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Physiological Studies of Grass Fodder Cowpea Mixtures as Influenced by Row Ratio

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ABSTRACT: *A Field experiment was conducted at the Instructional Farm, College of Agriculture, Vellayani, Thiruvananthapuram during January 2012 to March 2014 to find out the effect of grass-fodder cowpea mixtures and row ratio on the physiological aspects of fodder grasses and fodder cowpea in open and in partial shade. The experiments were laid out in RBD with three replications, comprising of two grasses [G_1-Hybrid napier (Suguna), G_2-Guinea grass (Harithasree)], two fodder cowpea varieties (V_1-COFC-8 (open and shade), V_2-UPC-622 (open), UPC-618 (shade) and three grass legume row ratios (R_1-1:1, R_2-1:2, R_3-1:3). The results indicated the superiority of the grass legume mixture of hybrid napier cv. suguna with both the fodder cowpea varieties in the grass legume row ratio of 1:3 with respect to dry matter production and leaf area index in open and shaded experiments.*

Keywords*: Hybrid napier grass, guinea grass dry matter production, leaf area index, row ratio.*

INTRODUCTION

A serious drawback of sustainable livestock production system in Kerala is the inadequate seasonal distribution of fodder production. The quantity and quality of herbage available in the lean dry months from January to May is very low. Therefore it is imperative to develop a fodder production system that increases the availability and improves the quality of herbage in the dry summer months. Intensive fodder production systems based on grasses are increasingly becoming important to the dairy farmers of Kerala. Development of compatible persistent grass legume mixtures could alleviate acute seasonal livestock feed deficiency in dry seasons (Njarui *et al.*, 2006). The major problem in grass fodder cowpea mixtures is the low legume plant density and shading of cowpea by grasses. To overcome this problem cropping systems using optimum cowpea densities and different crop combinations are to be standardized. The dairy homesteads of Kerala are mostly experiencing light stress of varying intensities. Tiller production and leaf, stem and stubble and root production of forages are reduced at low light with formation of thinner leaves with higher water content and higher specific leaf area (Wong, 1991). Poor adaptation of many improved fodder crops/ varieties in shade environment limits fodder production in homesteads and shade affects persistence, yield and quality of under storey forages. Hence this study was proposed to identify the performance evaluation of fodder cowpea varieties in mixtures with the popular fodder grasses of Kerala for improving the physiological aspects of fodder under open and shaded situations during the lean dry months.

MATERIALS AND METHODS

Field experiment was conducted at the Instructional Farm, College of Agriculture, Vellayani, Thiruvananthapuram during January 2012 to March 2014 to find out the effect of grass-fodder cowpea mixtures and row ratio on the physiological aspects of fodder grasses and fodder cowpea in open and in partial shade. The experiment was laid out in RBD with three replications, comprising of two grasses [G_1-Hybrid napier (Suguna), G_2-Guinea grass (Harithasree)], two fodder cowpea varieties (V_1-COFC-8 (open and shade), V_2-UPC-622 (open), UPC-618 (shade) and three grass legume row ratios (R_1-1:1, R_2-1:2, R_3-1:3). FYM @ 12 tha^{-1} was applied in the trenches taken for planting BN hybrid and guinea grasses. FYM @ 10 tha^{-1} was applied in the rows taken for planting fodder cowpea and incorporated in the

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soil. For grasses, entire dose of P and K was given as basal each @ 50 kg ha^{-1}. N @ 200 kg ha^{-1} was given in two equal splits, first as basal and second one month after planting. For fodder cowpea, entire dose of P and K was given as basal each @ 30 kg ha^{-1}. N @ 40 kg ha^{-1} was given in two equal splits, first as basal and second one month after sowing. Three nodded stem cuttings of BN hybrid were planted in the channels @ 1sett per hill, at a spacing of 60 cm x 60 cm. Slips of guinea grass were planted in the channels @ 2 slips per hill at a spacing of 60 cm x 30 cm. Seeds of fodder cowpea were sown @ 2 seeds per hole at a spacing of 30 cm x 15 cm in between the rows of fodder grasses as per the treatments. In 1:1 row ratio, 1 row of fodder cowpea was sown in the interspaces of fodder grasses. In 1:2 and 1:3 row ratios, 2 rows and 3 rows of fodder cowpea were sown in the interspaces respectively. Harvest of both grasses and fodder cowpea were done separately for recording the physiological aspects like dry matter production and leaf area index.

