grass grown there. The fodder crops decreased the bulk density at the surface layer, during these seasons. A decrease in the bulk density is also reported from the trials under All India Co-ordinated Research project on forage crops due to, continuous cultivation of fodder grasses (Annual report 1985).

4.1.3 Particle density

Table No.7 gives the results of particle density

Table No. 7 Particle density in g cm^{-3} at 15cm depth for three seasons.

Treatments	Ist Season	IInd Season	IIIrd Season
Guinea grass	1.83	1.81	1.73
Congo signal grass	2.05	2.03	1.73
Setaria grass	1.71	1.99	1.84
Molasses grass	1.91	1.88	1.90
Hybrid Napier grass	1.71	1.93	1.66
No grass	2.01	2.00	2.21
C.D at 5% level	N.S	N.S	N.S

Table No. 8 Particle density in $gm\ cm^{-3}$ at 30cm depth for three seasons.

Treatments	Ist Season	IInd Season	IIIrd Season
Guinea grass	1.89	2.03	1.79
Congo signal grass	1.77	1.93	1.92
Setaria grass	1.82	1.86	1.88
Molasses grass	1.70	1.97	1.96
Hybrid Napier grass	1.95	1.92	1.96
No grass	1.914	1.98	1.83
C.D at 5% level	N.S	N.S	N.S

Figure 6

PARTICLE DENSITY IN GM./C.C. AT 15 CM. DEPTH FOR THREE SEASONS

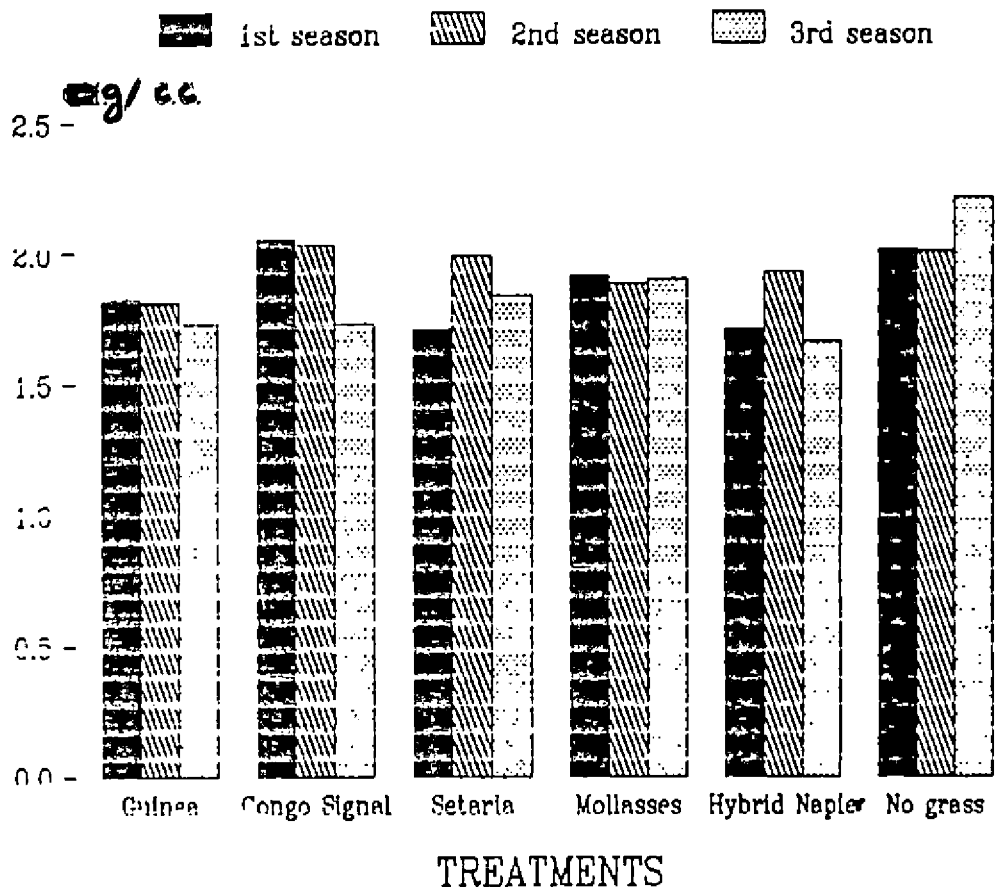
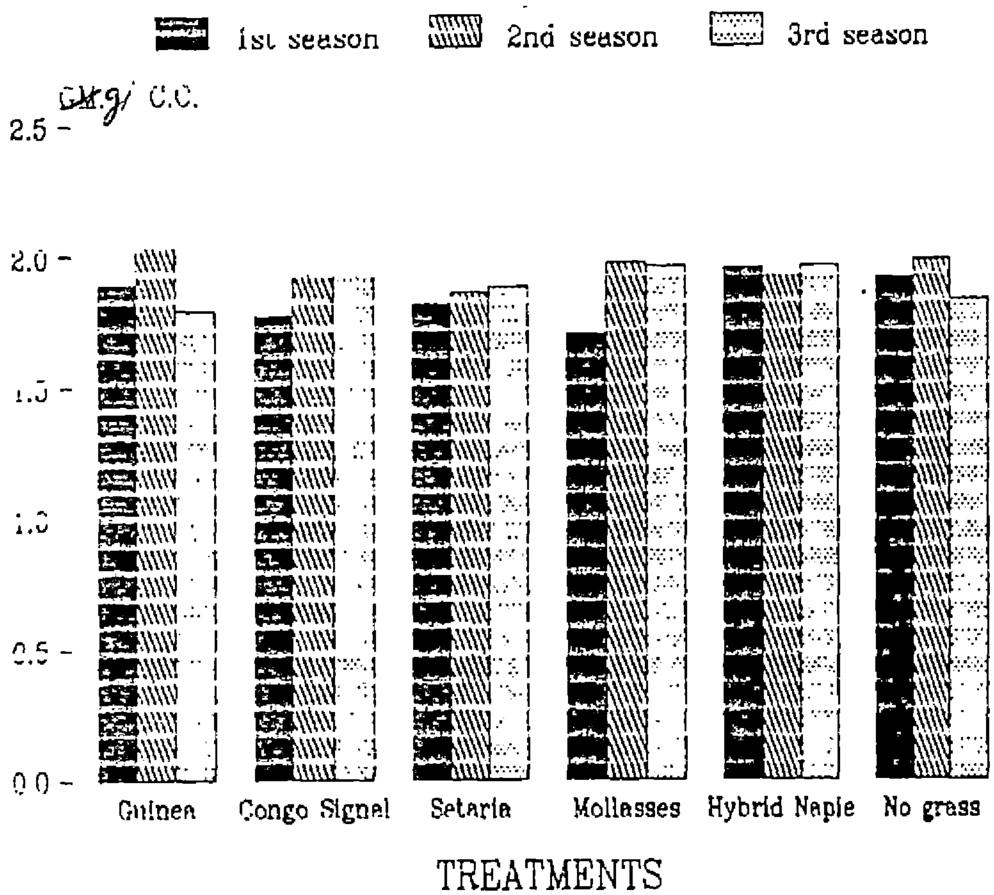


Figure 7

PARTICLE DENSITY IN GM/C.C. AT 30 CM DEPTH FOR THREE SEASONS



observed for three seasons at 15 cm depth. From the table it can be seen that there is no significant difference due to the treatments. Maximum value of 2.21 gm cm^{-3} is observed in control plot, while the lowest value of 1.71 gm cm^{-3} is observed in the Seteria grass.

It is clear from the table 8 that there is no significant difference when the particle density is measured at 30 cm depth for all the seasons. Maximum value of 2.03 gm cm^{-3} is observed under Guinea grass in the second season and a minimum value of 1.70 gm/cm^{-3} is observed under Molasses grass. The treatment effects are of same trend in both the depths.

The particle density values recorded by control plot are relatively higher, values are than obtained from grass cropped soil. In the present study, in fodder cropped soils both at 15 cm and at 30 cm the bulk density values are not seen affected significantly.

4.1.4. Water holding capacity

Table No. 9 indicates that the water holding capacity does not vary significantly for the different treatments at

Table No. 9 Water holding capacity in percentage 15cm depth for three seasons

Treatments	Ist Season	IInd Season	IIIrd Season
Guinea grass	38.52	33.93	38.23
Congo signal grass	38.31	33.12	34.35
Setaria grass	41.12	33.37	36.85
Molasses grass	40.25	33.67	30.81
Hybrid Napier grass	34.42	38.75	31.22
No grass	32.45	32.76	30.81
C.D at 5% level	N.S	N.S	N.S

Table No. 10. Water holding capacity at 30cm depth for three seasons.

Treatments	Ist Season	IInd Season	IIIrd Season
Guinea grass	36.36	33.75	32.91
Congo signal grass	39.98	34.68	29.95
Setaria grass	37.02	38.12	33.56
Molasses grass	35.67	36.12	27.42
Hybrid Napier grass	35.69	37.02	37.54
No grass	37.87	28.08	27.45
C.D at 5% level	N.S	5.01	N.S

15 cm depth. Here the maximum water holding capacity value of 41.12 per cent is given by Seteria grass in the first season and minimum value of 30.81 percentage is observed in the fallow region.

As seen in table No.10 the water holding capacity observed for the control plot is 28.08 per cent at 30 cm depth, which is significantly lower than the other treatments, for the second season. There is no significant difference among treatments during first and third season. The highest value of 39.98 percent is recorded for Congo signal grass in the first season.

The water holding capacity recorded for the summer season that is during the first season, at 30 cm depth was higher for all the fodder crops and control plot excepting the Setaria and Molasses grass. In the case of these two grasses higher values are recorded at 15cm depth. The rooting pattern of these two grasses are found to be shallow. And as such they influence the water holding capacity only at the surface layer. When there is a vegetative cover such as fodder or forest there is abundant life like earthworms, the organic matter content will be

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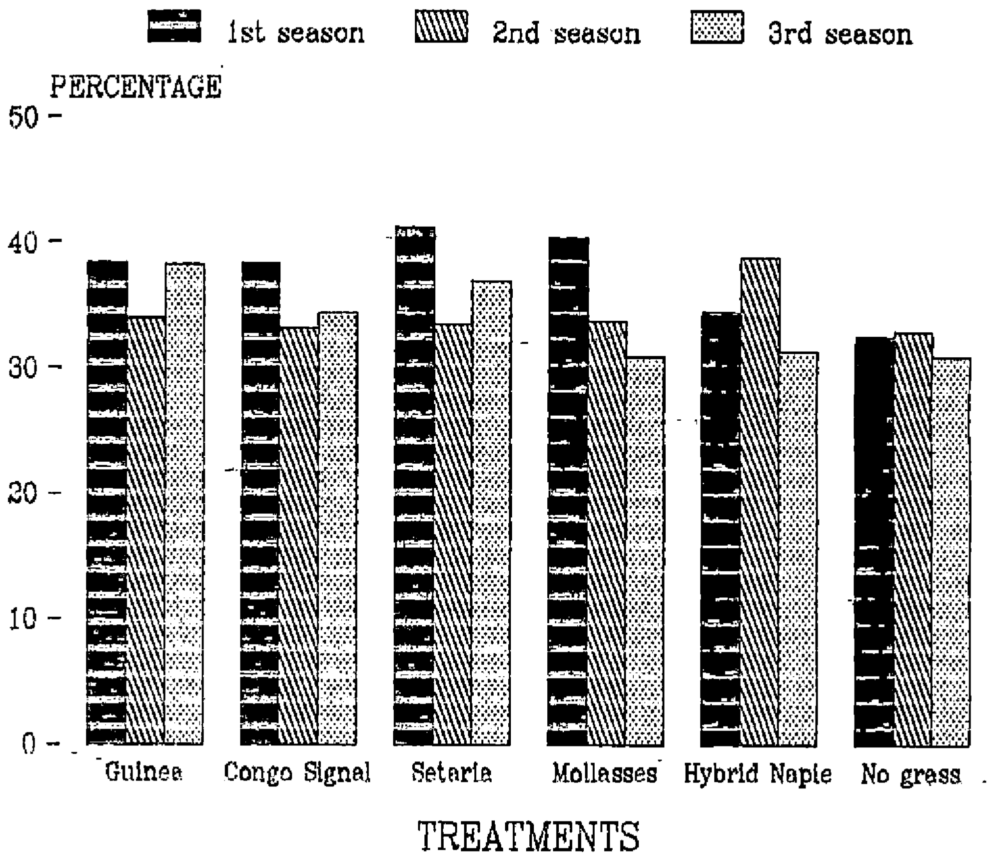
Figure 8

WATER HOLDING CAPACITY AT 15 CM. DEPTH FOR THREE SEASONS



increased in the soil resulting in higher water holding capacity. The relative higher values of water holding capacity at the sub surface layer show the influence of fodder grass in increasing the water holding capacity by acting as a mulch at surface.

4.1.5. Porosity

The values for porosity at 15 and 30 cm depth are given in table No. 11 and 12 respectively for the three seasons. No significant difference is observed for treatments both at 15 and 30 cm depth. At 15 cm depth the values range from 33.87 to 46.77 per cent. At the sub surface layer the porosity values range from 32.50 to 45.38 per cent. There is no much variation between the surface and sub surface sample values.

