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Growth parameters of perennial fodder species as influenced by integrated nutrient management practices in custard apple based Horti-pastoral system

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Abstract
A field experiment carried to determine Influence of integrated nutrient management practices on perennial fodders in custard apple based Horti-Pastoral system during *Rabi*, 2021 at Agroforestry research block, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad. The experiment was conducted with two fodder species (*C. ciliaris, M. maximus*) as main plots and 7 nutrient management practices along with control as sub plots in a split plot design and replicated thrice in between the tree species of 4 years old aged custard apple. Results revealed that *M. maximus* has recorded significantly higher number of tillers, fodder height and leaf area, SPAD values. And 75% RDN + 25% N through PGLM showed significantly higher number of tillers, fodder height and leaf area, SPAD values which is showed parity with 75% RDN + 25% N through PM, 100% RDF (60:60:40 NPK kg ha-1), 75% RDN + 25% N through FYM.

Keywords: Fodder species, nutrient management practice, number of tillers, fodder height, leaf area, SPAD values

Introduction

Cenchrus ciliaris, known as Anjan grass in India, is predominant pasture grass (Dabadghao and Shankarnarayan, 1973) [1]. The *Cenchrus* species can grow on wide range of soils and environments due to its drought and high temperature tolerance. It is highly palatable with high nutrition value (protein 8-10% with 60-70% digestibility) for all kinds of grazing animals (Sawal *et al*. 2009) [9]. *Megathyrsus maximus* (guinea grass) is a perennial, tufted grass with a short, creeping rhizome. This robust grass can reach a height of up to 2 m. Can be integrated with horticultural crops. They can grow in waste water and marshy land. Their crude protein ranges from 8-13% (Prakash *et al., 2019*) [6]. It is recommended for regions where annual rainfall ranges from 800 to 1800 mm in well-drained soil and it requires medium to high soil fertility (Muir and Jank, 2004) [4].

The country is deficient in respect of availability of green fodder, dry fodder. Future and development and growth of livestock are highly associated with scope of availability of fodder (Hembram *et al.,* 2016) [2]. Low fertility generally causes for reduction in forage yield nutrition is one of the most important factors to increase the forage productivity. Instead of using only chemical fertilizer alone Integrated nutrient management using locally available resources such as organic manures and green leaf manures reduce the production cost and improve the resilience of the farm system by improving soil fertility in rainfed areas (Ravi *et al*, 2009) [8]. Judicious combination of organic manures and chemical fertilizers depending upon the availability, nature and properties of the soil and crops to be grown would not only maximize the crop production and improve the quality of agricultural produces but would also help in maintaining the soil fertility (Madhavi Lata *et al*., 2014) [3]. Organic amendments such as FYM is known to improve soil physical properties. Poultry manure contains higher content of N which is readily available to crops and also possess various micro-nutrients (Pratap *et al*., 2008) [5]. Pongamia green leaf contains higher content of easily mineralizable N, important for improvement of soil physical properties and is a good source of nutrients for low fertility soils under dryland agriculture (Ranveer Singh *et al*., 2013) [7]. Therefore, this study was aimed to evaluate the influence of INM practices on yield and economics of the fodder species in horti-pastoral system.

Materials and Methods

A field experiment was conducted "Influence of integrated nutrient management practices on perennial fodder species in custard apple based Horti-Pastoral system" during *Rabi*, 2021 at Agroforestry research block, Professor Jayashankar Telangana State Agricultural University, Rajendranagar, Hyderabad, Telangana. situated at 17o19' N latitude, 78o28' E longitude and at an altitude of 555 m above mean sea level falls under the Southern Telangana agro-climatic zone of Telangana. The weekly mean maximum temperature during the crop growth period ranged from 27.140C to 31.640C with an average of 29.290C. The weekly mean minimum temperature during the crop period ranged from 11.070C to 18.570C with an average of 14.850C. During the entire crop growth period (October 2020 to February 2021) 18.08 mm of rainfall was received in 4 rainy days.