RESULTS AND DISCUSSION

The results on the effect of grass- fodder cowpea mixture and row ratio on dry matter production of grass and cowpea in open and shade in both the years are presented in Table 1. The results revealed that grasses and grass-legume row ratio had significant impact on dry matter production of grasses in open and shade. Significantly higher dry matter production was recorded by hybrid napier (G_1) in open and shade in both the years. The higher dry matter production of hybrid napier grass could be due to vigorous nature of the grass growth than guinea grass. The rapid establishment of the hybrid napier may have had a profound effect on the root system that enabled it to extract growth resources from the soil (Kechero, 2008). Similar result was also reported by Njarui *et al*. (2007) when hybrid napier/guinea grass was intercropped with seca/siratro. Fodder cowpea varieties had no significant effect on dry matter production of grasses. Among the row ratios, grasses intercropped with fodder cowpea at 1:3 row ratio recorded higher dry matter production in open and shade in both the years. This might be attributed to the transfer of more nitrogen to grasses from higher proportion of legumes which contributed to higher yields of grasses. This is in conformity with the findings of Alalade *et al.* (2013) in guinea grass-stylosanthes intercropping system.

The results on the dry matter production of fodder cowpea revealed that grasses, fodder cowpea varieties and row ratios had significant impact on dry matter production in open and shade in both the years. Fodder cowpea intercropped with guinea grass (G_2) recorded significantly higher dry matter production in open and shade in both the years. Lower dry matter production was recorded when cowpea was intercropped with napier, but when intercropped with guinea grass it had the highest dry matter production. Similar findings were reported by Njarui *et al*. (2007). Fodder cowpea cv. COFC-8 (V_1) recorded higher dry matter production (1.00 tha^{-1}) in first year and second year (0.89 tha^{-1}). Among the grass-legume row ratios, fodder cowpea intercropped with a row ratio of 1:2 (R_2) recorded higher dry matter production in open and shade in both the years. This may be attributed to the higher forage yield recorded by fodder cowpea when planted in double rows between grasses than in single or triple rows (Njarui *et al.*, 2007). Grass row ratio interaction was significant and g_2r_2 (fodder cowpea intercropped with guinea grass at 1:2 row ratio) recorded higher dry matter production (1.17 tha^{-1}) in open and it was significant only in open condition with a dry matter production of 1.06 tha^{-1}.

The results on the effect of grass, fodder cowpea varieties and row ratio on leaf area index of grasses and fodder cowpea in open and shade in both the years are presented in Table 2. The results revealed that grasses and row ratio had significant impact on leaf area index of grasses in open and shade. Significantly higher leaf area index was recorded by hybrid napier (G_1) in open condition and shade in both the years. The broad leaves of hybrid napier grass and higher tiller production resulted in a higher leaf area index compared to guinea grass. This is in conformity to the findings of Njarui *et al.* (2007) in hybrid napier. Grasses intercropped with fodder cowpea at 1:3 row ratio recorded higher leaf area index of grasses in open and shade. Tiller number of grasses was higher when intercropped with legumes in triple rows compared to single or double rows. Intercropping of grasses with legumes at more proportion transferred more nitrogen to grasses which results in more tiller number and hence leaf area index (Sima *et al*., 2010; Albayrak and Ekiz, 2005; Berdahl *et al*., 2001; Sleugh *et al*., 2000). This is in line with the findings of Alalade *et al.* (2013) in stylosanthes-guinea grass mixture. Grass row ratio interaction was significant in grass in open and shade. Hybrid napier intercropped with fodder cowpea at 1:3 row ratio recorded higher leaf area index in open and shade.

