Guinea Grass Forage Production under Varying Tree Shade Levels and Potassium

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Availability of land for fodder cultivation in Kerala is very low due to fragmentation and shifts in cropping patterns from food to cash crops. The State's current deficit in fodder production highlights a need for intensified fodder production, and given adequate nutrient management, raising guinea grass as an intercrop with coconut appears to be a viable solution.

The land devoted for fodder cultivation in Kerala is very negligible—only 1% of the cultivable area or 5,395 ha (Government of Kerala, 2011). It is estimated that out of the requirement of 23.2 million (M) t of fodder, only 5.1 M t is produced in Kerala. The only immediate opportunity is to increase productivity per unit area. Raising fodder as an intercrop within existing crop systems has been a common solution to this problem. Studies conducted at Central Plantation Crops Research Institute, Kasargode, on rooting pattern of coconut showed that actively growing palms had a spread of roots confined to an area of 2 m surrounding the tree base. Thus the remaining area is available for intercropping and will most likely not affect the yield of coconut. The total coconut plantation area in Kerala is about 700,000 ha.

Guinea grass (*Panicum maximum*) is a popular fodder grass of the tropics suited to the agro-climatic conditions of agro-forestry systems and grows well under coconut and other trees. Approximately 80 to 100 t/ha of green fodder is commonly obtained per year. The grass makes good, palatable hay and silage, and it is highly valued for its productivity, palatability, and good persistence. Experiments conducted under the All India Co-ordinated Research Project on Forage crops, at Vellayani, Kerala showed that guinea grass is a suitable fodder crop for intercropping in coconut gardens. But its fodder yield is highly variable under partial shade. Shading has both direct and indirect effects on forage production as it can alter morphological development and yield (Kephart and Buxton, 1996).

A field experiment was conducted during 2002 in the upland area of the Instructional Farm of College of Agriculture, Vellayani, Thiruvananthapuram, Kerala. The farm is located at 8.5°N latitude and 76.9°E longitude at an altitude of 29 m above mean sea level. The average rainfall is 151 cm distributed over a period of 107 days. The rainfall from southwest and northeast monsoons are received in plenty, and the period from November to April is mildly hot. The humidity is 80 to 85% and the area receives on an average 10 hours of sunshine per day. The mean maximum and minimum temperature recorded during the cropping season ranged from 26°C to 31°C and 20°C to 25°C, respectively. The soil of the experimental site was a red, sandy clay loam (Oxisol, Vellayani series). It had a pH of 5.5, 282 kg/ha available N, 25 kg/ha available P_2O_5, and 181 kg/ha available K_2O.

The experiment was laid out in a split-split plot design with three replications. Three levels of shade (0%, 25%, 50%), three levels of K (50, 100, 150 kg K_2O/ha), and two varieties of guinea grass (cv. Hamil and Haritha) were combined to form 18 treatment combinations. The recommended dose of K_2O for guinea grass is 50 kg/ha (KAU, 2006). Shade levels were maintained through the use of nets. Farmyard manure (FYM) was applied uniformly at 10 t/ha to all plots at the time of final land preparation. The entire dose of P was given as basal at 50 kg P_2O_5/ha. Nitrogen at 200 kg/ha was given in two equal splits (i.e. one basally at the time of planting and one after the second harvest). Healthy slips of guinea grass varieties as per treatments were planted at 40 × 20 cm spacing at 2 slips/hill. Harvesting of the crop was done at a height of 15 cm from the base. Six cuts were taken at 45 day intervals. Six observational plants were selected from each plot and observations were taken on green fodder yield and uptake of N, P, and K were also estimated. The green matter yield from the net plot area was recorded after each harvest as was total green fodder yield for the entire year.

Common abbreviations and notes: N = nitrogen; P = phosphorus; K = potassium; Ca = calcium; B:C = benefit-to-cost ratio.

Table 1. Effect of shade levels, varieties and K on yield, uptake of nutrients and net returns of guinea grass.

Treatment factors	Green fodder yield, t/ha	Uptake of Nutrients, kg/ha N	P_2O_5	K_2O	Net returns, INR/ha	Benefit-to-cost ratio
Shade						
0% (S_0)	100	311	34.0	461	53,502	2.24
25% (S_1)	95.5	310	30.1	446	44,482	2.00
50% (S_2)	67.2	218	24.2	313	26,499	1.71
SE	0.1	0.4	0.1	0.6	18	0.06
CD (p = 0.05)	0.2	1.5	0.3	2.3	72	0.22
Variety						
cv. Hamil (V_1)	89.6	283	30.8	415	43,935	2.06
cv. Haritha (V_2)	85.8	277	28.2	398	39,053	1.90
SE	0.1	0.4	0.1	0.4	17	0.04
CD (p = 0.05)	0.2	1.4	0.2	1.5	60	0.15
Potassium						
50 (K_1)	80.0	259	28.6	369	34,998	1.78
100 (K_2)	90.1	287	29.3	417	42,668	2.05
150 (K_3)	92.9	294	30.4	434	46,816	2.11
SE	0.1	0.5	0.1	0.6	14	0.06
CD (p = 0.05)	0.2	1.6	0.2	1.9	42	0.16

†Values (INR/kg) include: N = 14.7/kg, P_2O_5 = 27.5/kg, K_20 = 6.6/kg, FYM = 1/kg, Planting material = 0.20/slip, Market price of fodder = 7.5/kg. The authors consider B:C values above 1.0 as optimal.