The soil of the experimental site was sandy loam with a pH (6.70), EC (0.125 dS m-1) and organic carbon (0.66%). Soil was medium in available nitrogen (247.2 kg ha-1) and phosphorus (30.65 kg ha-1) while low in available potassium (179.1 kg ha-1). The experiment was laid out in Split plot design with three replications. Two main plot treatments comprised of two fodder species anjan grass and guinea grass and seven integrated nutrient management treatments *viz.*, T1-Control (no fertilizer and manure), T2-100% RDF (60:60:40 NPK kg ha-1), T3-75% RDN + 25% N through PGLM, T4-75% RDN + 25% N through NGLM, T5- 75% RD N + 25% N through SGLM, T6-75% RDN + 25% N through PM, T7 75% RDN +
25% N through FYM. P, K Common for all treatments except control and Organic manure is applied as basal and N in 3 Splits after each cutting.

Results and Discussion

Number of tillers hill-1

The data on number of final tillers hill-1 at 1st, 2nd and 3rd cut as influenced by the integrated nutrient management practices in horti-pastoral system presented in table 1. This data revealed that the no. of tillers hill-1 were significantly influenced by the type of fodder and integrated nutrient management practices.

Table 1: Number of tillers per hill of different fodder species as influenced by integrated nutrient management in horti-pastoral system

Main plots (Fodder species)	Initial no. of tillers (hill-1)	at 1st cut (hill-1)	at 2nd cut (hill-1)	at 3rd cut (hill-1)
1. *Cenchrus ciliaris* (Anjan grass)	42	49	53	48
2. *Megathyrsus maximus* (Guinea grass)	54	59	62	57
S.Em +	0.7	0.4	0.8	1.4
CD(P=0.05)	4.3	2.7	4.6	8.5
Sub plots (Nutrient management)				
T1 -Control (No fertiliser)	47	49	52	47
T2 -100% RDF (60:60:40) N-P-K kg ha-1	49	55	57	53
T3 -75% RDN + 25% N Through PGLM	49	60	62	57
T4 -75% RDN + 25% N Through NGLM	46	50	53	49
T5 -75% RDN + 25% N Through SGLM	48	52	55	50
T6 -75% RDN + 25% N Through PM	48	58	64	59
T7 -75% RDN + 25% N Through FYM	49	54	57	53
Mean	48	54	57	52
S.Em +	3.3	2.9	2.2	2.0
CD(P=0.05)	NS	8.7	6.5	5.9
Interaction (Main × Sub)				
S.Em +	4.7	4.1	3.2	2.9
CD(P=0.05)	NS	NS	NS	NS
Interaction (Sub × Main)				
S.Em +	4.4	4.0	2.9	2.6
CD(P=0.05)	NS	NS	NS	NS

Among the fodder species, maximum number of tillers hill-1 were recorded in Guinea grass at 1st, 2nd and 3rd cut *i.e.*, 59, 62, 57 tillers hill-1, respectively, which was significantly higher than Anjan grass. This might be due to nature of growth habit of Guinea grass with more tillering compared to the Anjan grass. These results are in agreement with the findings of Valentine and Matthew (1999) [18].

Among the integrated nutrient management practices, at first cut, significantly higher values were recorded in T3 -75% RDN + 25% N through PGLM (60 tillers hill-1) and all other treatments were at par with each other except control and T4 - 75% RDN + 25% N through NGLM. While at second cut, significantly higher values were recorded in T6 -75% RDN + 25% N through PM (64 hill-1) followed by T3 -75% RDN + 25% N through PGLM (62 hill-1) over all other treatments. Similar trend was also followed in third cut, significantly higher values were recorded in T6 -75% RDN + 25% N through PM (59 hill-1) followed by T3 -75% RDN + 25% N through PGLM (57 hill-1) over all other treatments. This reason may be due to availability of nitrogen in soil through mineralization of pongamia green leaf manure, could have triggered the production of new meristem, which in turn develop into tillers. As green leaf manure supplies nutrients at slow rate for longer time, it reduces tiller mortality and increases tillers hill-
1. These results are in conformity with Prasad *et al*. (2010) [16].

