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NUTRITIVE SCREENING AND FORAGE YIELD OF GUINEA AND HYBRID NAPIER GRASS VARIETIES UNDER DENSE SHADE OF MATURE OIL PALM PLANTATION

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ABSTRACT

Cattle grazing and sparse weed flora due to poor light infiltration in mature oil palm plantations have created a need for the identification of shade tolerant fodder grass varieties. A total of 14 varieties of Guinea grass and four varieties of hybrid Napier were screened for 4 years under dense shade of mature oil palm plantation. Significant differences were observed among the fodder grass varieties evaluated for fodder yield and nutritive quality attributes. Of all the varieties, Sampoorna (24.55 t/ha), CO-4 (22.52 t/ha) and KKM-1 (22.34 t/ha) among hybrid Napier grass and BG-1 (23.12 t/ha), DGG-1 (22.00 t/ha), CO-3 (21.38 t/ha) and Grazing Guinea-1 (20.28 t/ha) among Guinea grass have been identified as promising fodder yielders. Overall, better nutritive levels in fodder quality attributes like crude protein (11.88%), crude fat (2.15%), neutral detergent fibre (66.75%), acid detergent fibre (44.37%), lignin (8.91%) and acid insoluble ash (6.00%) were observed in Sampoorna. Because of unique/sturdy growth habit, better adaptation and optimum fodder yield, Sampoorna along with Grazing Guinea-1 can be the most suitable option for a sustainable oil palm-based farming system.

Keywords: fodder grass, growth, nutritive parameter, oil palm, shade.

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INTRODUCTION

Globally, oil palm (*Elaeis guineensis* Jacq.) is a promising edible oil-yielding crop which is cultivated to an extent of 0.40 million hectares in India (Anonymous, 2022). Equilateral triangular method with 9 x 9 x 9 m spacing is a recommended method for the establishment of oil palm plantations in India. Grazing of cattle is quite common and in fact, dairy farming has become an integral part of many oil palm plantations in Andhra Pradesh and Telangana in India. Due to the sparse growth of palatable weed flora in mature oil palm plantations, daytime grazing by cattle is supplemented with paddy straw/maize stalks/green fodder brought from outside. So, the existing situation offers a dire need for improving forage availability and quality through the introduction of improved fodder grass varieties in mature oil palm plantations. Oil palm requires about 40% area for its optimum growth and FFB yield and the rest of the area remains vacant which offers scope for intercropping (Ramachandrudu *et al*., 2018) with fodder crops. Cultivation of pastures in plantation crops will certainly enhance the availability of forage by using efficient natural resources like land and filtered sunlight. However, the presence of intense shade or poor light intensity (<30%) in mature oil palm plantations is the main limiting factor for the luxuriant growth of forage. In plantations, the shade environment changes gradually with the age of the tree crop. At maturity, levels of photon irradiance (PI) transmitted to the herbaceous layer at the ground may be very low in oil palm plantations (Chen, 1989). Light drives many vital processes in plants which show different morphophysiological responses to varying degrees of light intensity and quality as an adaptation

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(Formisano *et al*., 2022). Hence, shade-tolerant grass species/varieties are certainly needed for improving and sustaining forage production which can be a base for successful integrated/mixed farming in mature oil palm plantations.

Hybrid Napier and Guinea grasses are important forage grasses of the tropics known for good biomass production, palatability, persistence and fodder quality (Hindoriya *et al*., 2019). Further, it is proven that both grasses are highly suitable, productive, slightly shade tolerant and well-established in coconut-based cropping/farming systems in India. Guinea grass and bajra hybrid Napier (CO-5) grass were found to perform well under the shade of coconut garden (Vinodhini *et al*., 2022) and *Melia dubia* plantation (Ramah *et al*., 2022), respectively. Based on the available literature, fodder grasses Guinea and Hybrid Napier were selected for screening in the microclimate of mature oil palm plantations. Demographic pressure and shifts in land use patterns have been creating a gap between the demand and supply of fodder in India. The limited availability of land for fodder production and the high cost of concentrates are the major constraints in dairy farming in India. Presently, the country faces a net shortfall of 35.6% green fodder, 10.5% dry crop leftover and 44% concentrate feed ingredients (Singh *et al*., 2022). Thus, the present situation created an opportunity/challenge for the identification of shade-tolerant fodder grass varieties to convert oil palm plantations into a self-sustainable farming system. Under-storey productivity is generally a function of photosynthetically active radiation (PAR) which varies considerably among tree species (Yirdaw and Luukkanen, 2004). There are few reports about the performance of fodder grass like Napier grass, forage sorghum and kenaf (Tohiran *et al*., 2014) and *Pennisetum purpurium* cv. Mott (Muhtarudin *et al*., 2020) under the shade of oil palm. However, information about suitable fodder grasses/their varieties is very limited in major oil palm-growing countries and totally lacking in India. There is a great need for transforming mature oil palm plantations for forage production to sustain livestock integration as the vast area is under oil palm in India. Therefore, the present experiment was conducted with the objective of identifying shade-tolerant grass varieties with quality nutrition under the dense shade of mature oil palm plantations.