It was also observed that the treatments had no significant effect on leaf area index of fodder cowpea.

Table 1
Dry Matter Production (t ha^{-1} year^{-1}) of Grass Fodder Cowpea Mixtures as Influenced by Row Ratio

Treatments	*Grass*				*Cowpea*			
	Open		*Shade*		*Open*		*Shade*	
	I Year	*II Year*	*I Year*	*II Year*	*I Year*	*II Year*	*I Year*	*II Year*
Grasses (G)								
G_1-Hybrid napier	97.72	97.65	70.37	70.27	0.91	0.82	0.66	0.67
G_2-Guinea grass	69.00	68.89	54.11	53.96	1.04	0.92	0.74	0.75
SEM (±)	0.024	0.027	0.020	0.006	0.002	0.002	0.002	0.003
CD	0.050	0.055	0.042	0.011	0.005	0.005	0.004	0.006
Fodder cowpea varieties (V)								
V_1 - COFC-8	83.36	83.27	62.24	62.13	1.00	0.89	0.72	0.72
V_2 - UPC-622	83.35	83.26			0.95	0.85		
V_2 UPC-618			62.25	62.10			0.68	0.70
SEM (±)	0.024	0.027	0.020	0.006	0.002	0.002	0.002	0.003
CD	NS	NS	NS	NS	0.005	0.005	0.004	0.006
Grass-legume row ratio (R)								
R_1 - (1:1)	81.89	81.79	61.02	60.89	0.84	0.75	0.61	0.60
R_2 - (1:2)	83.79	83.72	62.59	62.46	1.15	1.04	0.86	0.86
R_3 - (1:3)	84.38	84.31	63.12	63.00	0.94	0.82	0.65	0.66
SEM (±)	0.030	0.033	0.025	0.007	0.003	0.003	0.002	0.003
CD	0.061	0.067	0.051	0.014	0.007	0.006	0.005	0.008
Interaction effect (GXV)								
g_1v_1	97.70	97.66	70.36	70.27	0.93	0.84	0.68	0.67
g_1v_2	97.73	97.63	70.38	70.27	0.88	0.78	0.64	0.65
g_2v_1	69.00	68.87	54.11	53.98	1.06	0.93	0.76	0.77
g_2v_2	68.99	68.90	54.12	53.94	1.02	0.90	0.73	0.73
SEM (±)	0.024	0.027	0.020	0.006	0.002	0.002	0.002	0.003
CD	NS	NS	NS	NS	NS	NS	NS	NS
Interaction effect (GXR)								
g_1r_1	96.48	96.35	69.34	69.24	0.76	0.68	0.55	0.55
g_1r_2	98.08	98.01	70.70	70.59	1.13	1.02	0.82	0.83
g_1r_3	98.59	98.59	71.07	70.99	0.83	0.74	0.60	0.61
g_2r_1	67.31	67.23	52.69	52.55	0.92	0.81	0.66	0.64
g_2r_2	69.51	69.42	52.48	54.32	1.17	1.06	0.89	0.90
g_2r_3	70.18	70.02	55.17	55.01	1.05	0.89	0.69	0.71
SEM (±)	0.061	0.067	0.051	0.014	0.007	0.006	0.005	0.008
CD	NS	NS	NS	NS	0.010	0.009	0.007	NS
Interaction effect (VXR)								
v_1r_1	81.91	81.82	61.01	60.92	0.86	0.75	0.60	0.58
v_1r_2	83.78	83.73	62.58	62.48	1.20	1.07	0.89	0.90
v_1r_3	84.37	84.25	63.12	62.98	0.94	0.82	0.66	0.66
v_2r_1	81.87	81.75	61.03	60.86	0.83	0.73	0.60	0.60
v_2r_2	83.81	83.69	62.60	62.44	1.10	1.00	0.83	0.82
v_2r_3	84.40	84.35	63.12	63.02	0.93	0.79	0.62	0.65
SEM (±)	0.061	0.067	0.051	0.014	0.007	0.006	0.005	0.008
CD	NS	NS	NS	NS	NS	NS	NS	NS
Interaction effect (GXVXR)								
$g_1v_1r_1$	96.51	96.40	69.34	69.27	0.78	0.69	0.55	0.54
$g_1v_1r_2$	98.05	98.04	70.68	70.61	1.74	1.06	0.86	0.86
$g_1v_1r_3$	98.56	98.55	71.06	70.94	0.85	0.75	0.61	0.59
$g_1v_2r_1$	96.45	96.30	69.35	69.21	0.75	0.66	0.53	0.55
$g_1v_2r_2$	98.11	97.98	70.72	70.57	1.09	0.96	0.79	0.80
$g_1v_2r_3$	98.63	98.62	71.07	71.04	0.80	0.71	0.57	0.61
$g_2v_1r_1$	67.32	67.24	52.68	52.58	0.93	0.82	0.65	0.63
$g_2v_1r_2$	69.50	69.43	54.48	54.34	1.23	1.08	0.92	0.95
$g_2v_1r_3$	70.18	69.95	55.18	55.02	1.03	0.90	0.71	0.72
$g_2v_2r_1$	67.30	67.21	52.71	52.52	0.90	0.80	0.67	0.65
$g_2v_2r_2$	69.51	69.40	54.47	54.3	1.11	1.04	0.86	0.85
$g_2v_2r_3$	70.17	70.09	55.17	55.00	0.17	0.87	0.67	0.69
SEM (±)	0.042	0.046	0.035	0.010	0.005	0.004	0.003	0.005
CD	NS	NS	NS	NS	NS	NS	NS	NS