The interaction between type of fodder species and integrated nutrient management practices on number of tillers revealed that there was no significant effect. The increase in tillers might be due to better growth and development of crop with organic manures that created favorable effects on soil physical, chemical and biological properties and also provided major nutrients to plants thus stimulating plant tiller development as reported by Singh *et al*. (2013) [7].

2. Fodder height (cm)

The data on fodder height of fodder species at 15, 30 and 45

DAI (at 1st cut), 2nd cut, 3rd cut as influenced by the integrated nutrient management practices in horti-pastoral system are presented in table 2. and depicted in figure 1.

Table 2: Fodder height (cm) as influenced by integrated nutrient management in horti-pastoral system

	15 DAI	30 DAI	45 DAI (1st cut)	2nd cut	3rd cut
Main plots (Fodder species)					
1. *Cenchrus ciliaris* (Anjan grass)	53.7	90.7	113.9	112.6	108.7
2. *Megathyrsus maximus* (Guinea grass)	100.5	174.8	207.1	210.0	205.9
S.Em +	1.44	2.15	4.08	2.96	3.46
CD(P=0.05)	8.73	13.09	24.83	18.04	21.02
Sub plots (Nutrient management)					
T1 -Control (No fertiliser)	60.2	114.2	133.1	135.9	131.8
T2 -100% RDF (60:60:40) N-P-K kg ha-1	83.3	141.2	162.2	165.0	160.9
T3 -75% RDN + 25% N Through PGLM	87.7	147.5	170.5	173.0	169.1
T4 -75% RDN + 25% N Through NGLM	73.3	120.7	151.0	153.8	149.7
T5 -75% RDN + 25% N Through SGLM	71.9	122.9	153.8	156.8	152.7
T6 -75% RDN + 25% N Through PM	84.1	144.4	173.4	175.7	172.3
T7 -75% RDN + 25% N Through FYM	78.9	138.5	179.4	169.0	164.9
Mean	77.07	132.76	160.49	161.3	157.33
S.Em +	3.73	5.44	5.76	5.51	4.48
CD(P=0.05)	10.89	15.88	16.82	16.09	13.08
Interaction (Main × Sub)					
S.Em +	5.28	7.69	8.15	7.79	6.34
CD(P=0.05)	NS	NS	NS	NS	NS
Interaction (Sub × Main)					
S.Em +	5.09	7.74	8.58	7.93	6.53
CD(P=0.05)	NS	NS	NS	NS	NS

DAI- Days after initiation

Perusal of the data (Table 1, 2) revealed that the plant height of fodder species at 15, 30 and 45 DAI (at 1st cut), 2nd cut, 3rd cut was significantly influenced by type of fodder species. *i.e*., maximum fodder height at 15, 30 and 45 DAI (at 1st cut), 2nd cut, 3rd cut was recorded in guinea grass 100.5, 174.8 and 207.1, 210.0, 205.9 cm, respectively when compared to anjan grass 53.7, 90.7 and 113.9, 112.6, 108.7cm, respectively. Guinea grass growth was fast and higher compared to anjan grass. This is due to shade tolerance effect and nature of growth habit of guinea grass. Among the integrated nutrient management practices, at 15 DAI, significantly higher plant height was observed in T3 -75% RDN + 25% N through PGLM (87.7 cm) followed by T6 -75% RDN + 25% N through PM (84.1 cm), T2 -100% RDF (60:60:40) NPK kg ha-1(83.3 cm) and T7 -75% RDN + 25% N through FYM (78.9 cm). At the 30 DAI,

maximum plant height was observed in T3 -75% RDN + 25% N through PGLM (147.5 cm) followed by T6 -75% RDN + 25% N through PM (144.4 cm), T2 -100% RDF (60:60:40) NPK kg ha-1(141.2 cm) and T7 -75% RDN + 25% N through FYM (138.5 cm) lowest was observed in T1-control (114.2 cm). At the 45 DAI i.e., at 1st cutting stage highest was observed in T7 -75% RDN + 25% N through FYM (179.4 cm) followed by T6 -75% RDN + 25% N through PM (173.4 cm), T3 -75% RDN + 25% N through PGLM

(170.5 cm) which were on par with each other and significantly superior over all other treatments and control (133.1 cm). The crop advances from 15 to 30 days after initiation, the plant height increased progressively and from 30 to 45 days after initiation, the plant height showed a marginal increase.