MATERIALS AND METHODS

A field experiment was carried out at ICAR-Indian Institute of Oil Palm Research, Pedavegi, Andhra Pradesh state, India for four consecutive years. The experimental site is located at 16° 43′ N and 81° 09′ E with a mean sea level of 13.41 m. Weather conditions of the location *i.e*., average annual temperature, relative humidity, rainfall and photosynthetically active radiation (PAR) in oil palm plantation recorded during the experimental period were described in *Table 1*. Photosynthetically active radiation was measured at monthly intervals by LI-COR Line Quantum Sensor between 11.00 AM-12.00 PM. The average temperature and relative humidity of oil palm plantation measured by HTC Thermohygrometer were 3°C-5°C lesser and 12%-15% higher, respectively when compared with outside conditions. Reduced solar light infiltration/dense shade, moderate temperature regime, higher humidity, lower rate of evaporation and higher soil moisture level are features of the microclimate of oil palm plantations as compared with the open condition. Experiment was laid out in randomised block design (RBD) with 18 treatments and 2 replications. Age of the oil palm plantation was 10 years when the study was initiated and the soil of the experimental site is sandy loam.

Fourteen varieties of Guinea grass (*Megathyrsus maximus*/*Panicum maximum*) and four varieties of Hybrid Napier grass (*Pennisetum purpureum* x *Pennisetum typhoides*) were used for the study. The varieties are CO-1 (Coimbatore-1), CO-3 (Coimbatore-3), Samruddhy, Harithasree, BG-1 (Bundel Guinea-1), BG-2 (Bundel Guinea-2), DGG-1 (Dharwar Guinea Grass-1), DGG-2 (Dharwar Guinea Grass-2), Grazing Guinea-1 (GG-1), Tanzania,

TABLE 1. WEATHER CONDITIONS PREVAILED DURING THE EXPERIMENTATION PERIOD AT ICAR-INDIAN INSTITUTE OF OIL PALM RESEARCH, PEDAVEGI, ANDHRA PRADESH, INDIA

Weather parameter	1 yr	2 yr	3 yr	4 yr
Temperature (°C)	22.94-32.47	23.55-34.81	21.82-31.24	23.04-33.74
Relative humidity (%)	52.40-96.02	48.09-91.97	49.56-90.89	49.98-94.38
Sun light infiltration ($\mu mol/m^2/s^1$)/shade (%)	359.75/23.12	292.79/18.82	347.52/22.34	356.94/22.92
Rainfall (mm)	1287	705	423	996

Riversdale, Colonel, Mumbasa and Hamil of Guinea grass and KKM-1 (Killikulum-1), Sampoorna, APBN-1 (Andhra Pradesh Bajra Napier-1) and CO-4 (Coimbatore-4) of Hybrid Napier grass planted under shaded condition of mature oil palm. All the fodder grass varieties were irrigated with drip system whereas oil palm with micro jet system in palm basins.

Fodder grass varieties were introduced into oil palm plantations where the trees are planted established in hexagonal/equilateral triangular method with 9 x 9 x 9 m spacing. Root slips of grass varieties were planted in four rows in interspace at 60 x 45 cm spacing. Intra space of the plantation was left vacant for the free movement of farm workers and ease of cultural operations around the year. Oil palm and fodder grass were maintained as per the recommended package of practices to avoid competition for nutrients and water. Observations on plant growth and yield parameters *i.e.*, plant height, number of tillers/clump, days to cutting of fodder, number of cuttings/yr, fresh and dry weight of grass were recorded by employing standard methods. Similarly, observations like fresh fruit bunches (FFB) production, bunch weight and annual FFB yield were recorded at the time of FFB harvesting. Chlorophyll and carotenoid contents were estimated by UV-VIS spectrophotometer (*Simadzu UV-1800*) by following dimethyl sulfoxide (DMSO) method. Third leaf from the top of the shoot was taken for pigment estimation.