Since the experimental area is sandy loam the structural influence might be negligible by growing fodder crops. In compacted heavy soils cropping pattern and cultivation practices including fodder grass can bring about changes in the pore distribution. The results obtained in the study is contrarary to the findings as

Figure 9
WATER HOLDING CAPACITY AT 30 CM. DEPTH
FOR THREE SEASONS

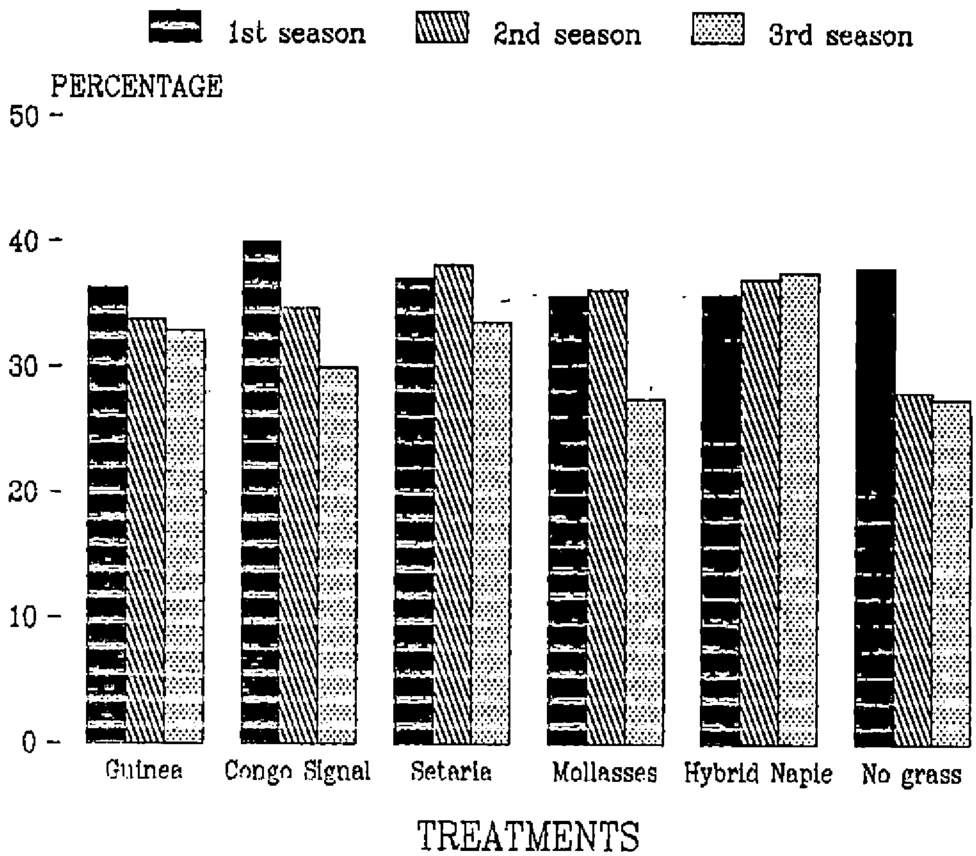


Table No. 11 Porosity in percentage at 15cm depth for th
seasons

Treatments	Ist Season	IInd Season	IIIrd Seaso
Guinea grass	45.92	40.75	40.32
Congo signal grass	40.51	40.57	37.33
Setaria grass	35.85	45.34	34.91
Molasses grass	39.1	45.29	33.87
Hybrid Napier grass	37.62	45.27	34.59
No grass	37.3	46.77	40.71
C.D at 5% level	N.S	N.S	N.S

Table No. 12 Porosity in precentage at 30cm depth for th
seasons

Treatments	Ist Season	IInd Season	IIIrd Season
Guinea grass	41.65	41.46	39.24
Congo signal grass	39.89	40.98	42.17
Setaria grass	43.32	40.04	32.88
Molasses grass	36.69	41.31	32.50
Hybrid Napier grass	40.12	45.38	38.94
No grass	44.09	44.69	33.68
C.D at 5% level	N.S	N.S	N.S

Figure 10

POROSITY IN PERCENTAGE AT 15 CM. DEPTH
FOR THREE SEASONS

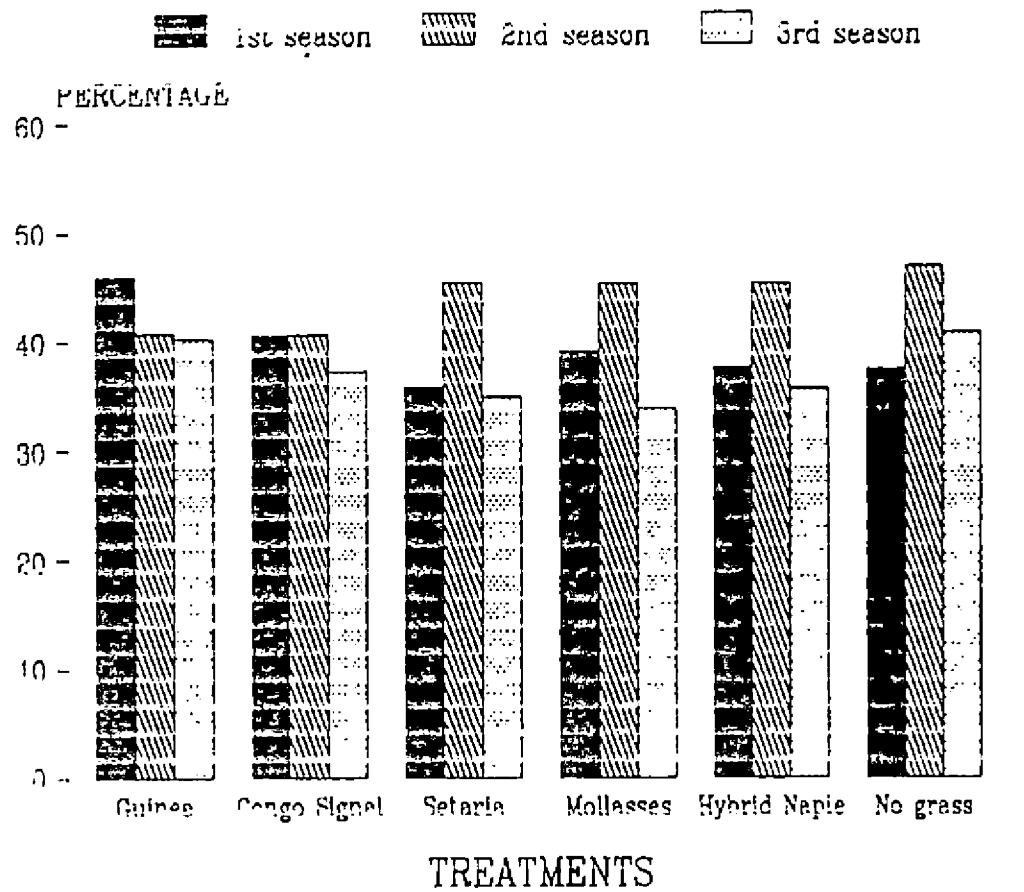
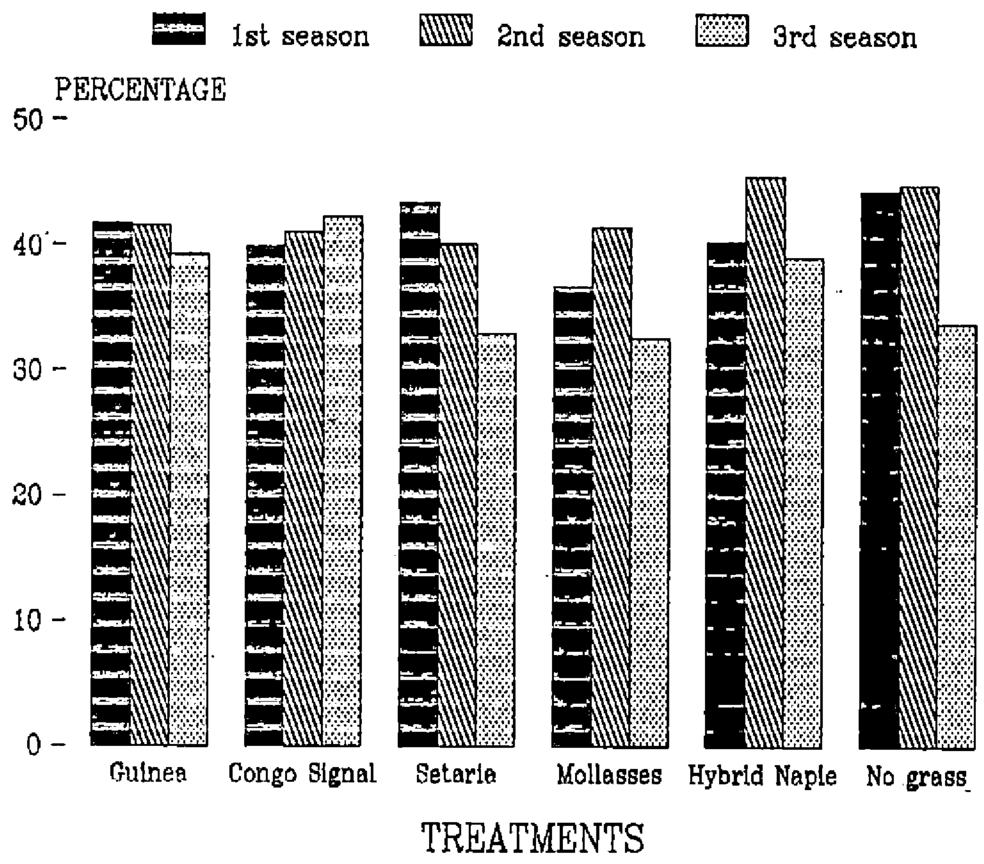


Figure 11
POROSITY IN PERNCENTAGE AT 30 CM. DEPTH
FOR THREE SEASONS



reported by Page and Willard (1946) for different cropping patterns.

4.1.6 Hydraulic conductivity and Infiltration rate

The hydraulic conductivity values recorded at 15 and 30 cm depths for the third season are given in table No. 13. The treatment effects are significant. The values obtained for 30 cm depth are comparatively lower than that observed for 15 cm depth excepting the control where a higher value was recorded at 30 cm depth. The maximum value for hydraulic conductivity is observed for Setaria grass 152.81 cm hr^{-1}. While the minimum value was obtained for Guinea grass at 30 cm depth (53.92 cm hr^{-1}).

The infiltration rate recorded during the final stage of the experiment is presented in table 13. Though the treatments effects are statistically not significant the plots with Hybrid Napier a high infiltration rate of 43.15 cm hr^{-1}

One of the factors which influence hydraulic conductivity as well as infiltration is cropping pattern. For uncultivated soil a higher value of hydraulic conductivity value was obtained by Bhatia and Sri Vastava (1982) for surface layer. The same trend is obtained for the control plot in the present study also. On the other hand the surface layer shows higher values for hydraulic conductivity where the fodder grass is cultivated. The movement of water from surface to sub surface layer will enable the coconut roots to extract more water. Various scientists like Anderson (1989) show that continuous cultivation increases the saturated hydraulic conductivity.

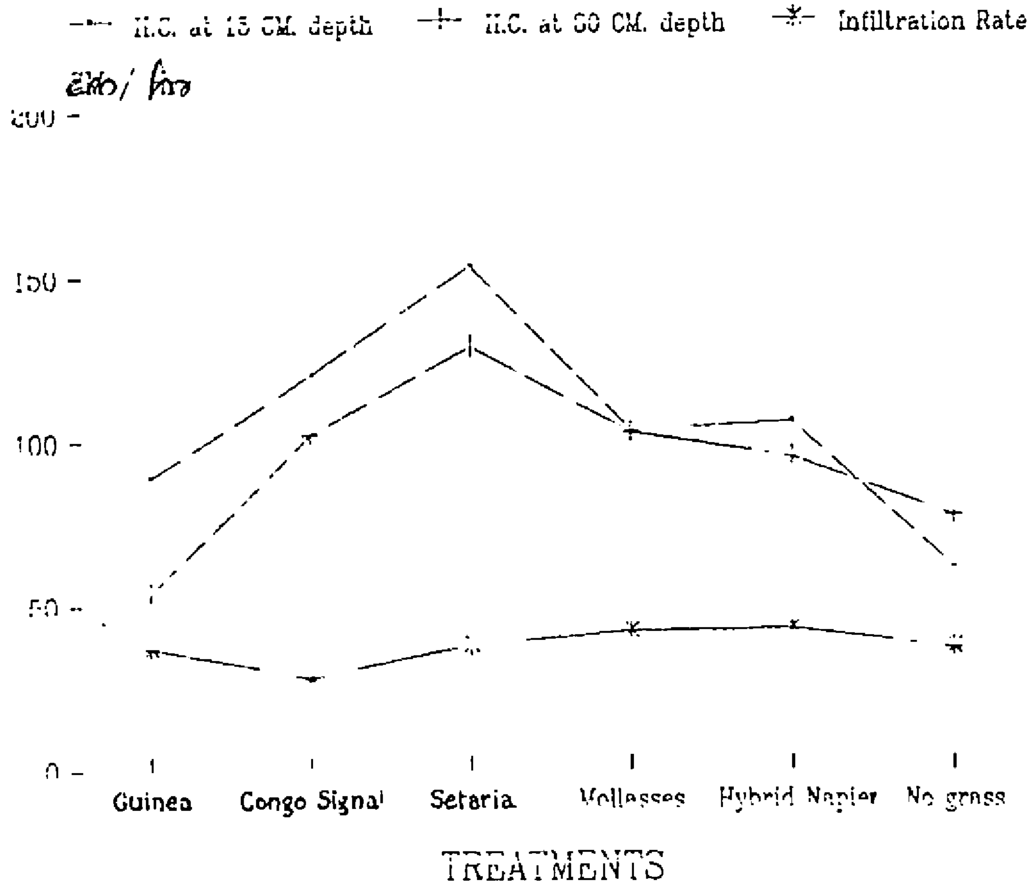
Infiltration, which is the downward entry of water in to the soil is also found to be influenced by fodder cultivation. The abundant growth of roots in Hybrid Napier grass may be one of the reasons for the high infiltration rate obtained for these plots. Higher bulk density and moisture content obtained in these plots might have influenced the infiltration characteristics. Subra maniyan and Kar (1976) observed a curvilinear relation between initial moisture content and infiltration rate. As per the report of Fahad et al (1982) low infiltration is associated with low macro porosity and decreased aggregate stability. Since the total porosity is considered in the present study a concurrent relationship between porosity and infiltration

Table No. 13 Hydraulic conductivity at 15 and 30 cm depth and Infiltration rate for 3rd Season

Treatments	Hydraulic conductivity ($Cm\ hr^{-1}$)		Infiltration rate $Cm\ hr^{-1}$
	15cm depth	30cm depth	
Guinea grass	85.05	53.92	37.20
Congo signal grass	120.05	102.07	28.30
Setaria grass	152.81	128.72	38.40
Molasses grass	103.02	102.73	42.45
Hybrid Napier grass	105.79	92.25	43.15
No grass	61.37	77.19	37.05
CD at 5% level	30.50	26.78	N.S.

