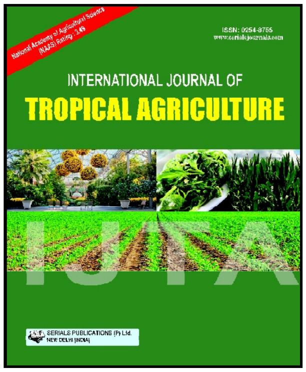


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# Root studies of grass fodder cowpea mixtures as influenced by Row ratio

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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 root volume, root dry weight and root shoot ratio 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 and 1:2 with respect to the root volume and root dry weight of fodder crops in open and shaded experiments.Significantly higher root volume was recorded by hybrid napier ($G_1$) in open in both the years (678.66 $cm^3$ and 675.33 $cm^3$). Grass legume row ratio of 1:3 ($R_3$) recorded significantly higher root volume in open (445.75 $cm^3$ and 443.00 $cm^3$) which was on par with 1:2 ($R_2$) (445.25$cm^3$ and 442.50 $cm^3$) in both the years. Root volume and root dry weight were significantly higher in hybrid napier cv. Suguna in open and shade. Root volume and root dry weight were on par at 1:2 and 1:3 grass fodder cowpea row ratio.

***Key words:*** Guinea grass, Hybrid napier grass, root dry weight, root volume, row ratio.

## INTRODUCTION

Inclusion of fodder legumes in the fodder production system is the most efficient way to increase herbage production and quality as discussed by Mwangi *et al* [7] and the most economic feed supplement than the commercial concentrates as discussed by Njarui *et al.* [9]. Legume in fodder grass production system would not only provide a nitrogen source to promote grass growth but enhance the quality of feed. Legumes benefit grasses by contributing Nitrogen is contributed to the soil through atmospheric fixation, decay of dead root nodules or mineralization of shed leaves. The inclusion of a legume in Napier grass based diet has shown to improve animal performance in terms of milk production because of their high nutrient contents as discussed by Muinga *et al.* [6]. Thus combining grasses with legumes capable of improving protein content of the overall ration clearly has nutritional and financial potential.

Fodder cowpea (*Vignaunguiculata* L. Walp) is a legume inherently more tolerant to drought than other fodder legumes as discussed by Fatokun *et al.* [2] and considered as a crop capable of improving sustainability of livestock production through its contribution in improving seasonal fodder productivity and nutritive value. It has shade tolerance, quick growth and rapid ground covering ability. Summer cowpea irrigated according to a schedule based on IW/CPE ratio of 0.8 recorded the maximum dry matter production as discussed by Subramaniam *et al.* [15] and plant height by Kher *et al.* [4]. Fodder cowpea varieties CO-5, COFC-8, UPC - 618, UPC-622, BundelLobia-1 are high yielding and suitable for cultivation in Kerala as discussed elsewhere [12, 5, 3]. It is the most widely cultivated fodder legume in areas where rainfall is scanty and soils are relatively infertile. Most households that keep livestock raise fodder cowpea as an intercrop with other crops and fodder cowpea forms an integral component of crop livestock farming system as discussed by Singh and Tarawali [14].

Development of compatible persistent grass legume mixtures could alleviate acute seasonal livestock feed deficiency in dry seasons. 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. Perennial fodder grasses like hybrid napier and guineagrass are widely accepted by the dairy farmers all over Kerala as these grasses are well adapted to tropical conditions with potential for higher yields per unit area and shade tolerance. Grass legume mixtures yielded as much or more drymatter than grasses alone and showed better seasonal distribution of forage production than grasses alone and were superiorto grasses in forage quality during summer as discussed by Posler *et al.* [11]. The dairy homesteads of Kerala are mostly experiencing light stress of varying intensities. Poor adaptation of many improved fodder crops/ varieties in shade environment limits fodder production in homesteads and shade affects persistence, yield and quality of understory forages. Evaporative demand is greatly reduced in the shaded environment and soil water availability for the pasture will be maintained at a higher level than in open through the combined effect of less evaporation from soil and lower transpiration rates of the pasture. *V. unguiculata*grows well in shade andis useful as a component crop of silvipastoral systems as discussed by Bazil [1].