Fodder grass quality parameters *viz*., crude protein (CP), crude fat (CF), lignin, silica and acid insoluble ash (AIA) were estimated as per AOAC method (2005) and neutral detergent fibre (NDF), acid detergent fibre (ADF), hemicellulose (HC) and cellulose by Van Soest *et al*. (1991) method. Data were analysed statistically as per the procedure given by Gomez and Gomez, (1984) for analysis of variance (ANOVA) for RBD design and analysed data are presented in tabular and graphical forms. ANOVA of growth and yield parameters of fodder grass varieties grown in mature oil palm plantations are presented in *Table 2*.

RESULTS AND DISCUSSION

Results of the present experiment revealed that there were significant differences among the grass varieties for all the characters studied except cellulose and silica. Morphological and physiological adaptation to shade is common for all plants but the extent of changes varies with plant species and genotype (Pierson *et al*., 1990). In the present study, maximum plant height (237.93 cm) was observed in KKM-1 which was significantly superior to other varieties (*Figure 1*). Except for Sampoorna (184.78 cm), shoots were taller in hybrid Napier grass varieties as compared with Guinea grass varieties. Among the Guinea grass varieties, CO-1 recorded the maximum plant height (194.17 cm) whereas plants were short and bushy in stature in Grazing Guinea-1 (107.65 cm) which is a short-statured variety by nature. Enhanced plant height was mainly attributed to the uptake of more nutrients by the variety which resulted in more vegetative growth and increase in protoplasmic constituent and acceleration in the process of cell division, expansion and differentiation thereby resulting in luxuriant growth (Dahipahle *et al*., 2015).

Tillering in grasses is a complex phenomenon which is due to the combined effect of genetic, physiological and environmental factors (Assuero and Tognetti, 2010). It is clear from the results that there was a significant variation among the varieties for tiller production (*Figure 2*). Maximum tiller production per clump was noticed with Grazing Guinea-1 (101.04) while the minimum production was recorded in APBN-1 (18.90). The highest number of tillers recorded in Grazing Guinea-1

TABLE 2. ANOVA OF VARIOUS GROWTH AND YIELD PARAMETERS OF FODDER GRASS VARIETIES

Parameter	Treatment mean sum of square	Replication mean sum of square	Error mean sum of square	Coefficient of variation
Plant height	5678.31 (0.0001)	124.70 (0.396)	120.65	6.42
Tillers	1516.94 (0.0001)	84.77 (0.188)	53.43	19.42
Green fodder yield	18.63 (0.0001)	0.0001(0.991)	1.388	6.16
Dry fodder yield	2.650 (0.0001)	0.209 (0.286)	0.172	10.960
Chlorophyll	0.702 (0.022)	0.453 (0.200)	0.255	12.990
Carotenoids	0.064 (0.015)	0.139 (0.008)	0.019	13.670

Note: Values in parentheses are F probability values.

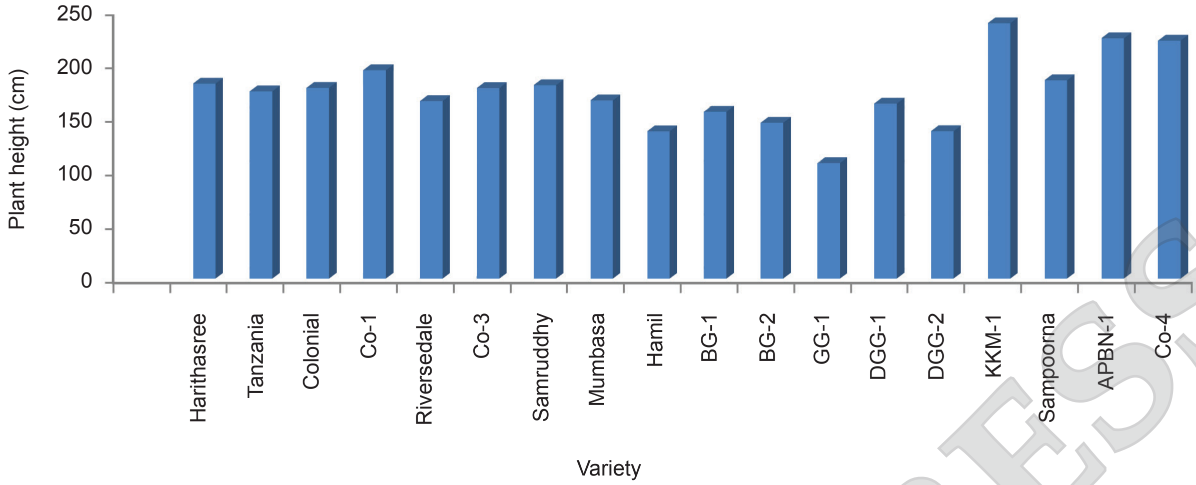

Figure 1. Plant height in Guinea and hybrid Napier grass varieties grown in mature oil palm (pooled mean) plantation.