Figure 16

HYDRAULIC CONDUCTIVITY AT 15 & 30 CM. DEPTH AND INFILTRATION RATE (3rd Season)



could not be drawn.

4.1.7. Soil Temperature

Table No. 14 to 17 show that the treatments have significant effect on soil temperature at 15 and 30 cm depths at 7.30 and 14.30 hours during all the three seasons.

The soil temperature recorded at 7.30 hours for the plots grown with Guinea grass show the maximum values in the first season ie. during April-May. At 7.30 hours the soil temperature at 30cm depth show higher value than at 15 cm depth.

The soil temperature values at 14.30 hours range from 32.93 ^{o}C to 46.50 ^{o}C at 15cm depth. At 30cm depth the values- range from 31.55 ^{o}C to 43.58 ^{o}C at both the depths while maximum values are obtained in the control plots. The treatment effects are prominent in the after noon hours than at morning hours. Fodder cropping reduce the soil temperature while there is an insulating effect in the morning hours.

The growth of plant is influenced by soil temperature.

The functional activity of plant roots such as absorption of water and nutrients can be affected at both low and high soil temperature. Vegetation plays a significant role in maintaining soil temperature because of the insulating property of plant growth. A good vegetative cover intercepts a considerable portion of sun's radiant energy which prevents the soil beneath from becoming as warm as bare soil during the summer. In winter the vegetation acts as an insulating blanket that reduces the rate of heat loss from the soil. A vegetative cover reduces the daily variations in soil temperature as compared with the bare soil. This is related to the extend of protective canopy rather than to other special characteristics. In the present study the fodder crop was acting as an insulating cover for the soil especially during the day time. This is in agreement with the observations of Baver (1983), who found a steady rise in soil temperature at depths of 5 and 10cm in bare soil whereas under a crop stand there was a tendency for lowering the soil temperature towards the close of the day.

4.2. The mean values of soil reaction and other chemical properties like available Nitrogen, available Phosphorus, available Potassium, exchangeable Calcium and exchangeable

Table No. 14 Soil Tempterature means at 15 cm depth for three seasons in ^{o}C at 7.30 AM

Treatments	Ist Season	IInd Season	IIIrd Season
Guinea grass	31.07	26.29	26.08
Congo signal grass	29.70	26.65	25.85
Setaria grass	28.92	28.52	26.08
Molasses grass	28.34	26.35	27.00
Hybrid Napier grass	27.92	27.15	27.19
No grass	28.92	29.00	28.45
CD at 5% level	1.74	1.54	1.80

Table No. 15 Soil Temperature means at 30cm depth for three Seasons in ^{o}C at 7.30 AM

Treatments	Ist Season	IInd Season	IIIrd Season
Guinea grass	32.06	29.25	27.13
Congo signal grass	31.21	29.25	28.31
Setaria grass	30.56	29.50	30.18
Molasses grass	31.00	29.80	31.18
Hybrid Napier grass	31.29	30.25	30.45
No grass	29.50	29.78	30.38
CD at 5% level	1.21	0.99	1.29

Table No. 16 Soil Temperature means at 15cm depth for three Seasons in ^{o}C at 2.30 PM

Treatments	Ist Season	IInd Season	IIIrd Season
Guinea grass	36.05	36.90	33.55
Congo signal grass	37.13	37.78	33.05
Setaria grass	37.15	37.70	32.93
Molasses grass	36.00	36.80	34.05
Hybrid Napier grass	33.83	35.90	34.50
No grass	44.17	46.45	41.38
CD at 5% level	2.69	1.69	1.94

Table No. 17 Soil Temperature means at 30cm depth for three Seasons in ^{o}C at 2.30 P.M.

Treatments	Ist Season	IInd Season	IIIrd Seas
Guinea grass	34.18	34.55	31.68
Congo signal grass	34.17	36.08	31.55
Setaria grass	36.59	33.60	31.90
Molasses grass	33.17	33.38	32.03
Hybrid Napier grass	37.04	32.45	32.60
No grass	39.92	43.58	40.18
CD at 5% level	2.40	2.24	2.22

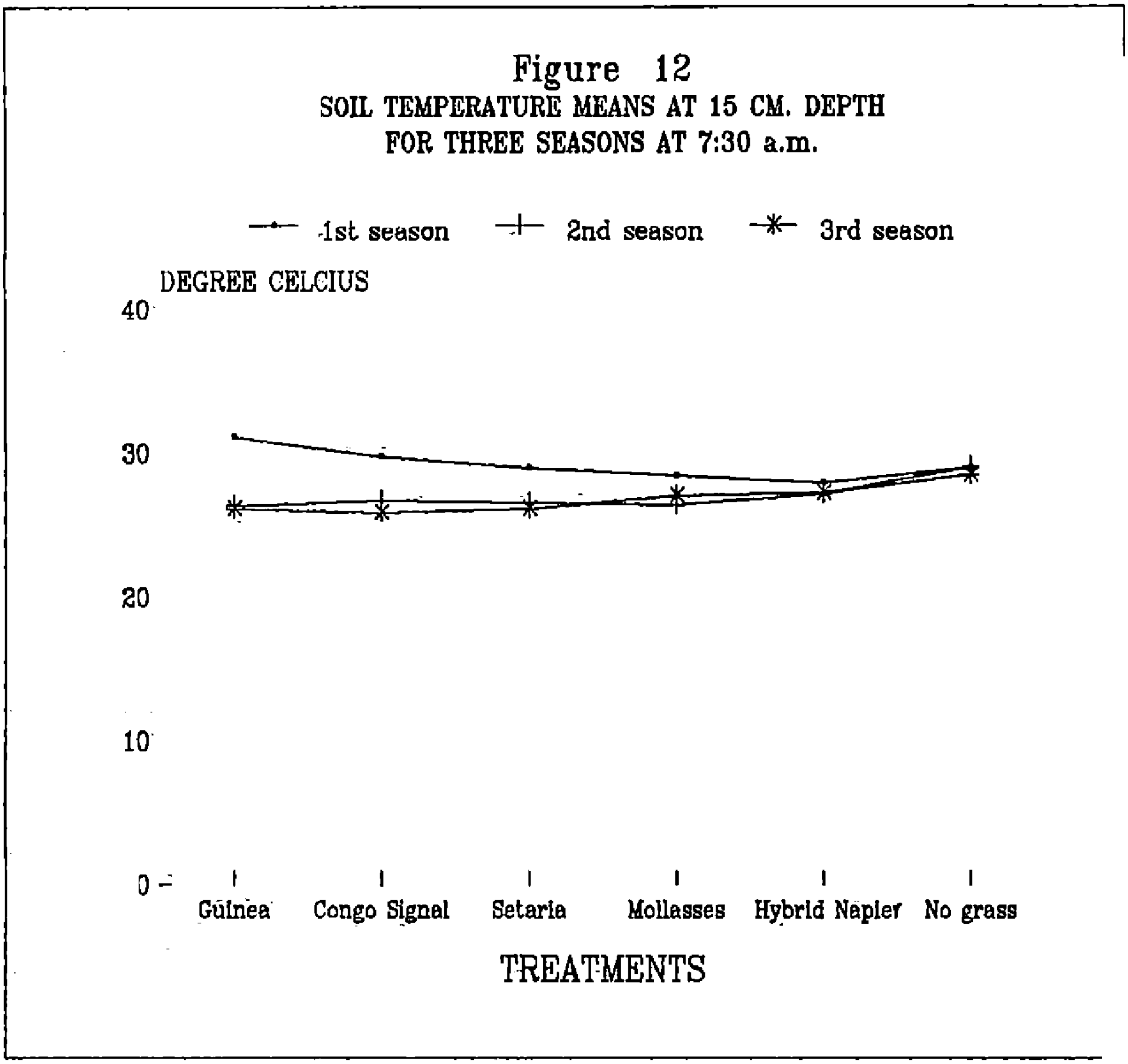


Figure 12
SOIL TEMPERATURE MEANS AT 15 CM. DEPTH
FOR THREE SEASONS AT 7:30 a.m.
1st season
2nd season
3rd season
DEGREE CELCIUS
40
30
20
10
0
Guinea
Congo Signal
Setaria
Mollasses
Hybrid Napier
No grass
TREATMENTS

Figure 13

SOIL TEMPERATURE AT 30 CM. DEPTH

FOR THREE SEASONS AT 7:30 a.m.

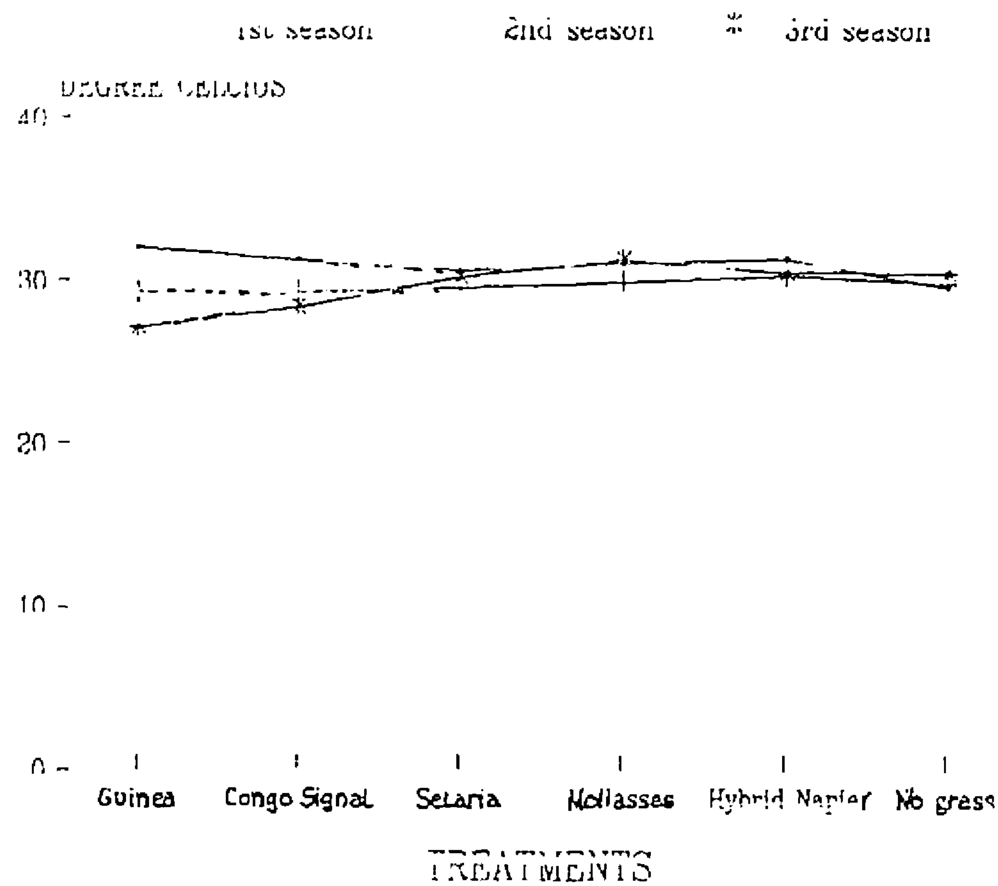


Figure 14
SOIL TEMPERATURE MEANS AT 15 CM. DEPTH
FOR THREE SEASONS AT 14:30 p.m.