The fodder at 2nd cut recorded significantly higher plant height (175.7 cm) in T6 (75% RDN + 25% N through PM) followed by T3 (75% RDN + 25% N through PGLM) over all other treatments. Similar trend was observed in 3rd cut *i.e.*, significantly higher plant height (172.3 cm) observed in T6 (75% RDN + 25% N through PM) followed by T3 (75% RDN + 25% N through PGLM) over all other treatments.

This might be due to the fact that supplying full dose of recommended nutrients in balanced manner with

organic and inorganic sources might have provided readily available nutrient forms to the crop which resulted in better root development and high photosynthetic rate. Similar results were obtained by Narolia *et al.* (2009) [13] and Giribabu *et al.* (2010) [11].

The interaction effect was found non-significant between type of fodders and nutrient management practices. Usage of combination of organic and inorganic fertilizers ensured availability of nutrients at initial stages of the crop, and also in long term for the entire crop growth period with improved soil properties. Better growth under intercropping could be owing to minimum competition for natural resources from trees and increased availability of nutrients as reported by Elamin and Madhavi (2015) [10]. These results are also obtained by Meena and Mann (2007).

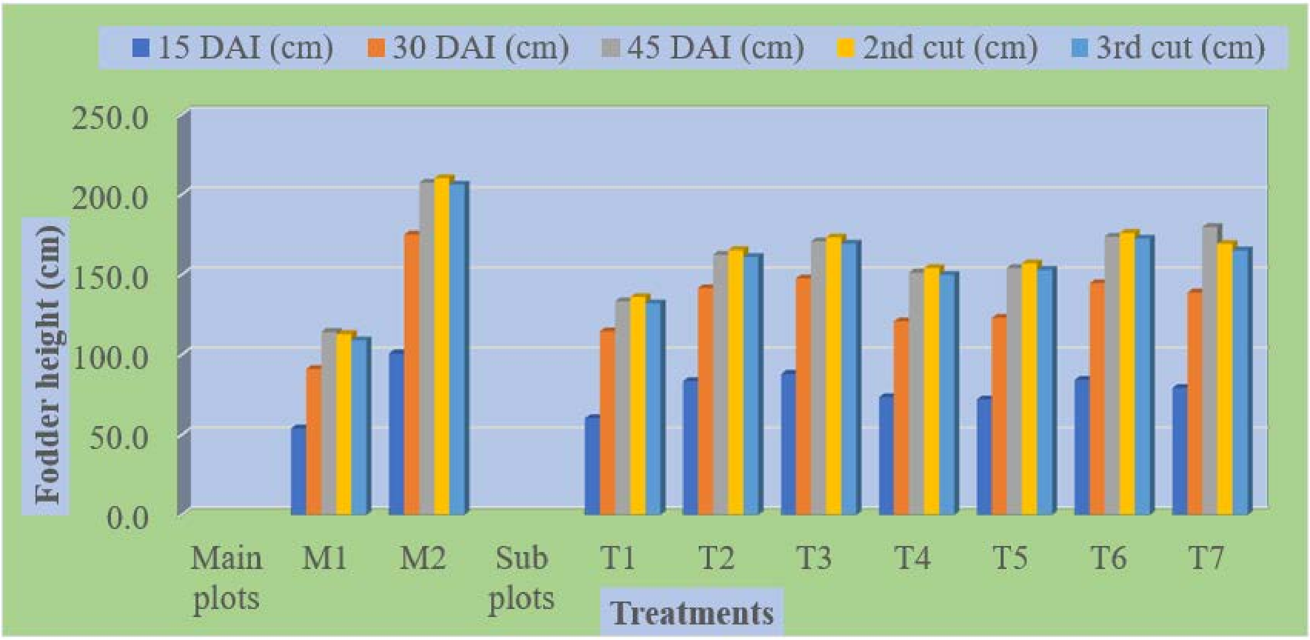

Fig 1: Fodder height (cm) as influenced by integrated nutrient management in horti-pastoral system

Leaf area (cm2)

Leaf area of fodder anjan grass and guinea grass at 15,30 and 45 DAI (at 1st cut), 2nd cut and 3rd cut are presented in Table 3.