which was markedly superior to other varieties and this may be due to better photosynthetic rate and acclimatisation to shade of oil palm. Further, profuse tiller production in Grazing Guinea-1 may be due to higher leaf area index which in turn might have resulted in more carbohydrate assimilation (Anita and Lakshmi, 2011). However, tillers did not have solid stem and mostly they are soft in texture and leafy in Grazing Guinea-1. Mean tiller production was significantly higher in many varieties of Guinea grass when compared to Hybrid Napier grass varieties. By nature, Guinea grass has more tiller production capacity when compared with Hybrid Napier grass. The increase in number of tillers in Guinea grass may be due to higher leaf area index which might have resulted in more carbohydrate assimilation (Anita and Lakshmi, 2011). High density of shade in oil palm might have suppressed the tiller production in Hybrid Napier grass by delaying the development of tiller buds into tillers (Gautier *et al*., 1999). The results of the current study are in tune with the findings of Jose *et al*. (2019) that inverse relation of tiller production with increasing shade levels and the rate of tillering existed among fodder grasses grown in mature coconut and rubber plantations. Tiller production was relatively better in Sampoorna (32.15) among Hybrid Napier grass varieties. Malaviya *et al*. (2020) reported the differential response among Guinea grass varieties for yield attributes under shade.

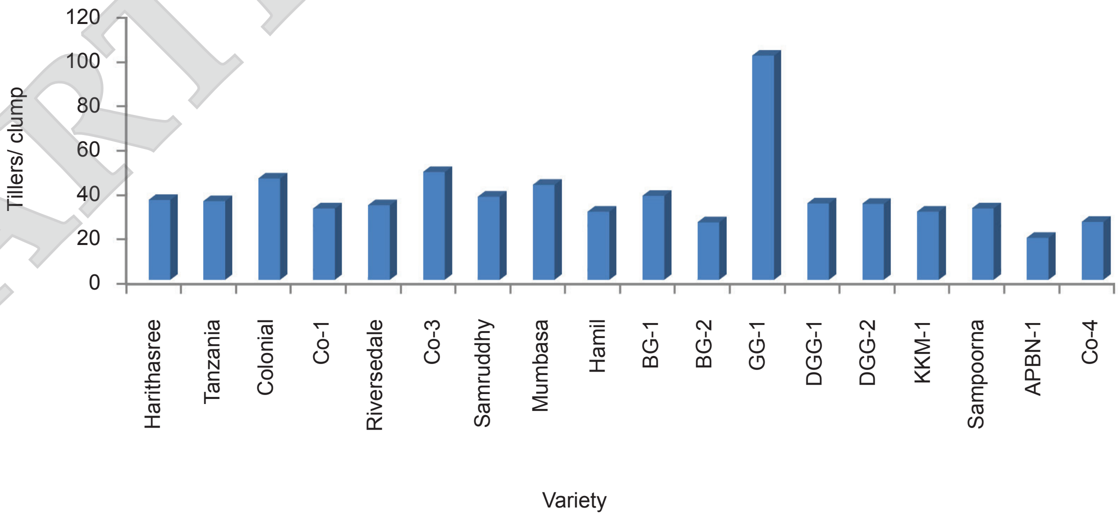

Figure 2. Tiller production in Guinea and hybrid Napier grass varieties grown in mature oil palm (pooled mean) plantation.