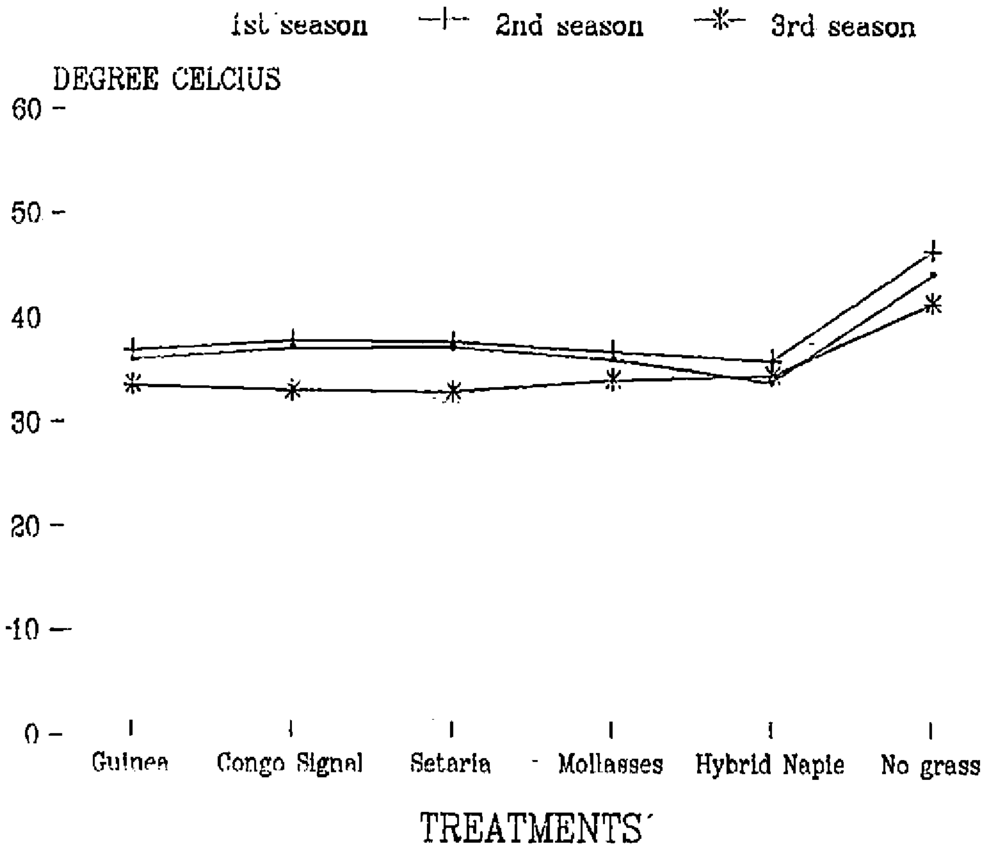
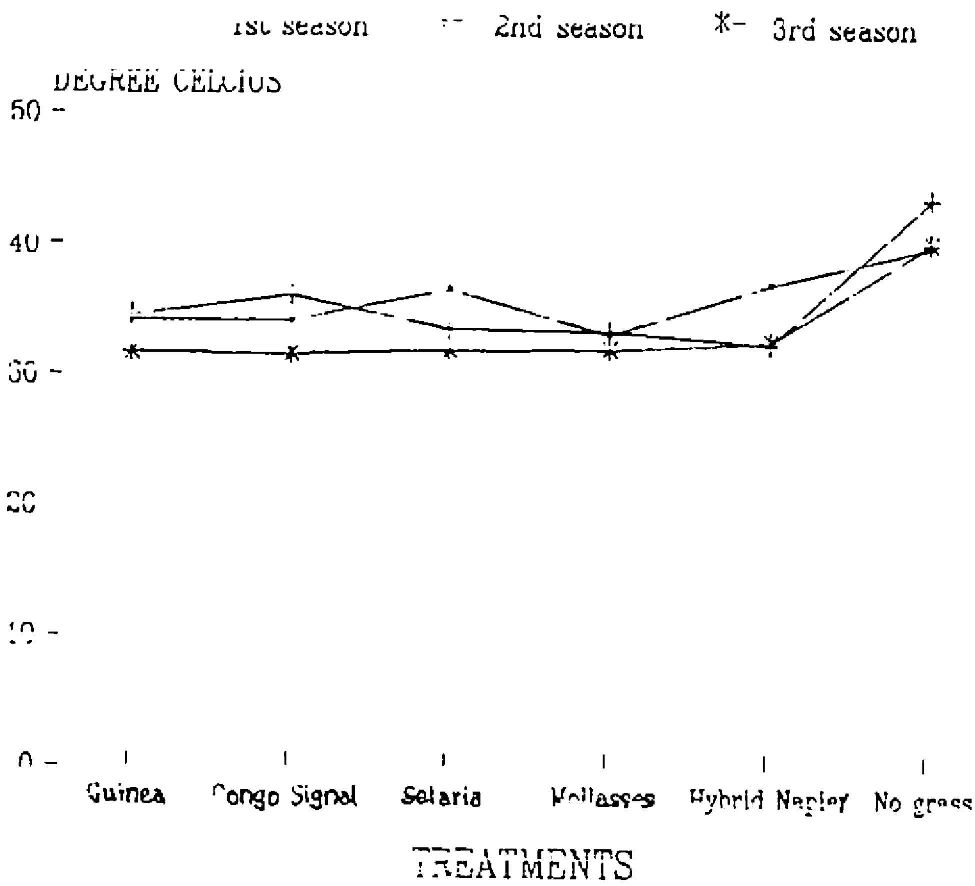


Figure 15

SOIL TEMPERATURE MEANS AT 30 CM. DEPTH
FOR THREE SEASONS AT 14:30 p.m.



Magnesium are shown in table 18 to 29.

4.2.1. Soil reaction

From the pH values in the tables No. 18 and 19 it can be seen that the soil is in the acidic range. The pH values at 15 cm range from 4.8 t(5.5 and at 30 cm depth the values range from 4.8 to 5.4. The surface and subsurface soil give almost similar values of pH for different seasons.

This clearly suggests that the factors operative in the determination of soil reaction are uniform in all these circumstances. Sahasranaman (1976) reported that there was no change in pH after five years of mixed cropping of fodder crops with coconut.

4.2.2. Available Nitrogen

The available Nitrogen content of the soil range from 260 to 600 Kg ha^{-1} as shown in the table 20. The variation between the treatments are not significant.

It is clear from Table 21 that the values of available Nitrogen obtained at 30cm depth maintain the same trend as in the case of 15 cm depth. The maximum value is 800 kg ha^{-1}

Table No 18. pH of the soil at 15cm depth for three seasons

Treatments	Ist Season	IInd Season	IIIrd Season
Guinea grass	5.43	4.98	4.85
Congo signal grass	5.45	5.25	4.83
Setaria grass	5.15	5.15	5.11
Molasses grass	5.08	5.08	4.92
Hybrid Napier grass	5.05	5.00	5.10
No grass	5.3	5.07	5.28
C.D at 5% level	N.S	N.S	N.S

Table No 19. pH of the soil at 30cm depth for three seasons

Treatments	Ist Season	IInd Season	IIIrd Season
Guinea grass	5.25	5.00	5.15
Congo signal grass	5.40	5.15	4.77
Setaria grass	5.09	5.13	5.06
Molasses grass	4.99	5.15	5.06
Hybrid Napier grass	5.08	5.08	4.86
No grass	5.33	4.95	5.02
C.D at 5% level	N.S	N.S	N.S

Figure 17
pH OF THE SOIL AT 15 CM. DEPTH
FOR THREE SEASONS

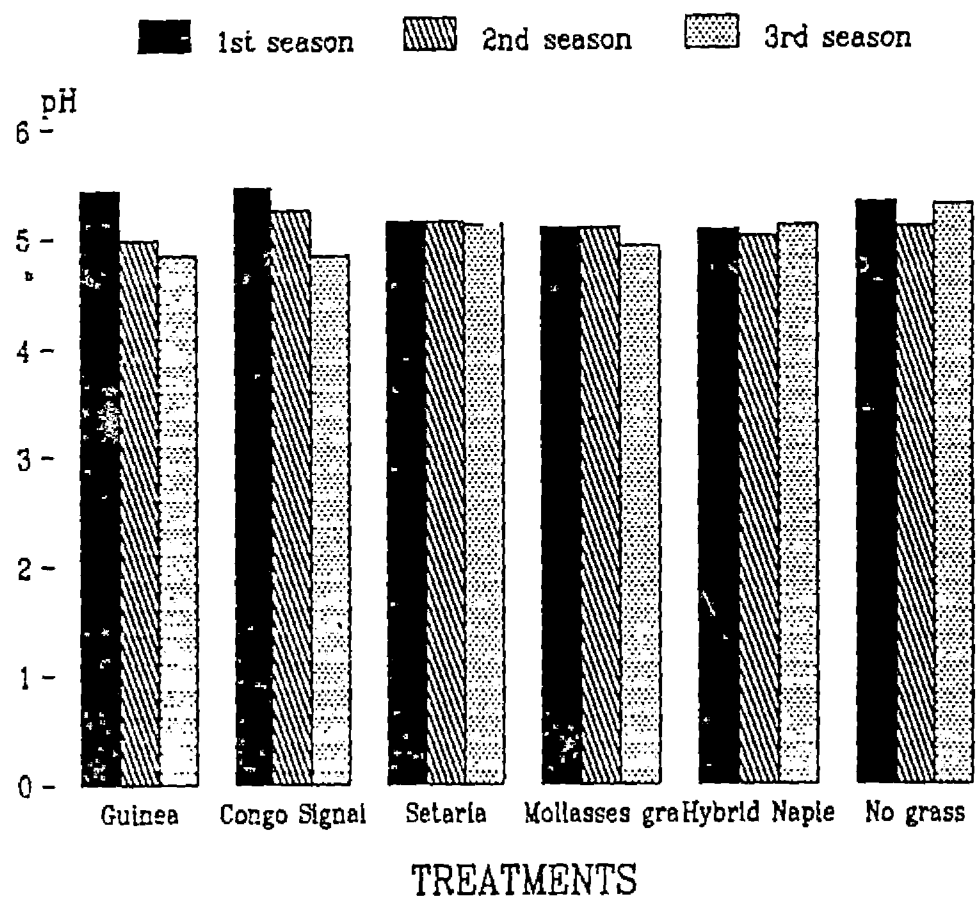
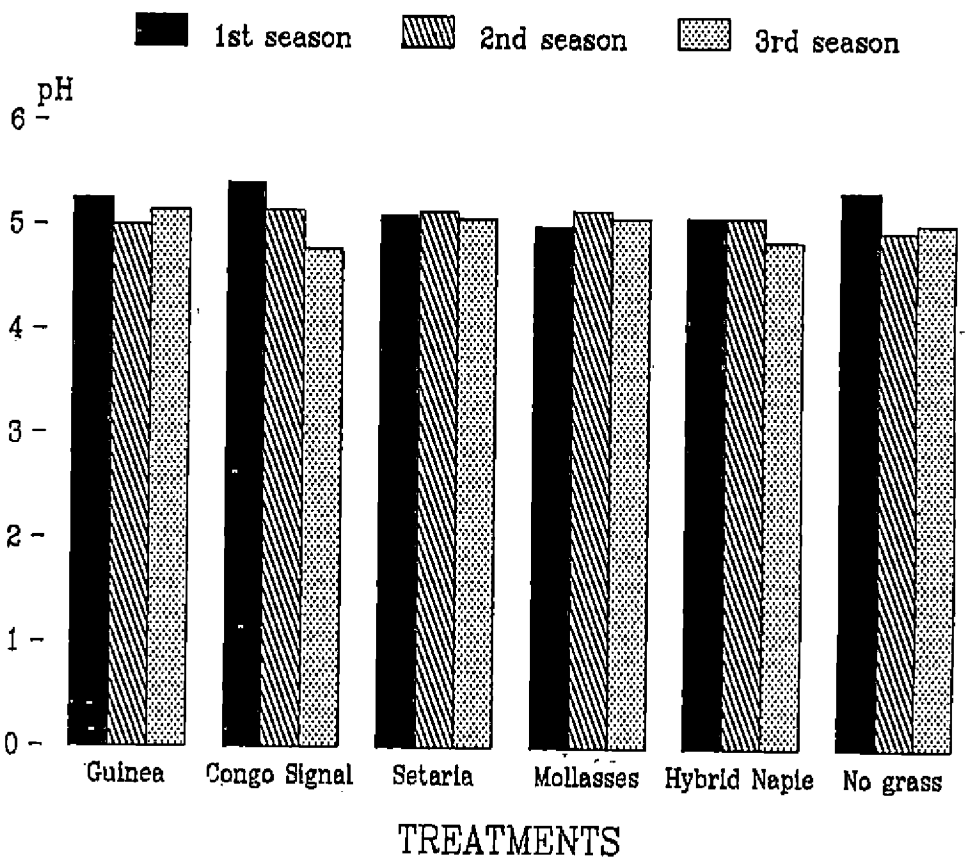


Figure 18
pH OF THE SOIL AT 30 CM. DEPTH
FOR THREE SEASONS



and the minimum value being 260 kg ha^{-1}. The treatment effects are not significant. The values of available Nitrogen indicate the fertility values are under medium class.

There is no significant variation in the available Nitrogen content. The result is in accordance with the observations made by Sahasranaman. et al (1967). It is observed that Nitrogen content is more in plots with Guinea grass in the third season at 30 cm depth . Such an increase in the available Nitrogen content in Guinea grass over Setaria grass was reported by Pillai (1986). This may be probably due to the higher nitrogen fixing capacity.