Table 2
Leaf Area Index of Grass–fodder Cowpea Mixtures as Influenced by Row Ratio

Treatments	*Grass*				*Cowpea*			
	Open		*Shade*		*Open*		*Shade*	
	I Year	*II Year*	*I Year*	*II Year*	*I Year*	*II Year*	*I Year*	*II Year*
Grasses (G)								
G_1- Hybrid Napier	6.81	6.79	6.79	6.77	2.01	2.01	1.99	1.98
G_2-Guinea grass	4.72	4.70	4.70	4.73	2.02	2.00	2.01	1.95
SEM (±)	0.004	0.005	0.001	0.004	0.005	0.004	0.005	0.004
CD	0.008	0.011	0.003	0.008	NS	NS	NS	NS
Fodder cowpea varieties (V)								
V_1 - COFC-8	5.77	5.75	5.77	5.76	2.20	2.01	2.01	1.94
V_2 - UPC-622	5.76	5.75			2.01	2.00		
V_2 - UPC-618			5.77	5.75			2.00	1.99
SEM (±)	0.004	0.005	0.001	0.004	0.005	0.004	0.005	0.004
CD	NS	NS	NS	NS	NS	NS	NS	NS
Grass-legume row ratio (R)								
R_1 - (1:1)	5.32	5.30	5.32	5.31	2.01	1.99	1.99	1.99
R_2 - (1:2)	5.94	5.93	5.95	5.93	2.01	2.00	2.02	2.01
R_3 - (1:3)	6.04	6.01	6.03	6.01	2.03	2.01	2.00	1.99
SEM (±)	0.005	0.006	0.002	0.005	0.006	0.005	0.007	0.005
CD	0.009	0.013	0.004	0.010	NS	NS	NS	NS
Interaction effect (GXV)								
g_1v_1	6.81	6.79	6.79	6.77	2.01	2.01	2.01	1.98
g_1v_2	6.81	6.80	6.79	6.78	2.00	1.99	1.99	1.98
g_2v_1	4.73	4.71	4.75	4.73	2.03	2.10	2.02	1.89
g_2v_2	4.72	4.70	4.74	4.73	2.02	2.01	2.01	2.00
SEM (±)	0.004	0.005	0.001	0.004	0.005	0.004	0.005	0.004
CD	NS	NS	NS	NS	NS	NS	NS	NS
Interaction effect (GXR)								
g_1r_1	6.39	6.38	6.38	6.37	1.99	1.98	1.99	1.97
g_1r_2	6.99	6.97	6.98	6.95	2.03	2.02	2.02	2.00
g_1r_3	7.06	7.03	7.02	7.01	2.01	2.00	2.00	1.98
g_2r_1	4.24	4.23	4.27	4.25	2.02	2.00	2.01	1.79
g_2r_2	4.90	4.88	4.92	4.91	2.03	2.02	2.03	2.02
g_2r_3	5.03	5.01	5.05	5.03	2.02	2.01	2.01	2.00
SEM (±)	0.005	0.006	0.002	0.005	0.006	0.005	0.007	0.005