Table 2. Effect of shade on K requirement of guinea grass.

Treatment	Green fodder yield, t/ha	Uptake of nutrients, kg/ha N	P_2O_5	K_2O	Net returns,† INR/ha	Benefit-to-cost ratio
S_0 K_1	89.1	278	32.4	405	41,343	1.90
S_0 K_2	104	324	34.8	479	55,732	2.45
S_0 K_3	107	331	35.6	498	63,432	2.37
S_1 K_1	87.0	289	29.2	407	39,674	1.88
S_1 K_2	97.8	315	30.1	454	45,914	1.95
S_1 K_3	102	327	31.0	478	47,858	2.17
S_2 K_1	63.9	209	24.2	295	23,979	1.58
S_2 K_2	68.1	221	23.6	317	26,360	1.75
S_2 K_3	69.6	225	24.6	327	29,158	1.79
SE	0.1	1	0.1	1	25	0.10
CD (p=0.05)	0.3	3	0.3	3	73	-

†Values (INR/kg) include: N = 14.7/kg, P_2O_5 = 27.5/kg, K_20 = 6.6/kg, FYM = 1/kg, Planting material = 0.20/slip, Market price of fodder = 7.5/kg. The authors consider B:C values above 1.0 as optimal.

Table 3. Optimum dose of K for guinea grass under different shade intensities.

Shade level	Optimum maximum dose, kg K_2O/ha	Optimum economic dose, kg K_2O/ha
0%	130	129
25%	149	143
50%	152	150

Results

Shade levels and K significantly influenced the green fodder yield. The response of guinea grass to K fertilizer was larger with higher light intensity (i.e. less shade) and this response decreased proportionally as shade level increased. Application of 150 kg K_2O/ha (K_3) recorded significantly higher green fodder yield (**Table 1**). Mullakoya (1982) also obtained maximum green fodder yield in guinea grass (cv.Mackuenii) under the study's highest level of K application. The higher green fodder yield at high K levels could also be attributed to increase in tiller numbers from 22 to 26 with the corresponding increase of K_2O levels from 50 to 150 kg/ha, respectively (data not shown).

Uptake of N, P and K was significantly higher in unshaded conditions and with the highest level of K (**Table 2**). According to Wong and Wilson (1980) N accumulation in all the plant components of green panic was markedly improved by shading. George (1996) recorded an N uptake of 139 kg/ha/yr and P_2O_5 uptake of 24 kg/ha/yr in guinea grass (cv. Hamil) under partially shaded conditions within coconut gardens. Potassium is absorbed by forage grasses in larger amounts than any other mineral element except N and in some cases, Ca. Potassium is required in plants as a catalyst and plays an essential role in the metabolic processes of plants and is required in adequate amounts in several enzymatic reactions. Potassium is also an essential key in the carbohydrate metabolism, a process by which energy is obtained from sugar. This is very important in forage grass survivability. Application of K will balance the ill effects of high soil N availability, increase rates of photosynthesis, improve overall yield potential and quality (Phillips and Kee, 1998). Jacob (1999) reported that K applied at 50 kg K_2O/ha increased the uptake of N, P, and K in congosignal grass (*Brachiaria ruziziensis*). Meerabai et al. (1993) obtained maximum response for guinea grass green fodder yield with up to 90 kg K_2O/ha.

Results indicated that guinea grass could be economically cultivated under shade intensities up to 50% where the B:C is 1.71 compared to 2.24 under open conditions. However, application of 100 kg K_2O/ha resulted in highest net returns and B:C in open conditions; whereas 150 kg K_2O/ha was required to achieve the highest net returns and B:C in 25% and 50% shade conditions (**Table 2**). The relationship between applied K and green fodder yield was estimated by fitting a quadratic response surface as follows:

Under 0% shade;

$Y = 0.8656 + 109.0722 \times -25.9196 X^2$

F for regression = 214.653

R^2 = 96.62%

Under 25% shade;

$Y = 0.8296 + 103.1753 \times -24.4870 X^2$

F for regression = 223.583

R^2 = 96.75%

Under 50% shade;

$Y = 0.5765 + 72.0418 \times -17.1457 X^2$

F for regression = 258.726

R^2 = 97.18%

The resulting maximum (physical) and economic optimum doses for K are provided in **Table 3**.

Summary

While forage yield was significantly reduced by shading, the optimum K dose for guinea grass was found to increase with shade intensity. This was due to the increase in K content of fodder under 50% shade conditions. Since the tiller number and green fodder yield of guinea grass (cv. Hamil and Haritha) increased with higher K application under shaded conditions as evidenced from the high economic optimum dose of K, it can be concluded that the present State recommendation of 50 kg K_2O/ha for guinea grass is less than optimal, but further studies are required to confirm the results of this investigation. BC-SA

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