4.2.3. Available Phosphorus

Available phosphorus in kg ha^{-1} for all the treatments are given in tables No. 21 and 23 at 15 and 30cm depth respectively. For all the three seasons the treatment effects are not significant. At 15cm depth the values range from 35.39 kg ha^{-1} to 109.48 kg ha^{-1} At 30cm depth the range is from 25.24 to 119.28 kg ha^{-1}. There is no significant difference between surface and subsurface values. Excepting

Table. 20 Available Nitrogen at 15 cm depth of Soil for thr

seasons in (kg ha^{-1})

Treatments	Ist Season	IInd Season	IIIrd Seas
Guinea grass	360	460	460
Congo signal grass	260	460	480
Setaria grass	480	300	520
Molasses grass	360	380	320
Hybrid Napier grass	280	340	6000
No grass	280	380	360
CD at 5% level	N.S	N.S	N.S

Table. 21 Available Nitrogen at 30 cm depth of Soil for three seasons in (kg ha^{-1})

Treatments	Ist Season	IInd Season	IIIrd Season
Guinea grass	280	460	580
Congo signal grass	260	420	520
Setaria grass	380	460	480
Molasses grass	280	400	440
Hybrid Napier grass	320	420	540
No grass	260	380	800
CD at 5% level	N.S	N.S	N.S

Figure 19
AVAILABLE NITROGEN AT 15 CM. DEPTH OF SOIL FOR THREE SEASONS

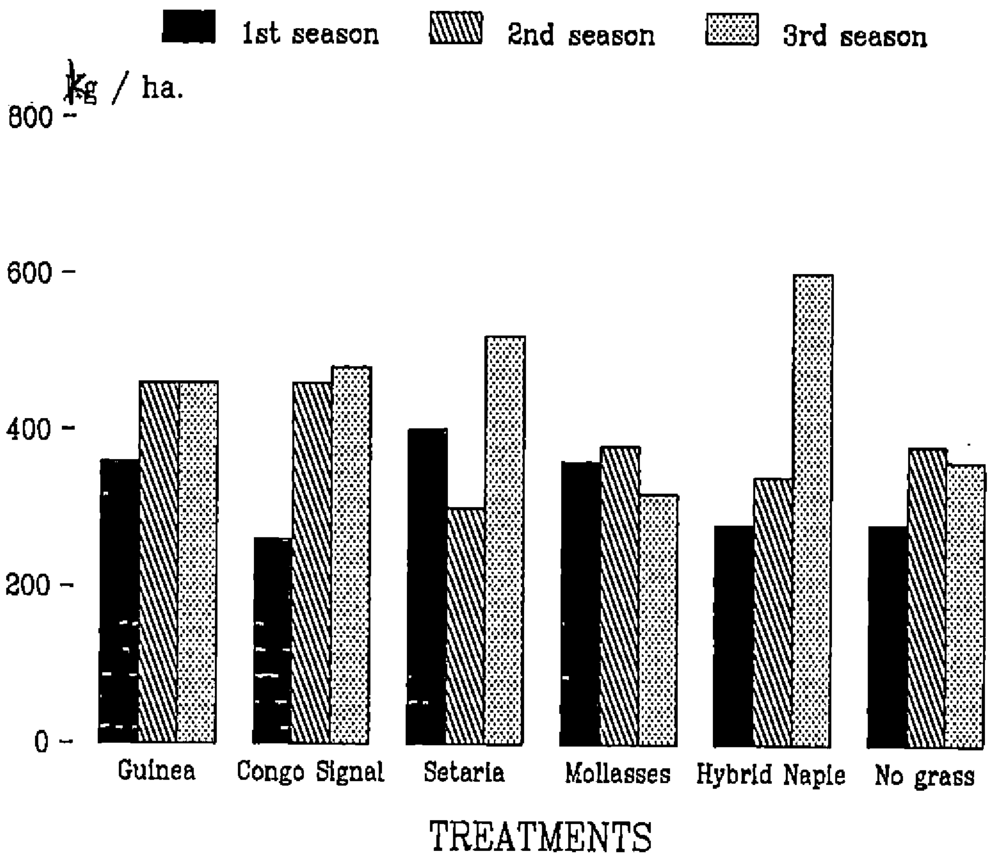
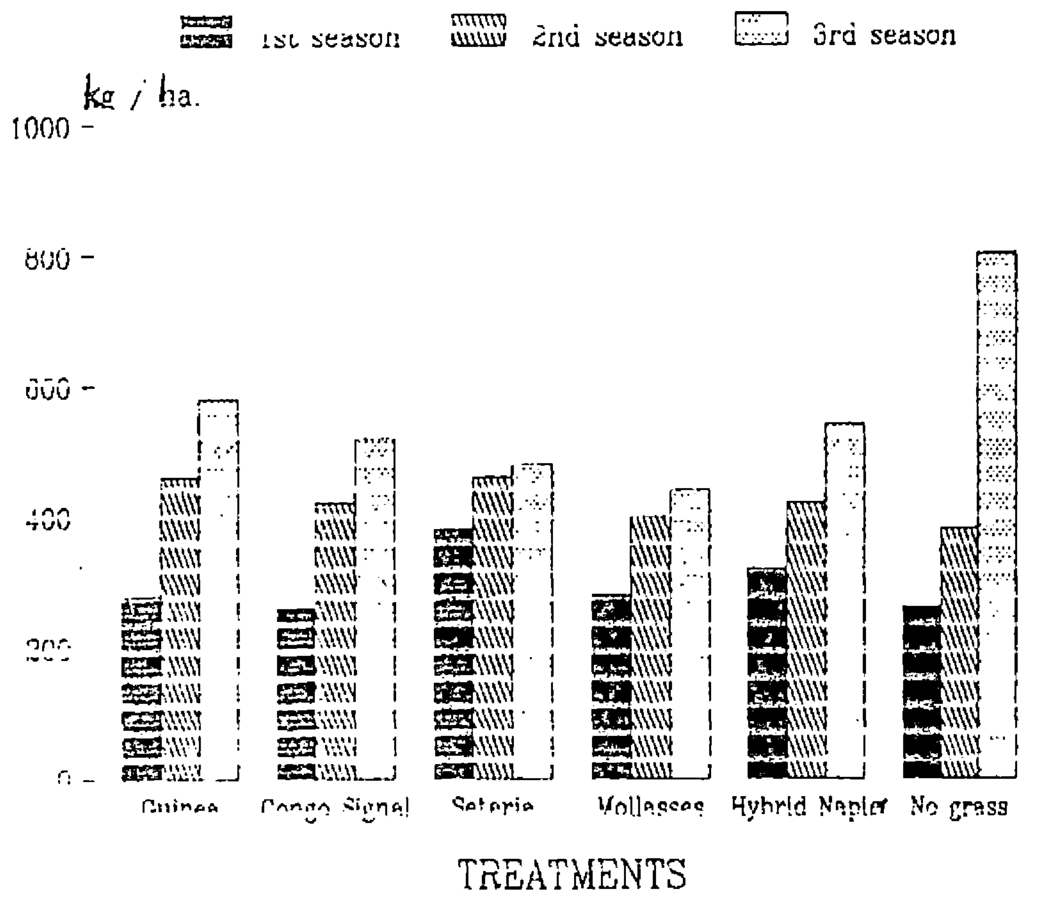


Figure 20
AVAILABLE NITROGEN AT 30 CM. DEPTH
FOR THREE SEASONS



the control plots the soil samples from Setaria grass plots showed a higher status of available Phosphorus.

Soil Phosphorus level from plots under Setaria grass is high. It may be due to the less utilization of Phosphorus by Setaria grass. Sahasranaman et al (1976) reported an increase in the Phosphorus content due to continuous cultivation of fodder crops.

4.3.4. Available Potassium

As seen from table 24 the available Potassium content at 15cm depth range from 28.3 to 90.3 Kg ha^{-1}. Though the values are statistically not significant the plots under Guinea grass show relatively higher values for available Potassium, Which may due to the profuse proliferation of the roots in this fodder grass.

At 30cm depth the maximum value of available Potassium is 105.1 and the minimum being 52.3 kg ha^{-1}. At this depth also relatively higher values of available Potassium are observed under Guinea grass plots.

Among the five fodder grasses tried Guinea grass plot show higher quantities of available Potassium in the soil at both depths. Sahasranaman et al (1976) found an increase in

Table No 22. Available Phosphurus in kg ha^{-1} at 15cm depth fo three seasons.

Treatments	Ist Season	IInd Season	IIIrd Season
Guinea grass	40.63	85.80	82.69
Congo signal grass	49.68	95.95	85.76
Setaria grass	66.870	107.72	99.85
Molasses grass	35.39	58.58	75.46
Hybrid Napier grass	37.75	64.12	79.43
No grass	66.89	94.09	109.48
C.D at 5% level	N.S	N.S	N.S

Table No 23 Available Phosphurus in kg ha^{-1} at 30cm depth f three seasons

Treatments	Ist Season	IInd Season	IIIrd Season
Guinea grass	25.34	90.69	84.20
Congo signal grass	33.55	80.58	93.62
Setaria grass	47.09	119.28	70.88
Molasses grass	30.98	62.97	78.11
Hybrid Napier grass	35.99	85.33	71.13
No grass	42.68	88.47	91.80
C.D at 5% level	N.S	N.S	N.S

Figure ~~20~~ 21

AVAILABLE PHOSPHORUS AT 15 CM. DEPTH
FOR THREE SEASONS

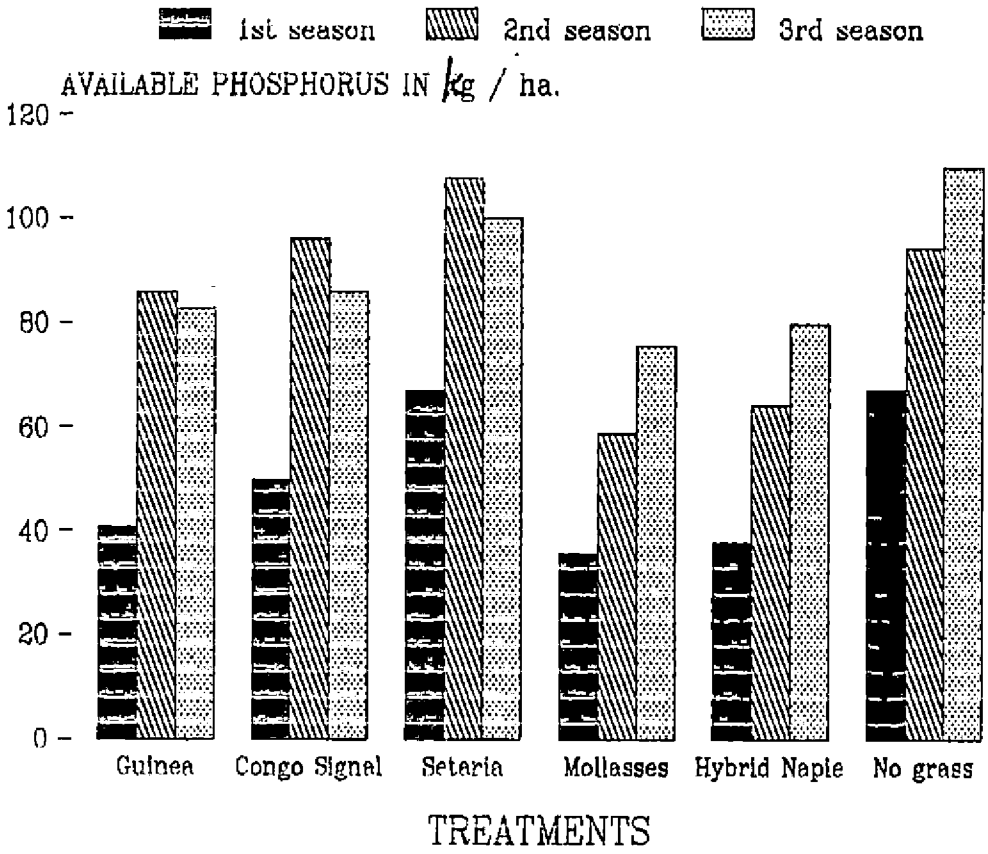


Figure 21
AVAILABLE PHOSPHORUS AT 30 CM. DEPTH
FOR THREE SEASONS

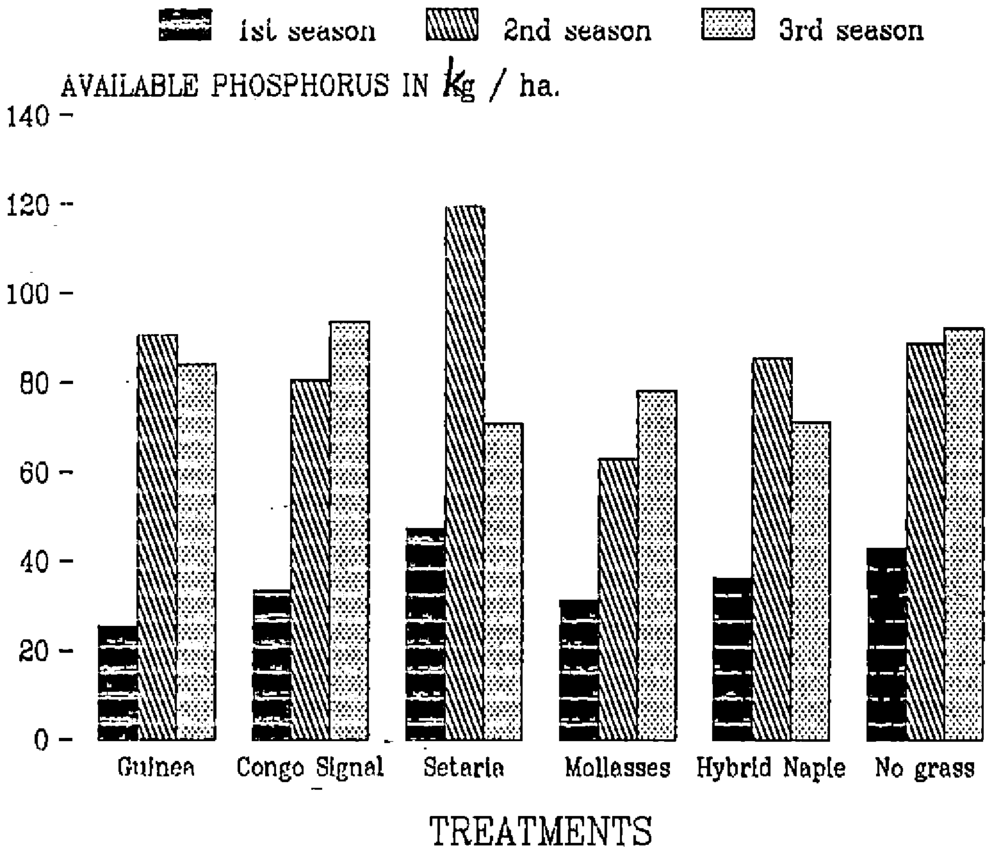


Table. 24 Available Potassium content at 15cm depth expressed i

kg ha^{-1}

Treatments	Ist Season	IInd Season	IIIrd Seaso
Guinea grass	37.2	90.3	56.8
Congo signal grass	28.3	52.05	56.6
Setaria grass	38.4	66.5	58.2
Molasses grass	42.5	62.3	52.6
Hybrid Napier grass	43.2	72.7	57.5
No grass	37.01	54.6	42.6
CD at 5% level	N.S	N.S	N.S