Biomass or fodder production in the understory is a function of the PAR reaching the ground. Of all the grass varieties, Sampoorna recorded the highest average green fodder yield (24.55 t/ha) over the years (*Figure 3*) and it was significantly superior to other varieties except BG-1 (23.12 t/ha), CO-4 (22.52 t/ha) and KKM-1 (22.34 t/ha). Among the Guinea grass varieties, BG-1 (23.12 t/ha), DGG-1 (22.00 t/ha), CO-3 (21.38 t/ha) and Grazing Guinea-1 (20.28 t/ha) were the promising fodder yielders. More or less, the same trend (*Figure 4*) was observed with respect to dry fodder yield among the varieties. The varieties CO-4 (6.23 t/ha) and Sampoorna (6.11 t/ha) recorded the highest dry fodder yield and both were more or less equal in yield and markedly superior to the rest of the varieties. The growth and development of Sampoorna indicated the sturdiness, compactness and anti-lodging properties. Higher fodder yield was due to enhanced plant growth attributes like plant height, increased number of tillers and leaf/stem ratio and because of these characteristics this variety is highly suitable for oil palm plantations. Similar to green fodder yield, more dry fodder yield levels were noticed in Guinea grass varieties like BG-1 (4.43 t/ha), CO-3 (4.09 t/ha), DGG-1 (3.88 t/ha) and GG-1 (3.87 t/ha). Except APBN-1 (18.55 t/ha), other Hybrid Napier grass varieties like Sampoorna, CO-4 and KKM-1 emerged as good forage yielders. Mean dry fodder yield was relatively higher in hybrid Napier grass varieties as compared with Guinea grass ones. Overall, higher forage yield in Hybrid Napier grass varieties might be due to more stem weight though tiller production was less as compared with Guinea grass varieties. Fodder yield is mainly dependent on tiller and foliage production in Guinea grass whereas tillers and sturdy stem growth in Hybrid Napier grass varieties. By nature, stem growth is weak in Guinea grass as compared with hybrid Napier grass which has strong and large stems. Higher biomass (green and dry fodder) production under a poor light intensity of mature oil palm plantations indicates a better adaptation of the above-mentioned varieties. Similarly, differential Guinea (Malaviya *et al*., 2020) and hybrid Napier grass (Antony and Thomus, 2015) genotypic response was observed for green and dry fodder yields under shade.

Results shown in *Figure 3* reflect an increasing trend in fodder yield in all the varieties of Guinea and Hybrid Napier grass over the years. This can be attributed to better morphological and physiological adaptation of fodder grasses under prevailing microclimate of oil palm plantation. In the present study, the number of fodder cuttings per annum was four times in all the varieties and this indicated the delayed and slow growth of Guinea and Hybrid Napier grasses under high shade of oil palm. Reasons for lower fodder yield and less number of cuttings in all the varieties must be due to reduced photosynthesis under poor light intensity in oil palm. This is in consistent with the statement of Salisbury and Rose (1986) that shade causes the light compensation point at lower irradiance levels and

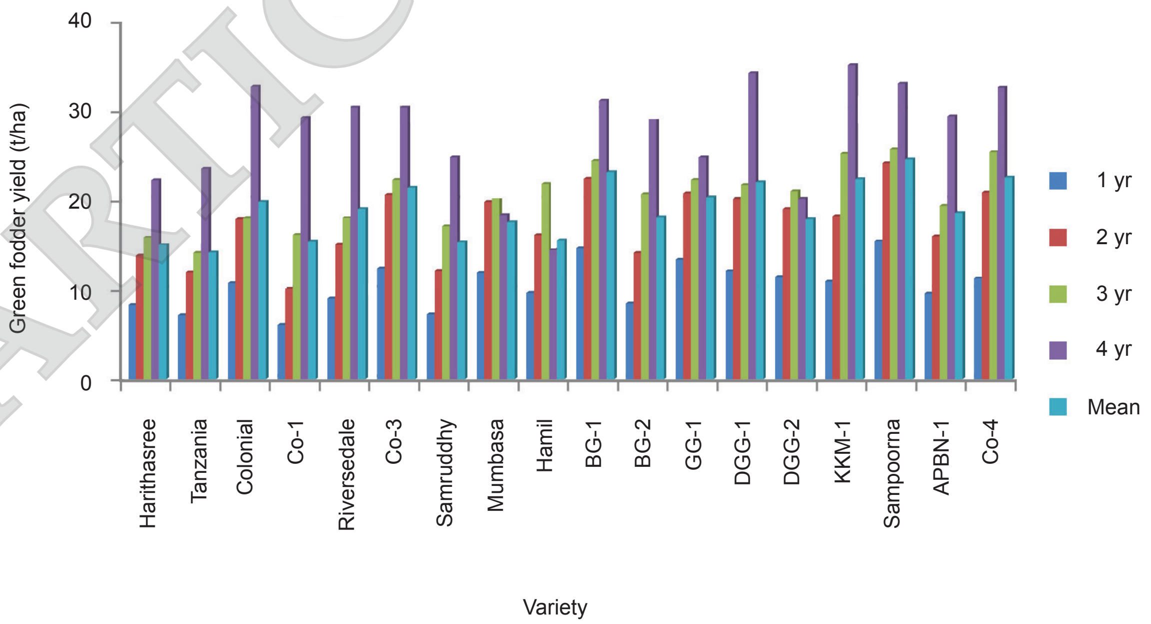

Figure 3. Green fodder yield of Guinea and hybrid Napier grass varieties grown in mature oil palm plantation.