Among the fodders, guinea grass recorded significantly maximum leaf area at 15, 30 and 45 DAI (at 1st cut), 2nd cut and 3rd cut 134.08,150.50 and 156.49, 158.1, 155.84 cm2 respectively when compared to anjan grass (9.26,13.86 and 19.42, 22.19, 18.97 cm2). In case of nutrient management practices, significant increase in leaf area at all stages (15, 30 and 45 DAI (at 1st cut), 2nd cut and 3rd cut). At 15 DAI leaf area (80.9 cm2) recorded significantly higher with application of T6 (75% RDN + 25% N through PM) followed by T3 -75% RDN + 25% N through PGLM (80.0 cm2) and T7 -75% RDN + 25% N through FYM (76.2 cm2) and T2 -100% RDF (60:60:40) NPK kg ha-1 (75.7 cm2) when compared with other nutrient management treatments and T1-control (49.7 cm2). At 30 DAI significantly higher leaf area was recorded in T6 -75% RDN + 25% N through PM (93.15 cm2) followed by T3 -75% RDN + 25% N through PGLM (89.94 cm2) and T7 -75% RDN + 25% N through FYM (89.25 cm2), T2 -100% RDF (60:60:40) NPK kg ha-1 (86.66 cm2) when compared with other nutrient management treatments. At 45 DAI (1st cut) significantly higher leaf area observed in T6 -75% RDN + 25% N through PM (102.48 cm2) and all other treatments were on par with each other except T5 -75% RDN + 25% N through SGLM (81.44 cm2) and T1-control (65.60 cm2). While at 2nd cut, significantly higher leaf area was recorded in T6 -75% RDN + 25% N through PM (101.49 cm2) followed by T3 -75% RDN + 25% N through PGLM (98.31 cm2) and all other treatments were on par with each other except T5 -75% RDN + 25% N through SGLM (83.84 cm2) and T1-control (67.83 cm2). Similar trend was followed at 3rd cut, significantly higher leaf area was recorded in T6 -75% RDN + 25% N through PM (98.46 cm2) followed by T3 -75% RDN + 25% N through PGLM (95.22 cm2) and all other treatments were on par with each other except T5 -75% RDN + 25% N through SGLM (80.50 cm2) and T1-control (64.84 cm2). Highest leaf area at 45 DAI in first cut might be due to more light interception and enhanced photosynthetic rate, which ultimately resulted in higher dry matter production and forage yield. Highest leaf area at 2nd cut among three cuttings is due to higher nutrient availability through decomposed organic sources. These are in conformity with the findings of Patil *et al.* (2003) [15].

The interaction effect of type of fodder species and integrated nutrient management practices are presented in Table 4. The two way analysis of variance results revealed that at 1st, 2nd and 3rd cuttings significantly higher leaf area observed in guinea grass under T6 (75% RDN + 25% N through PM) 182.83,178.67,175.67 cm2, respectively. The lowest leaf area observed in control plot at all three cuttings (Table 4). The combination of organic and inorganic fertilizers showed significant effect when compared to only inorganic fertiliser (100% RDF) and control. This was due to imbalance in nutrient availability at crop demand during grand growth stages under sole inorganic fertiliser (100% RDF) and low availability of nutrients at different growth stages in control. These are in conformity with the findings of Patil *et al.* (2007) [14].