Table. 25 Available Potassium content at 30cm depth expressed Kg ha^{-1}

Treatments	Ist Season	IInd Season	IIIrd Seas
Guinea grass	90.4	66	50.62
Congo signal grass	58.7	68.6	52.95
Setaria grass	67.1	68.9	52.92
Molasses grass	78.4	60.2	59.4
Hybrid Napier grass	62.3	76.7	59.09
No grass	70.0	105.1	52.3
CD at 5% level	N.S	N.S	N.S

Figure 23

AVAILABLE POTASSIUM AT 15 CM. DEPTH
FOR THREE SEASONS

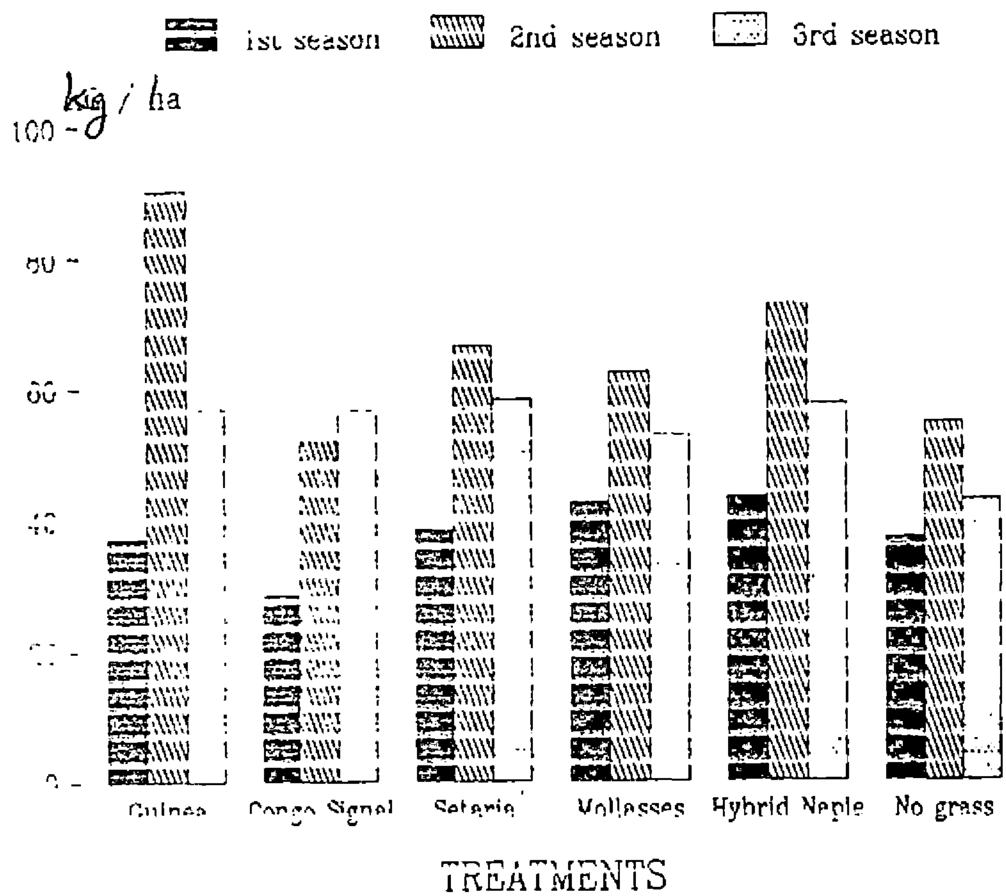
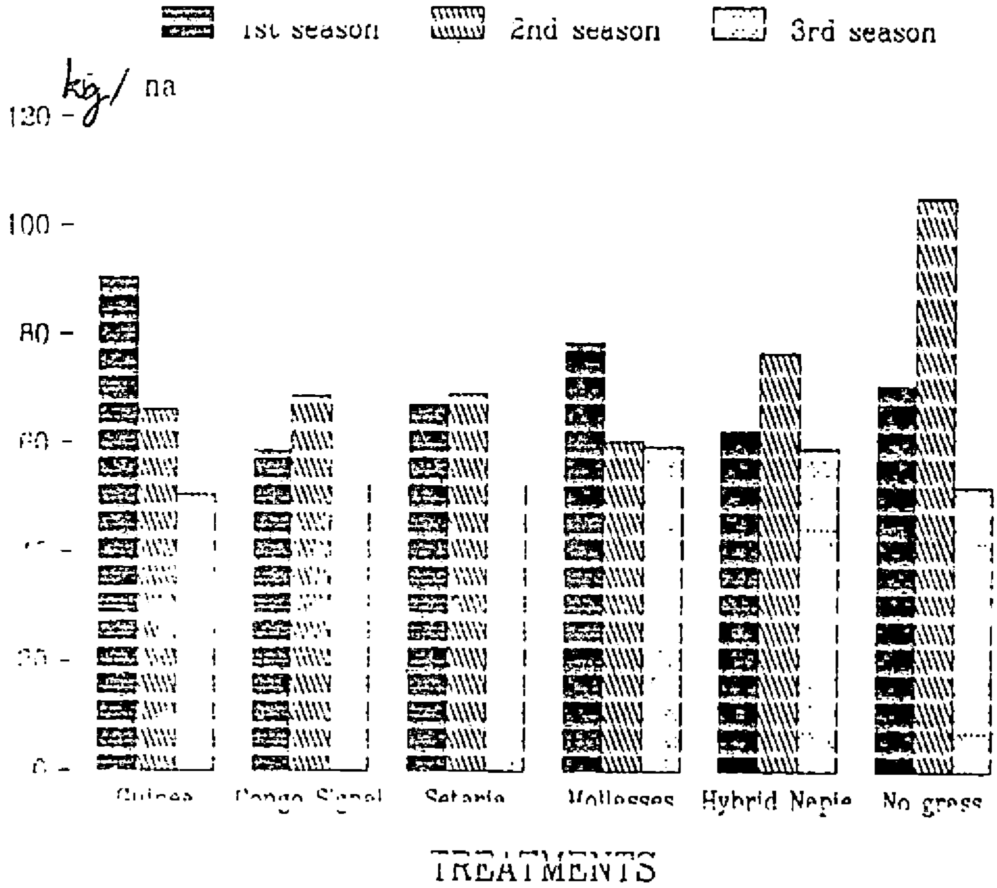


Figure 24
AVAILABLE POTASSIUM AT 30 CM. DEPTH
FOR THREE SEASONS



available Potassium content at 50 cm and 100cm depths of soil where Guinea grass was grown in coconut garden. 4.3.5.

Exchangeable Calcium

Exchangeable Calcium at 15cm and 30cm depths for the three seasons are given in table No. 26 and 27. On analysis it is found that the treatment effects are not significant. The variation in values at both depths is only of 0.5 cmols kg^{-1} for all season. At 30 cm depth the control plots show the lowest values. Though there is no statistical significance the plots grown with fodder crops show higher values of exchangeable Calcium content at 15 and 30 cm depths. These results agree with the finding of Sahasranaman et al (1976). Wherein higher value of exchangeable Calcium content is noticed grass in inter-cropped soils.

4.3.6. Exchangeable Magnesium

Table 28 and 29 depict the exchangeable Magnesium at 15 cm and 30 cm depths respectively. Almost uniform values are obtained at surface and sub surface layers. There is no statistical difference between the treatments as far as the exchangeableMagnesium is concerned. The values lie between

Table. No. 26 Exchangeable Calcium at 15 cm depth of Soil for three seasons in cmol (+)/kg of Soil

Treatments	Ist Season	IInd Season	IIIrd Season
Guinea grass	3.0	2.5	2.5
Congo signal grass	3.0	3.0	3.0
Setaria grass	2.5	2.5	3.0
Molasses grass	2.5	3.0	2.0
Hybrid Napier grass	3.0	3.0	3.0
No grass	2.5	2.5	3.0
CD at 5% level	N.S	N.S	N.S

Table. No. 27 Exchangeable Calcium at 30 cm depth of Soil fo
three seasons in cmols (+) kg^{-1} of Soil

Treatments	Ist Season	IInd Season	IIIrd Seaso
Guinea grass	3.0	2.5	3.5
Congo signal grass	2.5	2.5	2.5
Setaria grass	2.5	2.0	2.0
Molasses grass	2.5	2.5	2.5
Hybrid Napier grass	2.5	2.5	2.5
No grass	2.0	2.0	2.2
CD at 5% level	N.S	N.S	N.S

Figure 25
EXCHANGABLE CALCIUM AT 15 CM. DEPTH
FOR THREE SEASONS

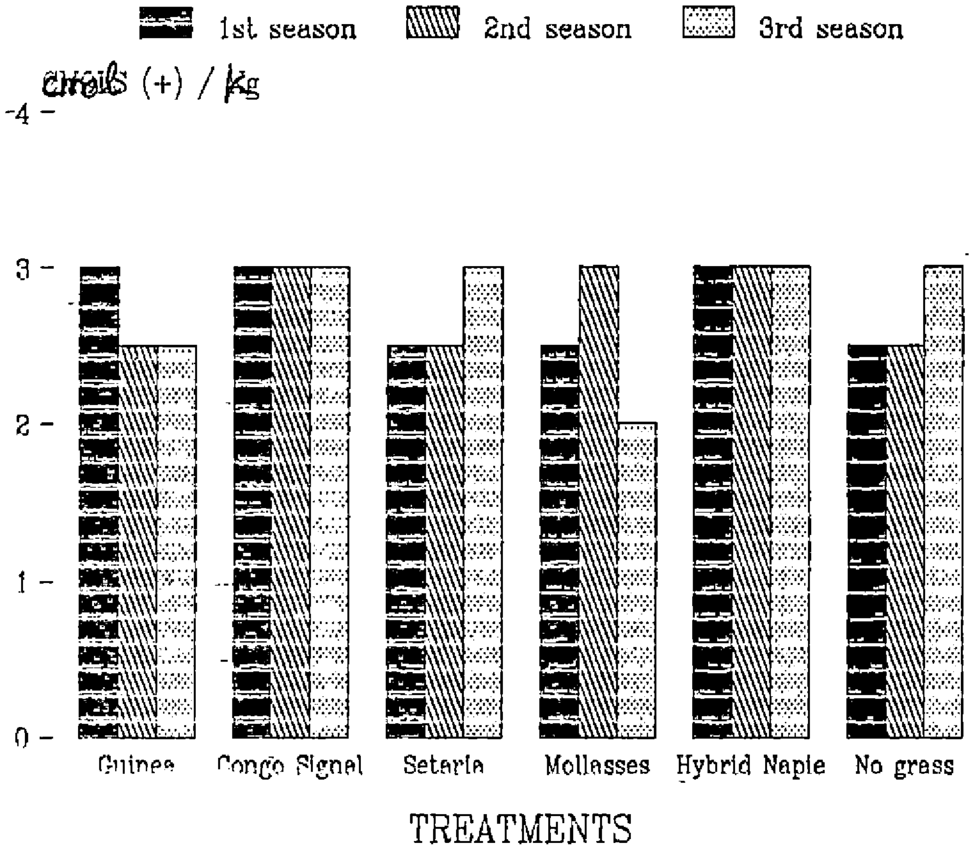
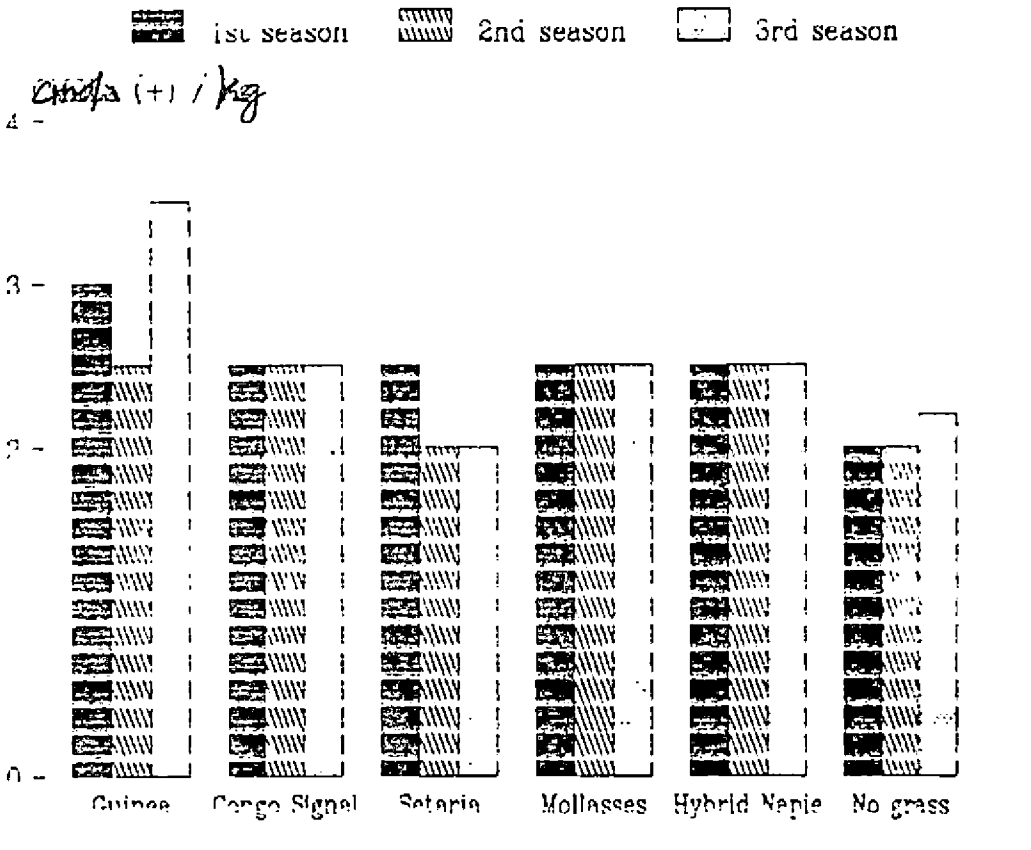


Figure 26

EXCHANGABLE CALCIUM AT 30 CM. DEPTH
FOR THREE SEASONS



0.3 and 0.6 $cmol(+) kg^{-1}$ of soil.