## 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 root studies of fodder grasses and fodder cowpea in open and in partial shade. The investigation was conducted as two separate experiments, one in open and another in shaded situation (25-35 per cent shade), *i.e.*, under natural shade. Shade intensity was measured using quantum sensor. Photosynthetic photon flux density (PPFD), μ mol $m^{-2}$ $s^{-1}$) was measured by a quantum sensor (LI-COR model, L1-250). The global radiation was measured by using pyranometer and radiometer. For standardization, all readings were taken in the middle of tree shade at 1 m height on a clear day within 45 minutes of solar noon. The relative shading for the PAR ranges were determined as SPAR= 100 × (1-PAR/PARo) where o corresponds to the solar radiation measured in open.

Light intensities under open and shade were determined for each month. Light intensities in PAR was obtained by integration over the respective wavelength ranges of the solar radiation spectra as discussed by Oren-shamir *et al.* [10]. 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 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 × 60 cm. Slips of guinea grass were planted in the channels @ 2 slips per hill at a spacing of 60 cm × 30 cm. Seeds of fodder cowpea were sown @ 2 seeds per hole at a spacing of 30 cm × 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. For fodder grasses growth observations of ten randomly selected BN hybrid and guinea grass plants in the net plot were recorded prior to harvest. Average of the observations were worked out and presented. In case of fodder cowpea observations were taken from five randomly selected plants in the net plot at the time of harvest and their average was worked out and presented. Root volume was recorded by water displacement method as stated below. The roots of sample plants were washed free of adhering soil with a low jet of water. The roots are immersed in 1000 ml measuring cylinder containing water and the rise in water level was recorded. Displacement in volume of water is taken as a measure of the volume of the root measured. Ratio of weight of dried roots and shoots of five plants were calculated and the mean value arrived. The roots of sample plants were washed free of adhering soil with a low jet of water. The roots were oven dried and dry weight was recorded.

## RESULTS AND DISCUSSION

The results showed that grasses and row ratio had significant impact on root volume of grasses in open. Significantly higher root volume was recorded by hybrid napier ($G_1$) in open in both the years (678.66 cm$^3$ and 675.33 cm$^3$) (Table 1).The root biomass of hybrid napier was significantly higher than that of guinea grass (Fig.1). Grass legume row ratio of 1:3 ($R_3$) recorded significantly higher root volume in open (445.75 cm$^3$ and 443.00 cm$^3$) which was on par with 1:2 ($R_2$) (445.25 cm$^3$ and 442.50 cm$^3$) in both the years. This is likely to be the main cause of the greater success of grasses, compared with legumes, in terms of growth and competitive ability as discussed by Schmid and Kazda [13]. The interaction effects were not significant. In partial shade, significantly higher root volume (319.50 cm$^3$ and 318.00cm$^3$) was recorded by hybrid napier ($G_1$) in first and second year. Fodder cowpea varieties had no significant effect onroot volume of grasses.Grass legume row ratio of 1:3 ($R_3$) recorded significantly higher root volume in open (265.5 cm$^3$ and 264.75.00 cm$^3$) which was on par with 1:2 ($R_2$) (265.50 cm$^3$ and 264.50 cm$^3$) in both the years. The interaction effects were not significant. The results revealed that treatments and their interaction had no significant effect on root volume of fodder cowpea.

The results revealed that grasses and row ratio had significant impact on root dry weight of fodder grasses. Significantly higher root dry weight (76.73 g and 75.80 g) was registered by hybrid napier in open

**Table 1**
**Root volume of grass and cowpea as influenced by grass, cowpea varieties and row ratios of grass-legume mixture, cm$^3$**