CD	0.014	0.018	0.005	0.014	NS	NS	NS	NS
Interaction effect (VXR)								
v_1r_1	5.34	5.32	5.34	5.32	2.02	2.00	2.01	1.82
v_1r_2	5.94	5.92	5.94	5.92	2.04	2.03	2.03	2.01
v_1r_3	6.03	6.01	6.04	6.01	2.01	2.00	2.00	1.98
v_2r_1	5.29	5.29	5.31	5.30	2.00	1.98	1.99	1.98
v_2r_2	5.95	5.94	5.96	5.94	2.03	2.01	2.02	2.01
v_2r_3	6.05	6.02	6.04	6.02	2.02	2.00	2.01	1.99
SEM (±)	0.005	0.006	0.002	0.005	0.006	0.005	0.007	0.005
CD	NS	NS	NS	NS	NS	NS	NS	NS
Interaction effect (GXVXR)								
$g_1v_1r_1$	6.42	6.40	6.40	6.38	2.01	2.00	2.01	1.98
$g_1v_1r_2$	6.98	6.95	6.96	6.93	2.03	2.03	2.02	2.01
$g_1v_1r_3$	7.05	7.02	7.02	7.00	2.00	2.00	1.99	1.97
$g_1v_2r_1$	6.36	6.36	6.36	6.36	1.98	1.97	1.97	1.97
$g_1v_2r_2$	7.01	7.00	7.00	6.97	2.02	2.01	2.01	2.00
$g_1v_2r_3$	7.07	7.04	7.03	7.02	2.01	2.00	2.00	1.99
$g_2v_1r_1$	4.26	4.24	4.28	4.26	2.02	2.01	2.01	1.66
$g_2v_1r_2$	4.90	4.89	4.92	4.91	2.04	2.03	2.03	2.02
$g_2v_1r_3$	5.02	5.00	5.05	5.02	2.02	2.01	2.01	2.00
$g_2v_2r_1$	4.22	4.22	4.26	4.25	2.01	2.00	2.00	2.00
$g_2v_2r_2$	4.90	4.88	4.92	4.91	2.03	2.02	2.03	2.02
$g_2v_2r_3$	5.04	5.01	5.06	5.03	2.02	2.01	2.01	2.00
SEM (±)	0.007	0.009	0.003	0.007	0.009	0.006	0.009	0.006
CD	NS	NS	NS	NS	NS	NS	NS	NS

CONCLUSION

Based on the results it can be concluded that hybrid napier cv. suguna intercropped with fodder cowpea varieties COFC-8 and UPC-622 in open condition and with COFC-8 and UPC-618 in partial shade (30 percent) in the row ratio of 1:3 is the best for obtaining maximum dry matter production and leaf area index which contributed for obtaining maximum yield and net returns during the dry months in the dairy homesteads of Kerala.

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