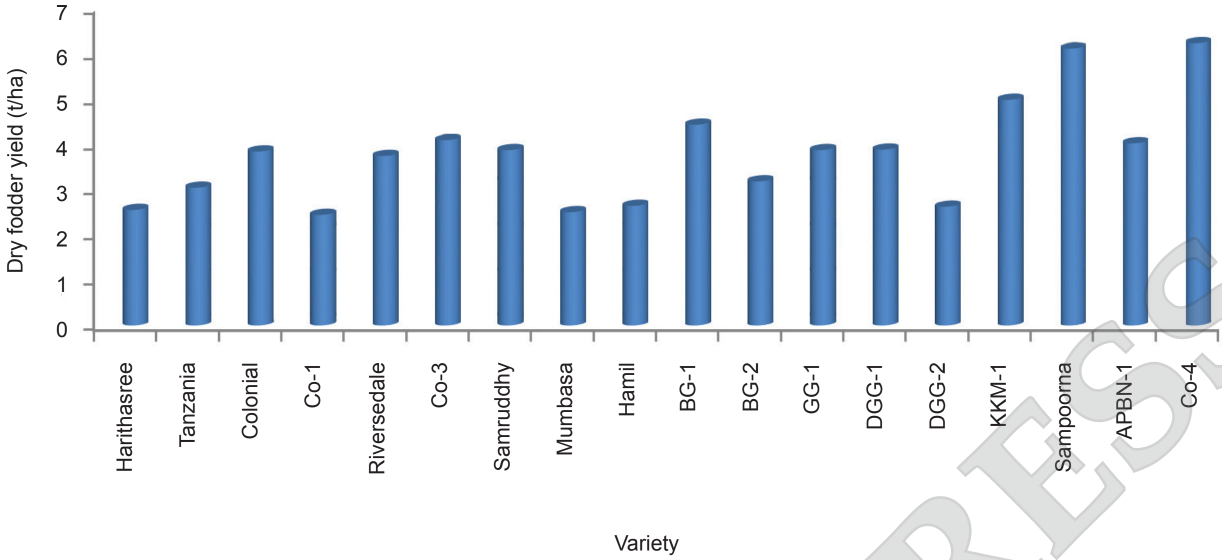

Figure 4. Dry fodder yield of Guinea and hybrid Napier grass varieties grown in mature oil palm (pooled mean) plantation.

stunted grass growth by developing ability to grow under shade. Even though grasses are fairly tolerant to shade, showed a reduction in forage production under intense shade, especially when the level of shade exceeds 50% of the incident radiation (Paciullo *et al*., 2007). Further, plants do show elasticity only in a limited range and beyond that, plants do not make any adaptation attempts (Valladares *et al*., 2007). Similarly, Jose *et al.* (2019) reported decreased yields in Guinea and hybrid Napier grasses in understory of rubber plantation.

Chlorophyll and carotenoids play a vital role in light reactions of photosynthesis and photosynthetic electron transport system in plants (Gardener *et al*., 2010). Among the tested grass varieties, the maximum chlorophyll content (4.61 mg/g) was recorded in variety DGG-2 (*Figure 5*) which was closely followed by Riversedale (4.54 mg/g) and Sampoorna (4.52 mg/g) whereas the minimum was estimated in Samruddhy (3.23 mg/g). Similarly, the variety DGG-2 (1.24 mg/g) recorded the maximum carotenoid content while the minimum was estimated in Harithasree [(0.82 mg/g) and BG-2 (0.82 mg/g)]. Chlorophyll plays a crucial role in plant growth and in general the content is relatively higher in shady situation as compared with partial and open conditions. Because of this, foliage of all the grass varieties was dark green in colour and reflecting the direct relation between chlorophyll content and photosynthesis rate. Increased levels of chlorophyll were also reported in Guinea grass genotypes grown under dense shading (Malaviya *et al*., 2020). The higher chlorophyll density influences efficiency of interception and use of solar radiation with growth potential at low level of radiation (Shelton *et al*., 1991).

Fodder grass plays a key role in growth and performance of livestock. Forage fed to the cattle must have good nutritional value and palatability. Crude protein, crude fat and crude fibre are the major components which decide the nutritive quality of forage. There were significant differences among the varieties for most of the nutritive quality parameters (*Table 3*). Among all the varieties, Harithasree recorded the highest crude protein (12.98%) content and closely followed by Sampoorna (11.88%) and CO-4 (11.28%) and these varieties were more or less consistent in crude protein content among themselves. The higher the crude protein level, the more digestible is the forage. Higher crude protein yield must be due to higher photosynthetic activity leading to beneficial effects like cell division and cell elongation which in turn resulted in more fodder production and accumulation of photosynthates (Dahipahle *et al*., 2015). The present results are in accordance with findings of Dahipahle *et al.* (2015) in Guinea grass.