| | *Grass* | | | | *Cowpea* | | | |
|---|---|---|---|---|---|---|---|---|
| | *Open* | | *Shade* | | *Open* | | *Shade* | |
| *Treatments* | *I Year* | *II Year* | *I Year* | *II Year* | *I Year* | *II Year* | *I Year* | *II Year* |
| *Grasses (G)* | | | | | | | | |
| $G_1$-Hybrid napier | 678.66 | 675.33 | 319.50 | 318.00 | 3.88 | 3.73 | 2.30 | 2.18 |
| $G_2$-Guinea grass | 210.00 | 208.33 | 210.00 | 209.83 | 3.86 | 3.68 | 2.28 | 2.18 |
| SEm (±) | 0.379 | 0.388 | 0.164 | 0.150 | 0.002 | 0.003 | 0.002 | 0.003 |
| CD (0.05) | 0.786 | 0.805 | 0.340 | 0.312 | NS | NS | NS | NS |
| *Fodder cowpea varieties (V)* | | | | | | | | |
| $V_1$ - COFC-8 | 444.16 | 442.16 | 265.00 | 263.83 | 3.88 | 3.73 | 2.28 | 2.18 |
| $V_2$ - UPC-622 | 444.50 | 441.50 | | | 3.86 | 3.86 | | |
| $V_2$ UPC-618 | | | 264.5 | 264.00 | | | 2.26 | 2.23 |
| SEm (±) | 0.379 | 0.388 | 0.164 | 0.150 | 0.002 | 0.003 | 0.002 | 0.003 |
| CD (0.05) | NS | NS | NS | NS | NS | NS | NS | NS |
| *Grass-legume row ratio (R)* | | | | | | | | |
| $R_1$ - (1:1) | 442.00 | 440.00 | 263.25 | 262.5 | 3.85 | 3.72 | 2.27 | 2.15 |
| $R_2$ - (1:2) | 445.25 | 442.50 | 265.5 | 264.5 | 3.90 | 3.72 | 2.30 | 2.20 |
| $R_3$ - (1:3) | 445.75 | 443.00 | 265.5 | 264.75 | 3.87 | 3.67 | 2.30 | 2.21 |
| SEm (±) | 0.464 | 0.475 | 0.200 | 0.184 | 0.003 | 0.004 | 0.003 | 0.004 |
| CD (0.05) | 0.963 | 0.985 | 0.416 | 0.382 | NS | NS | NS | NS |

**$R_1$-1:1** **$R_2$-1:2** **$R_3$-1:3**

**Fig 1. Roots of Hybrid napier cv. Suguna**

in first and second year respectively (Table 2). Grass legume row ratio of 1:3 ($R_3$) recorded significantly higher root dry weight which was on par with 1:2 ($R_2$) in open in both the years. The interaction effects were not significant. The results revealed that grasses and row ratio had significant impact on root dry

**Table 2**
**Root-shoot ratio of grass and cowpea as influenced by grass, cowpea varieties and row ratios of grass-legume mixture**

| | *Grass* | | | | *Cowpea* | | | |
|---|---|---|---|---|---|---|---|---|
| | *Open* | | *Shade* | | *Open* | | *Shade* | |
| *Treatments* | *I Year* | *II Year* | *I Year* | *II Year* | *I Year* | *II Year* | *I Year* | *II Year* |
| *Grasses (G)* | | | | | | | | |
| $G_1$-Hybrid napier | 0.91 | 0.90 | 0.89 | 0.89 | 0.09 | 0.09 | 0.08 | 0.07 |
| $G_2$-Guinea grass | 0.87 | 0.87 | 0.88 | 0.89 | 0.08 | 0.08 | 0.07 | 0.07 |
| SEm (±) | 0.002 | 0.002 | 0.001 | 0.001 | 0.001 | 0.002 | 0.002 | 0.003 |
| CD (0.05) | 0.006 | 0.002 | NS | NS | NS | NS | NS | NS |
| *Fodder cowpea varieties (V)* | | | | | | | | |
| $V_1$ - COFC-8 | 0.89 | 0.89 | 0.90 | 0.89 | 0.09 | 0.09 | 0.07 | 0.07 |
| $V_2$ - UPC-622 | 0.89 | 0.90 | | | 0.009 | 0.08 | | |
| $V_2$ UPC-618 | | | 0.89 | 0.90 | | | 0.07 | 0.08 |
| SEm (±) | 0.002 | 0.002 | 0.001 | 0.001 | 0.001 | 0.002 | 0.002 | 0.003 |
| CD (0.05) | NS | NS | NS | NS | NS | NS | NS | NS |
| *Grass-legume row ratio (R)* | | | | | | | | |
| $R_1$ - (1:1) | 0.89 | 0.89 | 0.89 | 0.89 | 0.10 | 0.08 | 0.08 | 0.07 |
| $R_2$ - (1:2) | 0.90 | 0.89 | 0.90 | 0.90 | 0.09 | 0.09 | 0.07 | 0.08 |
| $R_3$ - (1:3) | 0.89 | 0.90 | 0.90 | 0.89 | 0.08 | 0.08 | 0.07 | 0.08 |
| SEm (±) | 0.003 | 0.003 | 0.002 | 0.002 | 0.002 | 0.003 | 0.003 | 0.004 |
| CD (0.05) | NS | NS | NS | NS | NS | NS | NS | NS |