Sahasranaman *et al* (1979) found an increase in the Magnesium content of the soil due to intercropping of fodder crops in coconut garden soil. But in the present study no significant difference is observed due to intercropping of fodder crops in coconut garden.

The correlation of the soil temperature with the main physical and chemical properties of the soil are given in table No. 30. It can be seen that the soil moisture is negatively correlated with soil temperature with a maximum negative correlation of 63 per cent for the second season. Soil temperature is positively correlated with bulk density infiltration rate and available Phosphorus. All the other parameters are negatively correlated with soil temperature.

Higher soil temperature might have increased the infiltration rate, being a surface property of the soil. The surface soil has higher temperature, which influenced the entry of water into the soil.

The observation on yield data of coconut in the experimental field shows that there is a 20.5 per cent

Table. No. 28 Exchangeable Magnesium at 15 cm depth in cmol Kg^{-1}

Treatments	Ist Season	IInd Season	IIIrd Season
Guinea grass	0.5	0.4	0.5
Congo signal grass	0.3	0.3	0.3
Setaria grass	0.6	0.5	0.6
Molasses grass	0.3	0.6	0.3
Hybrid Napier grass	0.3	0.4	0.3
Control	0.3	0.3	0.3
CD at 5% level	N.S	N.S	N.S

Table. No. 29 Exchangeable Magnesium at 30cm depth in Cmols Kg^{-1}

Treatments	Ist Season	IInd Season	IIIrd Seaso
Guinea grass	0.4	0.3	0.4
Congo signal grass	0.4	0.3	0.4
Setaria grass	0.3	0.3	0.3
Molasses grass	0.3	0.5	0.3
Hybrid Napier grass	0.3	0.4	0.3
Control plot	0.5	0.3	0.5
CD at 5% level	N.S	N.S	N.S

Figure 27
EXCHANGABLE MAGNESIUM AT 15 CM. DEPTH
FOR THREE SEASONS

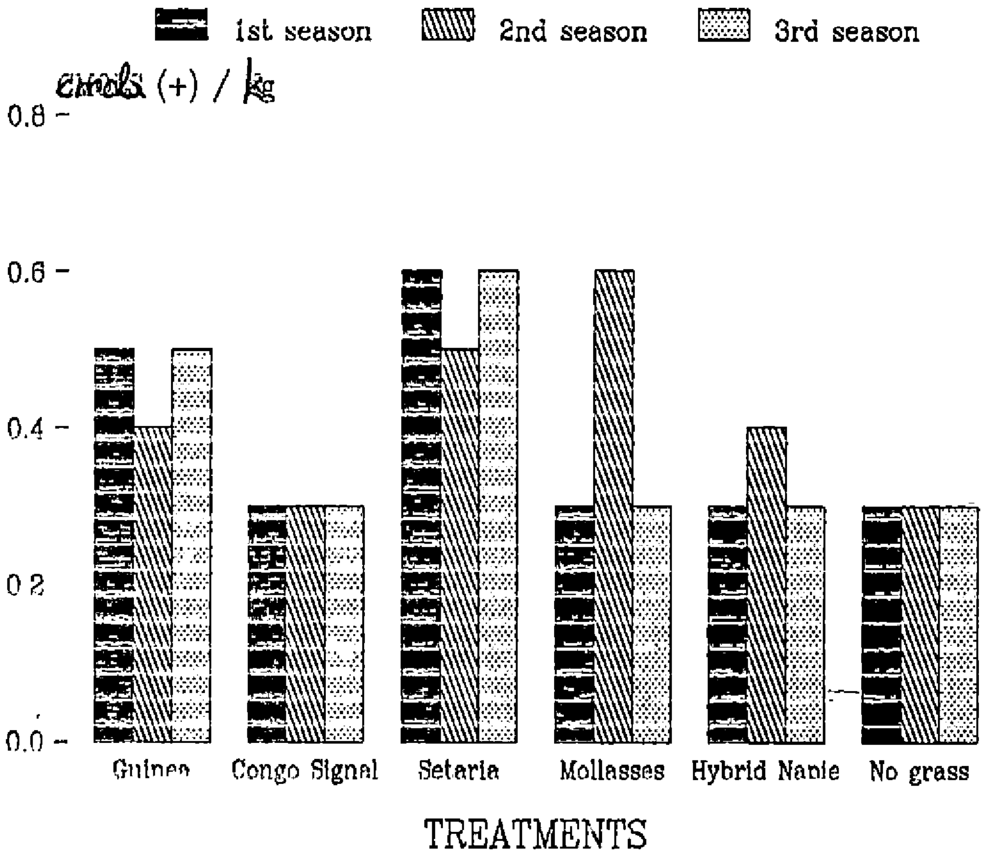
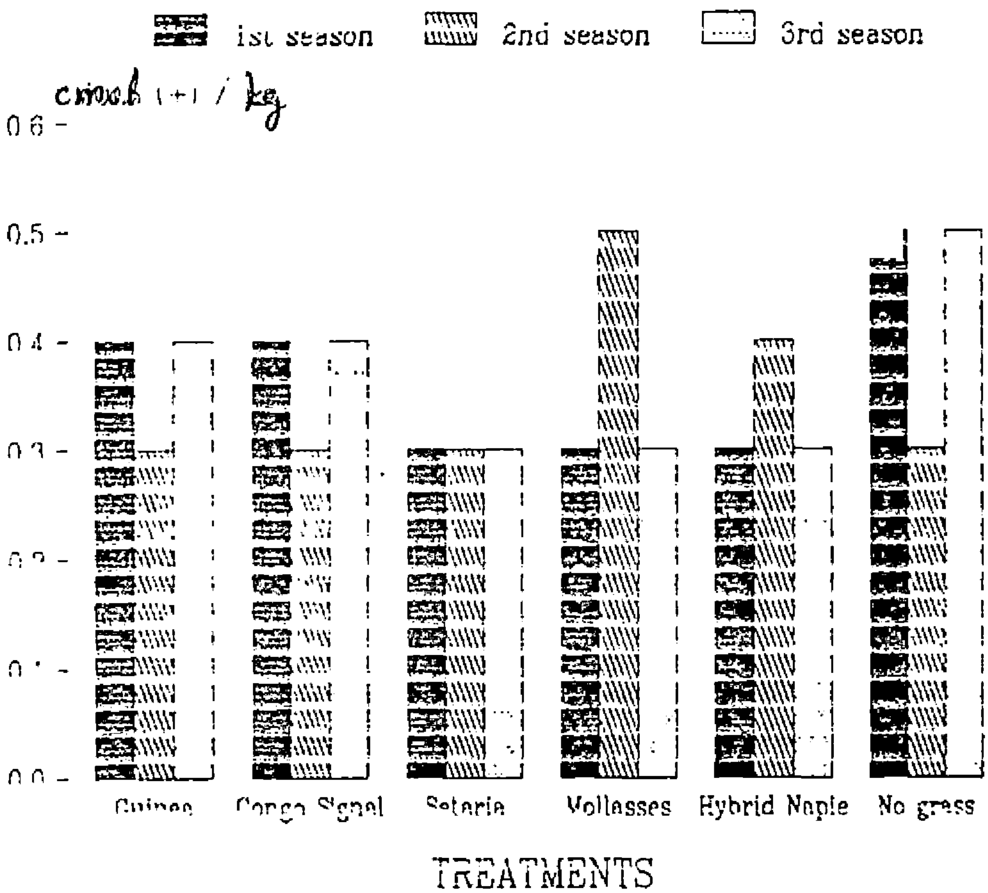


Figure 28
EXCHANGABLE MAGNESIUM AT 30 CM. DEPTH
FOR THREE SEASONS



increased in the average yield of coconuts per tree in the fodder intercropped area (Pillai 1986). Similarly as shown in Table 30 the yield of coconut has increased from 1989 to 1992 in fodder cultivated plots.

Table 30.

Yield of Nuts in the fodder intercropped Coconut Garden

No. of palm	Yield of nuts per annum			
	1989	1990	1991	1992
F 62	85	87	83	85
F 63	96	91	89	97
F 65	90	77	88	71
Yield of Nuts in the Coconut Garden without fodder grass.				
F 584	62	68	61	58
F 195	71	78	75	60

Table 31. Correlation values between soil temperature and important physico chemical parameters at 15 cm depth

	Ist Season	IInd Season	IIIrd Season
1. Moisture	- .1994*	- .6319*	- .4044*
2. Bulk density	+ .2685	+ .2317	+ .0557
3. Particle density	- .0254	- .1144	- .0231**
4. Porosity	- .0659	- .1329	- .2141
5. Water holding capacity	- .3494	- .0565**	- .0231
6. Available Nitrogen	- .1815	- .0016	- .1264
7. Available Phosphorus	+ .1058	+ .1569	+ .5643
8. Available Potassium	- .2580	- .1534**	- .2312**
9. Soil reaction	- . 0359	- .1311	- .3[illegible]21
10. Infiltration rate	--	--	+ .2252
11. Hydraulic conductivity	--	--	- .5996**

* Significant at 5% level

** Significant at 1% level

SUMMARY AND CONCLUSION

Present investigation is under taken to study the influence of fodder crops on various physico-chemical properties of coconut inter-cultivated plots. The experiment is laid out in randomised block design in the farm area of college of Agriculture Vellayani. Preliminary analysis of soil samples are conducted for major nutrients and important physical properties. The treatments include five varieties of grasses and control. The grasses are Guinea grass, Congo signal grass, Setaria grass, Molasses grass and Hybrid Napier grass. Samples are collected from two depths ie. from 15cm and 30 cm depth from the surface. The samples are collected during March-April, July-August and December-January. Soils collected from all the treatments from two depths in three seasons are analysed for various physical properties such as moisture content, bulk density, particle density water holding capacity and porosity. The available Nitrogen available Phosphorus, available Potassium, exchangeable Calcium, exchangeable Magnesium and soil reaction are determined for all the samples for the three seasons. Effect of soil temperature due to fodder cropping is measured for three seasons at 7.30 and 14.30 hours. At the close of the experiment during December-January the hydraulic characteristics such as infiltration rate and hydraulic conductivity are measured. The analysis of variance for all these observations are done. Important parameters are correlated and interpreted. From the results obtained the following conclusions are drawn.

1. Soil moisture is not much affected by growing fodder crops. Thick canopy of Guinea and Congo signal grass could retain more soil moisture in the field. The competition for water from soil will be minimum for fodder crops and coconut. surface evaporation is prevented by the fodder canopy. It is negatively correlated with soil temperature.

2. Bulk density values are reduced by growing fodder crops. The control plots recorded a higher values of bulk density. It is positively correlated with soil temperature. Soil temperature recorded for control plots are more.

3. The fodder crops do not change the particle density. This is negatively correlated with soil temperature.

4. For Setaria and Molasses grass since the rooting pattern is on the surface they conserved moisture on the surface of the soil. While the other grasses conserve moisture on the subsurface layer. Water holding capacity in the control plots is much less than fodder plots.

5. Fodder grass roots improve the structure of the soil. Changes on the porosity values by fodder grass is negligible, The values are negatively correlated with soil temperature.

6. The hydraulic conductivity value observed for Setaria grass was as high as 152.81 cm hr^{-1}. The treatment effects are significant. Minimum value is obtained for Guinea grass at subsurface (53.92 cm hr^{-1}). It is negatively correlated with soil temperature.

7. The infiltration rate recorded are insignificant for different treatments. The infiltration rate is positively correlated with soil temperature.