Extractable ether/crude fat improves the palatability of fodder by providing essential fatty acids. Crude fat content was ranged from 2.15% in Sampoorna to 1.10% in DGG-1. Of all the tested varieties, higher crude fat level was observed in Sampoorna (2.15%), BG-2 (2.09%) and Mumbasa (2.00%) and these were found equal to one another. Neutral detergent fibre (NDF) is total fibre present in fodder which influences level of intake. Though high level limits intake but minimum level is

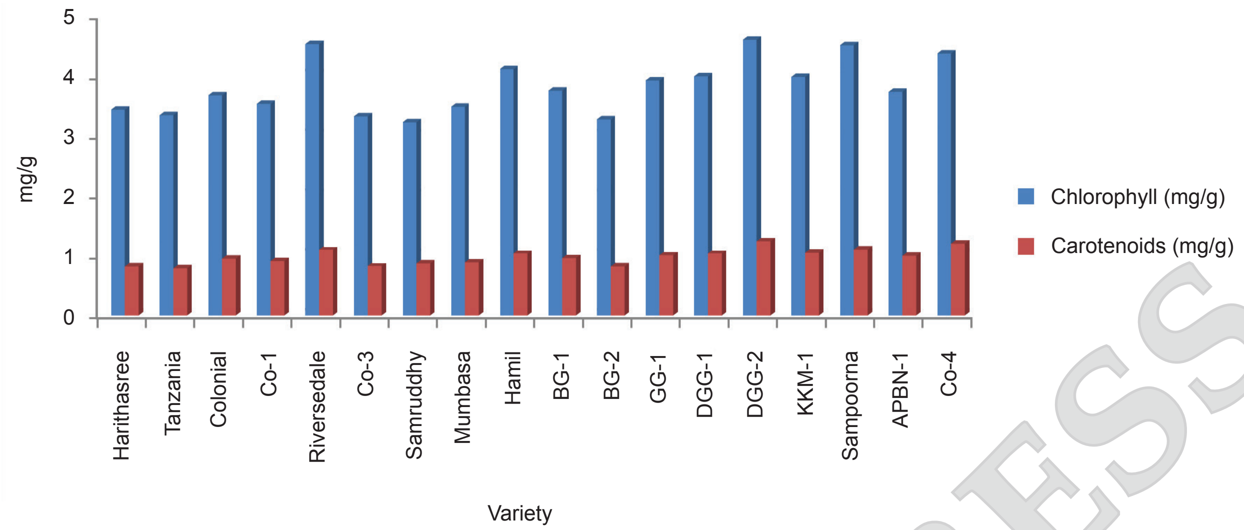

Figure 5. Chlorophyll and carotenoid content of Guinea and hybrid Napier grass varieties grown in mature oil palm (pooled mean) plantation.

necessary for healthy rumen in ruminants. The variety DGG-2 contained the maximum quantity of NDF (78.02%) which was markedly superior to most of the varieties and it was closely followed by CO-4 (77.72%), KKM-1 (77.33%) and CO-3 (77.11%). Out of all the grass varieties, NDF was lesser in Sampoorna (66.75%), BG-1 (68.90%) and Harithasree (69.46%) which were similar with one another. Acid detergent fibre (ADF) is the least digestible portion of fibre which affects a feed digestibility. The lower the ADF content, the higher the digestibility of fodder. Acid detergent fibre ranged from 44.37% in Sampoorna to 54.63% in Hamil. It is observed from the results that fodder of Sampoorna is more digestible as compared to other varieties.

Hemicellulose content was the highest in the variety Mumbasa (26.62%) while the lowest level was recorded in Harithasree (16.05%) followed by BG-1 (17.13%). Hemicellulose in plants possesses inverse relation with nitrogen uptake and crude protein content. Results were not significant among the varieties of Guinea and Hybrid Napier grass for cellulose and silica content. Comparatively, higher cellulose and silica content were observed with Co-3 and Hamil, respectively. Lignin has no known nutritive value except a bulk factor which limits organic matter digestibility and nutrient availability in forages by interfering with microbial enzymatic activity (Moore and Jung, 2001). At high levels, it reduces digestibility of other nutrients in a ration. Higher level of lignin content was recorded in CO-1 (11.48%) and closely followed by CO-3 (11.45%), KKM-1 (11.25%) and Tanzania (11.16%). Varieties like Harithasree (7.86%), DGG-2 (8.40%), DGG-1 (8.50%), Sampoorna (8.91%) and BG-1(8.95%) contained lesser lignin in their fodder. Acid insoluble ash (IAA) is the measure of total mineral content of forage and its quantity was varied from 3.00% in BG-2 and KKM-1 to 7.17% in Riversedale. Similarly, Hindoriya *et al*., (2019) in various fodder crops and Singh and Chauhan (2018) in bajra Napier hybrids reported proximate principles and fibre fractions.