Table 3: Leaf area (cm2) of different fodder species as influenced by integrated nutrient management in horti-pastoral system

	15 DAI	30 DAI	45 DAI (1st cut)	2nd cut	3rd cut
Main plots (Fodder species)					
1. *Cenchrus ciliaris* (Anjan grass)	9.26	13.89	19.42	22.19	18.97
2. *Megathyrsus maximus* (Guinea grass)	134.08	150.50	156.49	158.81	155.84
S.Em +	0.39	1.81	1.57	3.81	3.61
CD(P=0.05)	2.38	11.01	9.56	23.20	21.96
Sub plots (Nutrient management)					
T1 -Control (No fertiliser)	49.71	59.60	65.60	67.83	64.84
T2 -100% RDF (60:60:40) N-P-K kg ha-1	75.73	86.66	92.65	94.88	91.71

T3 -75% RDN + 25% N Through PGLM	80.02	89.94	94.28	98.31	95.22
T4 -75% RDN + 25% N Through NGLM	70.06	81.33	87.34	89.63	86.78
T5 -75% RDN + 25% N Through SGLM	69.22	75.44	81.44	83.84	80.50
T6 -75% RDN + 25% N Through PM	80.94	93.15	102.48	101.49	98.46
T7 -75% RDN + 25% N Through FYM	76.27	89.25	91.92	97.54	94.33
Mean	71.67	82.20	87.96	90.50	87.41
S.Em +	2.74	3.97	5.24	5.63	5.16
CD(P=0.05)	8.01	11.58	15.28	16.44	15.05
Interaction (Main × Sub)					
S.Em +	3.88	2.61	7.41	7.96	7.29
CD(P=0.05)	11.33	7.62	21.61	23.24	21.28
Interaction (Sub × Main)					
S.Em +	3.61	3.01	7.03	7.24	6.97
CD(P=0.05)	11.34	12.23	21.64	22.22	20.35

Table 4: Leaf area (cm2) of different fodder species as influenced by integrated nutrient management in horti-pastoral system

Treatment			**Fodder species**			
	1st cut			**2nd cut**		**3rd cut**
Nutrient management	***C. ciliaris***	***M. maximus***	***C. ciliaris***	***M. maximus***	***C. ciliaris***	***M. maximus***
T1 -Control (No fertiliser)	15.10	116.10	17.35	118.30	13.91	115.78
T2 -100% RDF (60:60:40) N-P-K kg ha-1	21.13	164.17	23.32	166.44	20.00	163.42
T3 -75% RDN + 25% N Through PGLM	19.56	168.99	25.28	171.33	22.29	168.14
T4 -75% RDN + 25% N Through NGLM	19.08	155.60	21.25	158.00	18.67	154.90
T5 -75% RDN + 25% N Through SGLM	18.18	144.70	20.79	146.89	17.00	144.00
T6 -75% RDN + 25% N Through PM	22.13	182.83	24.31	178.67	21.25	175.67
T7 -75% RDN + 25% N Through FYM	20.77	163.07	23.00	172.08	19.67	169.00
	S.Em + CD(P=0.05)		S.Em +	CD(P=0.05)	S.Em +	CD(P=0.05)
Interaction						
Main × Sub (M X S)	7.40	21.61	7.96	23.24	7.29	21.28
Sub × Main (S X M)	7.03	21.64	7.24	22.22	6.97	20.35

SPAD values

The data on SPAD values of different fodder species at 15, 30, 45 DAI as influenced by the nutrient management practices (Table 5). Among the fodder species the guinea grass recorded significantly higher SPAD values (39.4, 41.7, 43.1) at 15, 30, 45 DAI compared to anjan grass 16.7, 19.2, 22.0, respectively. This is due to highest leaf area, more light interception, enhanced photosynthetic rate and higher photosynthates accumulation in guinea grass.

Perusal of data shown in Table 6, SPAD values were found to increase gradually from 15 to 45 DAI. At 15 DAI, maximum SPAD reading was observed in T6 -75% RDN + 25% N through PM (31.3) followed by T3 -75% RDN + 25% N through PGLM (30.9) and T2 -100% RDF (60:60:40) NPK kg ha- 1(29.7) as compared to control (20.0). At 30 DAI, significantly higher SPAD reading was observed in T6 -75% RDN + 25% N through PM (33.7) followed by T3 -75% RDN + 25% N through PGLM (33.4) and T2 -100% RDF (60:60:40) NPK kg ha-1(32.4) which was superior over other nutrient treatments and control (21.15). At 45 DAI, maximum SPAD reading was observed in T6 -75% RDN + 25% N through PM (36.4) followed by T3 -75% RDN + 25% N through PGLM (35.7), T7 -75% RDN + 25% N through FYM (35.0) and T2 -100% RDF (60:60:40) NPK kg ha-1 (34.2) which were on par with each other and significantly superior over other treatments and control.