8. Soil temperature is affected by intercropping of fodder crops in coconut garden during the day time fodder

crops reduce the soil temperature while there is an insulating effect in the morning hours. Fodder grass grown in the coconut garden has definite influence on soil temperature. The nutrient availability, nutrients are correlated with soil temperature. So the soil temperature indirectly affect the nutrient movement, and water availability.

9. Eventhough there is no significance in the available Nitrogen content, the Guinea grass plot left the maximum quantity of Nitrogen. This is negatively correlated with soil temperature. There is no difference in the soil reaction, available potassium, Exchangeable Calcium, exchangeable Magnesium content due to the intercropping of fodder crops in coconut garden. Soil Potassium and soil reaction are negatively correlated with soil temperature.

11. Soil Phosphorus level shown by Setaria grass is high. It may be due to the less utilization of Phosphorus by Setaria grass. It is positively correlated with soil temperature.

REFERENCES

Acharya, C.L. and Gupta, R.P. (1945). "Thermal diffusivity valaues based upon time dependant soil temperature distribution" J. Indian Soc. Soil Sci, 23(1) : 1-7.

Alway, F.,(1916). "The loess soil of Nebrarka proportion of the transition region" I, II Soil Sci., 1:197-258.

Anderson, S.H. and Gantzer C.J.(1989). Soil physical properties after 100 years of continuous soil and crop management Special Report College of Agriculture University of Mission (1989) SR. 415 71-82.

Annual report (1985). All India Co-ordinated Research Project on forage crops.

Balguru, T. 1970 Studies on the forms, distribution status and relationships of various soil properties in respect of manganese, com and Molybdeum in typical soil profiles of TamilNadu M.Sc (Ag) Dirrertation. Submitted to the university of Madras.

Baver, A.F. (1983). "A short experiement demonstrating the thermal difference between soil under crop stands and uncropped soil during daily temperature rises in summer". Soils and Fertilizers 46 (8) 806.

Bhagat, R.M. and Acharya, C.L. (1988). "Soil water dynamics during wheat growth under different management practices". J. Indian Soc. Soil Science 36 (3) 389 - 396.

Bhatia and Srivastava (1982). "Hydraulic conductivity and related soi properties under different land use." Annals of Arid Zone 21(3) : 195 - 198.

Bridley, S.F. (1965). Agric Metotol. 1965, 2, 373.

Casmann, K.G. and Munns, D.N. (1980). "Nitrogen mineralization as influenced by soil moisture, temperature and depth". Soil Sci. Soc. Am. J. 44 : 1233-1238

Chaudhari, T.N. and Bhatnagar, V.K. (1980). Agric. water Mgmt. 3, 115.

Chibba, I.M. and sekhon, G.S. (1973). "Physico-chemical characteristics and nutrient availabily of some acid soils of Kangra district." Paper presented in the Symposium on "Acid Sulphate and other acid soils of India" held at Trivandrum during February, 1973.

Choudharhy, M.S. and vehmi, M.V. (1985). Long term effect of ammonium sulphate on the productivity status of the rice soil" Indian J. Agron 10 (2) : 145-152

Clark, R.V. and Mack A.R. (1974). "Effect of growing barley continuously on yield, chemical constitments and disease prevelence" Candian J. Plant Sci 54(2) : 307-314.

Decka and Singh (1984). "Studies on rice based multiple cropping sequence, effect of crop on potassium on fertility status of soil" Indian J. Agron 29(4) : 441-447.

Dickman, S.R. and Bray, R.H. (1940). Colorimetric determination of phosphate. Indus and Engin Chem. Annual Ed., 12 : 665-668.

Fahad A.A., Mielke, L.N., Flowerday, A.D. and Swartzendruber, D. (1982). "Soil physical properties as affected by soyabean and other cropping sequence." <u>Soil Sci. Soc. AM. J. 46</u> : 377-389.

Figwan (1963). "Soil fraction of Vindyan soils of Mirzapur district" in <u>Soils and Fertilizer</u> 10 : 423.

Ganeshamoorthy and Biswas (1985). "Non exchangeable sources in soil to crops" <u>J.Indian Soc. Soil Sci 83</u> : 60-66.

Ghildyal B.P. and Tripathi R.P. (1971). "Effect of varying bulk densities on thermal characteristics of laterite sandy clay loam soils" <u>Soil Sci. Soc. Am. J.</u>44 : 17-20.

Ghosh, A.B. and Kanzaria, M.V. (1964). "Soil fertility investigations under continous manuring and cropping in Pusa Permanent manurial experiments" <u>Bull. Natl. Inst. SCi India 26</u> : 245-259.

Gupta, R.P. and Dhakshinamoorthi, C. (1980). "Procedures for physical analysis of and collection of agrometerological data". I.A.R.I, New Delhi.

Heiberg, S.O. and Leaf (1960). "The application of potassic fertilization on coniferous plantations" in New York Proc. 7th Intern. congr, Soil Sci. 3; 376.

Hira, G.S. and Sigh, N.T. (1979). "Effect of some soil physical properties on Phosphorous diffusion from the applied fertilizer" Bull. Indian Soc. Soil Sci. 12 : 121-

Jackson, M.L. (1974) Soil Chemical analysis, printice Hall, Inc. New Jerssey. Juo, A.S.R. and Lal R, (1975). "Effect of Continuous cropping and residence management on chemical and physical properties of alfisol in southern Nigeria." Agron. Abst. 2 & 38.

Kamper, W.D. and Rosenw, R.C. (1984). "Soil cohesion as affected by time and water content" Soil Sci. Soc, Am. J. 48 : 1001-1008.

Kanwar, J.S. and Prihar, S.S. (1962). "Effect of continuous application of fertilisers in the tropics and subtropics of

Asia". Proceedings of the 10th congress of the Potash Inst. in Badapest, Hungary.

Koshy, M.M. and Brito mutunayagom, (1961). "Fixation and availability of Phosphate in soil of Kerala." Agric Res. J. Kerala

Lal, R.B. (1978). "Effect of different cropping intensities and irrigation methods on an economics of crop production". PhD. thesis in Agronomy submitted the Faculty of the post graduate school, IARI, New Delhi.

Lal, R. and Greenland, D.J. (1979). Soil physical properties and crop production in the tropics. John Wiley and Sons New York pp 17-19.

Mackay, A.D. and Barber, B.A. (1984). "Soil temperature effects on root growth and phosphorus uptake by corn." Soil Sci. Soc. Am. J 48 : 818-822.

Maidl, F.X. and Fischbeck, G. (1987). "Effects of different tillage practices on soil structure, and Nitrogen dynamics in loess soils with and without long term application of F.Y.M." Journal of Agronomy and crop science 159(5) : 335 - 344.

Mandal, B.C., Mandal, A.K. and Ghosh, A.B. (1982). "Changes in organic carbon and total Nitrogen in a gangetic aluvium after five years of multiple cropping with rice-wheat" J. Indian Soc. Soil Sci.30(1) : 94-98.

Moore, R.E. (1942). "The relation of soil temperature to soil moisture, pressure potential and infiltration rate" Soil Sci. Soc Am. Proc 5:61-66.

Naka No, V., Cho, T. and Hillel, D. (1983). "Effect of partial shading on evaporation from a bare soil" Soil Science 135 (5) 282-295.

Norstadt, F.A. and Porter L.K. (1984). "Soil gases and temperature" Soil Sci. Soc. Am. J. 48 : 783-789.

Noshita and Hang (1986). "Distribution of different Forms of Nitrogen m Some desert soils". Soil Sci 116 (1) : 116-172.

Oliver, R., Rubiolopez, J.E. and Agafonov, A.O. (1986). "Bulk density of sugar cane soils, changes and effects on infilteration" Moletin INICA cuba 2 : 82-91.

Page, J.B. and Willard (1946). "Cropping systems and soil properties" Soil Sci. Soc. Am. Proc. 11:81-88.

Pillai, G. (1986). "Production potential of two fodder grasses under different management practices". Ph.D. Thesis, Kerala Agricultural University.

Prasad and Palaniappan (1987). "Pulse crop residues as Nitrogen source in rice based cropping system". International Rice Research News letter T.N.A., 12 (1).

Ravina, I. (1983). "The influence of Vegetation on the moisture and volume changes" Soils and Fertilizers 46 (8) 805.

Rodskjer. N., Tuvesson, M., and Wallsten, K. (1990). "Soil temperature during the growth period in winter wheat spring barly and ley compared with that under bare soil surface at

Ultana Sweeden". Soils and Fertilizers 53 (9) 1357.

Sahasranaman, Pillai, K.N., Jayasankar, N.P., Potty, V.P., Varkey, T., Kamalakshy Amma, P.G., and Radha, K. (1976). "Mixed farming in coconut gardens - Economics and its effects on root (wilt) disease" paper presented in International symp. Cocon. Res. Development, Kasaragod, India, Dec., 28-31, 1976.

Schaff, B.E. and Skogley, E.O. (1982). "Diffusion of Potassium, Calcium and Magnesium in Bozeman silt loam as influenced by temperature and moisture" Soil Sci. Soc. Am J. 46 : 521-524.

Skidmore W.A., Carstenson and Bambury, (1975). "Soil changes resulting from cropping" Soil Sci. Soc. Am. Proc 39 : 964 - 967.

Smith, W.O. and Byers (1938). "The thermal conducting of dry soils of certain great soil groups" Soil Sci. Soc. Am.Varma 1968 STudies on availabale K in soil of Proc. 3:13-19.

Sturgis, M.B. (1934). "Changes in the Oxidation, reduction equilibrum in soils as related to physical properties soil and growth of rice " LA. Agri. Expt. Stn. Bull. 271.

Subha Rao and Ghosh (1981). "Effect of the intensive cropping and fertilizer use on organic and inorganic forms of pea in an alluvial soil" Madras Agric. J. 68(1) : 19-23.

Subbaih, B.V. and Asija, G.L. (1956). "A rapid procedure for the estimation of available Nitrogen in soils" Current Sci. 25(8) : 259-260.

Subramaniyan T.K., and Kar. S. (1976). Journal of Indian Society of Soil Sci. 24(8).

Varma, (1968). "Studies on available Potassium in soils of Madhya Pradesh" J. Indian Soc. Soil Sci. 16 : 61:64.

Velayudhan, M. and Roy, D. (1971). "Inter relationship between soil seperates and properties of Tamil Nadu" J. Indian Soc. Soil. Sci. 19 (4) : 353-361.

Vyas, M.K and Motiramani, D.P. (1971). "Effect of organic matter, silicata and moisture levels an availability of Phosphorus" J. Indian Soc. Soil Sci. 19(1) : 39-43.

White, E.M., Kruerger, C.R. and Moore, R.A. (1976). "Changes in total Nitrogen, organic matter, available phosphorus and bulk densities of cultivated soil, eight years after pastures were established." Agron. J 68 (4) 581-583.

SOIL TEMPERATURE AND MOISTURE CHARACTERISTICS AS INFLUENCED BY INTER-CROPPING OF FODDER CROPS IN COCONUT GARDEN.

By

ASOK P,I

ABSTRACT
OF THE
THESIS

RTIAL FULFILMENT OF THE REQUIREMENT FOR THE DEGREE
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DEPARTMENT OF SOIL SCIENCE AND AGRICULTURAL CHEMISTRY
COLLEGE OF AGRICULTURE
VELLAYANI
TRIVANDRUM

1993

ABSTRACT

Land availability exclusively for fodder cropping is a major constraint to take up large scale fodder cultivation. It can be grown as an intercrop in coconut garden. The present investigation is undertaken to study the effect of fodder grasses grown as inter crop in coconut garden on the soil characteristics.

From the already laid out experimental plot in the farm area of college of Agriculture. The observations are carried out. The layout is in randomised block design with six treatments and four replications. The treatments include Guinea grass, Congo Signal grass, Setaria grass, Molassess grass, Hybrid Napier and control plot without fodder. Soil samples are collected from two depths namely 15cm and 30 cm from the surface. The samples are collected during March-April, July-August and December-January. The soil analysis is done for moisture, porosity, bulkdensity, particle density and water holding capacity. The soil temperature, infiltration rate and hydraulic conductivity are carried out. The infiltration rate and hydraulic conductivity are carried out only at the close of the experiment. Chemical

analysis is done for Nitrogen, Phosphorous, Potassium, Calicum and Magnesium. All the data are statistically analysed and interpreted. Correlation is carried out with soil temperature and other important physical and chemical characteristics.

The effect of growing fodder crops on moisture content is not significant. The thick canopy of Guinea and Congosignal grass can retain moisture in the field. The water holding capacity in the control plot is less than the fodder plot. So the competition for water will be minimum for coconut and fodder crops. The soil moisture is negatively correlated with soil temperature. Setaria and Molasses grass can conserve moisture on the surface while other grasses retain moisture on the subsurface layer.

Fodder grass roots improved the structure of the soil. Bulk density values are reduced. The changes on particle density and porosity values are negligible.

The hydraulic conductivity value observed for Setaria grass is highest and the lowest value is recorded by guinea grass. Infiltration rate showed no significant difference among treatments. Soil temperature values are brought down by fodder grass cultivation during daytime, insulated the soil when it is cooled.

There is no significant effect on the chemical properties of the soil namely, soil reaction, available Nitrogen, available Potassium, exchangeable Calcium and exchangeable Magnesium. Soil Phosphorous level shown by the Setaria grass is high, which is positively correlated with the soil temperature.

Inter-cultivation with fodder grass in coconut garden, is not deteriorating the physical properties, but it can improve the hydraulic characteristics and thermal properties thereby leading to an increase in the coconut yield.