Increased FFB yield in oil palm over the years was recorded in intercropped (28.24 t/ha) area as compared with mono crop (25.92 t/ha). This indicates that intercropping with fodder crop promoted the yield of oil palm which must be due to drawing of nutrients and water by oil palm from the inter cropped area owing to its dense mat like growth of root system (data not shown) in inter cropped area. In fact, oil palm has the capacity to produce lot of feeder roots wherever water and nutrients are available even beyond its active feeder root zone (Corley and Tinker, 2016). Experiments clearly demonstrated that intercropping has complementary effect on coconut productivity if proper nutrient management practices are adopted for the fodder crops (Subramanian *et al*., 2019).

CONCLUSION

Results revealed the relative performance of Guinea and Hybrid Napier grass varieties under dense shade of mature oil palm plantation. Varieties Sampoorna, CO-4 and KKM-1 of hybrid Napier grass and BG-1, DGG-1, CO-3 and Grazing Guinea-1 of Guinea grass have been identified as most promising shade tolerant and high yielding varieties under microclimate of mature oil palm plantation. Of all the varieties tested, the hybrid

TABLE 3. NUTRITIVE QUALITY (% DRY MATTER BASIS) OF FODDER IN GUINEA AND HYBRID NAPIER GRASS VARIETIES GROWN IN MATURE OIL PALM PLANTATION (POOLED MEAN)

Variety	CP	CF	NDF	ADF	HC	Cellulose	Lignin	Silica	AIA
Harithasree	12.98	1.42	69.46	53.41	16.05	40.97	7.86	2.51	6.20
Tanzania	10.98	1.45	75.22	53.03	22.19	37.84	11.16	2.86	4.90
Colonial	10.68	1.45	75.09	54.01	21.08	41.03	10.53	3.29	6.20
Co-1	10.11	1.40	73.36	50.85	22.51	38.52	11.48	3.15	5.70
Riversedale	9.59	1.31	76.17	51.67	24.50	38.35	10.01	3.40	7.15
Co-3	9.04	1.30	77.11	53.95	23.16	42.43	11.45	3.92	5.50
Samruddhy	10.92	1.85	72.41	50.32	22.09	42.12	9.87	3.54	6.05
Mumbasa	9.05	2.00	76.83	50.21	26.62	39.13	10.46	3.86	7.10
Hamil	9.56	1.40	73.59	54.63	18.96	40.42	10.90	4.53	5.90
BG-1	9.76	1.53	68.90	51.77	17.13	38.29	8.95	4.41	5.70
BG-2	9.64	2.09	72.56	50.85	21.71	41.97	9.16	4.15	3.00
GG-1	10.11	1.16	72.68	49.31	23.37	38.24	10.61	4.20	6.95
DGG-1	8.16	1.10	75.97	54.40	21.57	37.17	8.50	4.03	5.90
DGG-2	8.15	1.81	78.02	52.55	25.47	39.43	8.40	3.87	6.00
KKM-1	10.89	1.40	77.33	52.05	25.28	39.63	11.25	3.96	3.00
Sampoorna	11.88	2.15	66.75	44.37	22.38	39.13	8.91	4.15	6.00
APBN-1	9.96	1.42	71.03	49.06	21.97	37.15	10.10	4.16	6.20
Co-4	11.28	1.45	77.72	53.39	24.33	40.16	10.97	3.72	4.90
CV	8.93	9.32	3.44	4.32	8.62	6.55	8.72	15.14	10.78
CD-5%	1.91	0.31	5.36	4.71	4.25	NS	1.85	NS	1.31

Note: NS- Not significant.

Napier grass variety Sampoorna possessed better nutritive levels in fodder. A combination of varieties Sampoorna and Grazing Guinea-1 can be ideal for oil palm plantations due to their better adaptability and suitability. Cropping system with fodder grass in oil palm provides potential alternative to overcome fodder problem to some extent in India as it utilises natural resources like available light and space more efficiently. Further, results of the study clearly reflected the complementary effect of intercropping over the productivity of oil palm. This study also revealed appreciable variability for shade tolerance among various grass genotypes which can be used in crop improvement programmes. Thus, the successful performance of fodder grass varieties can certainly pave the way for sustainable integrated/mixed farming system in mature oil palm plantations which in turn leads to optimising land productivity and doubling farmer's income.

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