Combination effect of type of fodder species and nutrient management practices for SPAD values found to be significant and represented in Table 6 at all stages 15, 30 and 45 DAI. This might be due to higher PAR with more leaf area in guinea grass and also influenced by the balanced supply of nutrients from integrated nutrient sources which influenced the vegetative growth of the fodder.

Table 5: SPAD values of different fodder species as influenced by integrated nutrient management in horti-pastoral system

	15 DAI	**30 DAI**	**45 DAI (At 1st cut)**
Main plots (Fodder species)			
1. *Cenchrus ciliaris* (Anjan grass)	16.7	19.2	22.0
2. *Megathyrsus maximus* (Guinea grass)	39.4	41.7	43.1
S.Em +	0.4	0.5	0.4
CD(P=0.05)	2.31	2.7	2.4
Sub plots (Nutrient management)			
T1 -Control (No fertiliser)	20.0	21.1	23.2
T2 -100% RDF (60:60:40) N-P-K kg ha-1	29.7	32.4	34.2
T3 -75% RDN + 25% N Through PGLM	30.9	33.5	35.7
T4 -75% RDN + 25% N Through NGLM	27.5	30.1	31.4
T5 -75% RDN + 25% N Through SGLM	28.4	31.0	31.9
T6 -75% RDN + 25% N Through PM	31.3	33.7	36.4
T7 -75% RDN + 25% N Through FYM	28.7	31.2	35.0
Mean	28.0	30.4	32.5
S.Em +	0.7	0.6	0.8

CD(P=0.05)	2.0	1.7	2.2
Interaction (Main × Sub)			
S.Em +	1.0	0.8	1.1
CD(P=0.05)	2.8	2.4	3.1
Interaction (Sub × Main)			
S.Em +	1.0	0.9	1.2
CD(P=0.05)	3.5	3.3	3.6

Table 6: SPAD values of different fodder species as influenced by integrated nutrient management in horti-pastoral system

Treatment			**Fodder species**			
	15 DAI			**30 DAI**	**45 DAI (at 1st cut)**	
Nutrient management	***C. ciliaris***	***M. maximus***	***C. ciliaris***	***M. maximus***	***C. ciliaris***	***M. maximus***
T1 -Control (No fertiliser)	10.30	29.70	11.10	31.20	13.27	33.20
T2 -100% RDF (60:60:40) N-P-K kg ha-1	19.10	40.20	22.30	42.60	23.78	44.60
T3 -75% RDN + 25% N Through PGLM	19.80	42.10	22.70	44.28	25.03	46.28
T4 -75% RDN + 25% N Through NGLM	16.10	38.87	19.10	41.20	20.86	41.97
T5 -75% RDN + 25% N Through SGLM	16.70	40.00	19.70	42.40	21.53	42.31
T6 -75% RDN + 25% N Through PM	19.50	43.17	21.90	45.50	25.39	47.50
T7 -75% RDN + 25% N Through FYM	15.50	42.00	17.80	44.70	24.18	45.73
	S.Em + CD(P=0.05)		S.Em +	CD(P=0.05)	S.Em +	CD(P=0.05)
Interaction						
Main × Sub (MxS)	0.97	2.82	0.83	2.41	1.09	3.15
Sub × Main **(**SxM)	0.99	2.87	0.87	2.53	1.12	3.20

Conclusion

From the result it could be concluded that guinea grass with 75% RDN + 25% N through PGLM or 75% RDN + 25% N through PM,100% RDF (60:60:40) NPK kg ha-1 obtained higher number of tillers, fodder height and leaf area, SPAD values useful for sustainable agriculture development.

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