weight of fodder grasses in partial shade. Significantly higher root dry weight (55.45 g and 54.45 g) was registered by hybrid napier in open in first and second year respectively. Grass legume row ratio of 1:3 ($R_3$) recorded significantly higher root dry weight which was on par with 1:2 ($R_2$) in open in both the years. The interaction effects were not significant. The results revealed that treatments and their interaction had no significant effect on root dry weight of fodder cowpea.

The results revealed that grasses varied significantly with respect to root: shoot ratio in open condition. Hybrid napier ($G_1$) recorded significantly higher root: shoot ratio (0.91) in first year and second year (0.90) (Table 3). Grasses had high tillering ability, and an extensive rooting system that enabled it to take up nutrients and water from the subsoil of legumes and thereby overcome periods of low nutrient and water available in the topsoil as discussed by Neukirchen *et al.* [8]. So the root biomass increased faster than above ground biomass which leads to higher root: shoot ratio in grass. Similar findings were reported by Xu *et al.* [16] in switch grass and sainfoin intercropping system. The other treatments and the interaction had no significant impact on root: shoot ratio of fodder grasses in open. In shade, the

**Table 3**
**Root dry weight of grass and cowpea as influenced by grass, cowpea varieties and row ratios of grass-legume mixture, g plant$^{-1}$**

| | *Grass* | | | | *Cowpea* | | | |
|---|---|---|---|---|---|---|---|---|
| | *Open* | | *Shade* | | *Open* | | *Shade* | |
| *Treatments* | *I Year* | *II Year* | *I Year* | *II Year* | *I Year* | *II Year* | *I Year* | *II Year* |
| *Grasses (G)* | | | | | | | | |
| $G_1$-Hybrid napier | 76.73 | 75.80 | 55.45 | 54.45 | 0.32 | 0.31 | 0.25 | 0.24 |
| $G_2$-Guinea grass | 58.74 | 58.30 | 49.20 | 48.20 | 0.31 | 0.31 | 0.24 | 0.25 |
| SEm (±) | 0.206 | 0.384 | 0.163 | 0.225 | 0.002 | 0.003 | 0.005 | 0.003 |
| CD (0.05) | 0.427 | 0.797 | 0.339 | 0.466 | NS | NS | NS | NS |
| *Fodder cowpea varieties (V)* | | | | | | | | |
| $V_1$ - COFC-8 | 67.77 | 67.05 | 52.33 | 51.32 | 0.33 | 0.32 | 0.25 | 0.25 |
| $V_2$ - UPC-622 | 67.70 | 67.04 | | | 0.31 | 0.31 | | |
| $V_2$ UPC-618 | | | 52.32 | 51.33 | | | 0.24 | 0.24 |
| SEm (±) | 0.206 | 0.384 | 0.163 | 0.225 | 0.002 | 0.003 | 0.005 | 0.003 |
| CD (0.05) | NS | NS | NS | NS | NS | NS | NS | NS |
| *Grass-legume row ratio (R)* | | | | | | | | |
| $R_1$ - (1:1) | 66.23 | 65.26 | 51.00 | 49.91 | 0.31 | 0.31 | 0.24 | 0.23 |
| $R_2$ - (1:2) | 68.33 | 67.92 | 52.94 | 52.02 | 0.32 | 0.32 | 0.25 | 0.24 |
| $R_3$ - (1:3) | 68.65 | 67.97 | 53.03 | 53.05 | 0.32 | 0.31 | 0.25 | 0.24 |
| SEm (±) | 0.252 | 0.470 | 0.200 | 0.275 | 0.002 | 0.004 | 0.006 | 0.004 |
| CD (0.05) | 0.523 | 0.976 | 0.415 | 0.571 | NS | NS | NS | NS |

treatments and interactions were non-significant with respect to root : shoot ratio of grasses. The root : shoot ratio of fodder cowpea was also not influenced by fodder grasses, fodder cowpea varieties and row ratio in open and shade.

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