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Response of intercropping of Browntop Millet (*Urochloa ramosa* L.) + Pulses on yield and economics under rainfed conditions of Coimbatore

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Abstract

Browntop millet (*Urochloa ramosa* L.) is a minor millet drought-tolerant crop that can be grown in marginalized land with rainfed conditions. Legumes and oilseeds could be intercropped and help to frame resources more efficiently and increase their productivity. The experiment was conducted in a field in 2025-26 of late *Kharif* at the south farm of Karunya institute of technology and science, Coimbatore under rainfed conditions. The experiment was set up in Randomized Complete Block Design of three replication and nine treatments namely browntop millet with green gram, horse gram, groundnut and sesame in the ratio of 4:2 and 6:2 rows and sole cropping. Higher plant height (92.64 cm), total dry matter was produced (5373.28 kg/ha), grain yield (933.64 kg/ha) and straw yield (2010.69 kg/ha) were registered on sole browntop millet. The intercropping systems of browntop millet + green gram (4:2) resulted higher grain equivalent yield (GEY) of (915 kg/ha).

Keywords: Browntop millet, dryland farming, grain equivalent yield, land equivalent ratio, legume intercropping, resource use efficiency

1. Introduction

Browntop millet (*Urochloa ramosa* L), formerly referred to as *Brachiaria ramosa*, is a crop from the *Poaceae* family believed to have originated in Southeast Asia. The crop has historically been cultivated in India, primarily in Karnataka, Andhra Pradesh and Tamil Nadu. Its characteristics of being climate-resilient and short duration crop (75-90 days), low input requirements and ability to thrive on marginal lands, qualify it as a climate-resilient small millet. It can tolerate climatic conditions with limited precipitation (400-600 mm), drought, poor soil fertility, mildly acidic to neutral soils.

Although the area of cultivation for browntop millet is minor compared to that of major cereals, its importance is beginning to rise due to the increased interest in; therefore, nutri-cereals and continue to provide producers with sustainable agricultural practices. The crop produces small, high nutrient density grains (i.e. dietary fiber, iron, calcium and essential amino acids). Under rainfed conditions, the average grain yield of browntop millet is approximately 800-1200 kg/ha depending on the variety and agronomic practice used by the farmer. Many small and marginal farmers especially in dryland areas suffer from a wide range of production constraints such as erratic rainfall, declining soil fertility and lack of economic resources. Farmers who are dependent upon monocrop systems cannot meet their economic and food security needs.

Therefore, intercropping has been recognized as an alternative production system. Intercropping is a system of growing two or more crops simultaneously on the same land with a specific spatial arrangement. The basic concept of intercropping is the optimal use of natural resources such as light, water, nutrients and space. The intercropping of browntop millet and pulse crops provides examples of the complementary interactions that can occur between the component crops in an intercropping system. Browntop millet utilizes the available soil nutrients and solar energy to their fullest potential; while the legumes (green gram, black gram, horse gram) help add nitrogen to the soil and improve soil productivity.

The difference in the structure of the canopy and the distribution of the roots from each of the crops maximizes the use of light and the use of resources, thus increasing the efficiency of land use compared to monoculture systems.

The aim of this research is to measure growth and yield characteristics as well as productivity of browntop millet grown alone and in combinations with various legume crops by measuring the same with respect to each of the legume crops. The research will help determine which intercropping arrangement provides the best and most profitable cropping system possible.

2. Materials and Methods

The experiment was conducted at South farm of Karunya Institute of Technology and Sciences (Coimbatore), Tamil Nadu. The research was carried out under rainfed condition during late *Kharif* season of 2025-26. During the crop growth period (17th September to 30th December), total rainfall received was 689 mm. Soil texture was silty loam with pH 8.36, EC 0.17 dS/m, organic carbon (1.05%), High in available nitrogen (442.1 kg/ha), Low in available phosphorus (9.6 kg/ha) and medium in available potassium (320 kg/ha). Randomized Complete Block Design was followed with three replications and nine treatments viz., T₁ - Brown top millet + Green gram (4:2) T₂ - Brown top millet + Horse gram (4:2) T₃ - Brown top millet + Green gram (6:2) T₄ - Brown top millet + Horse gram (6:2) T₅ - Brown top millet + Groundnut (4:2) T₆ - Brown top millet + Sesame (4:2) T₇ - Brown top millet + Groundnut (6:2) T₈ - Brown top millet + Sesame (6:2) T₉ - Brown top millet (sole crop). All the recommended package of practices were adopted during the period of experimentation. The parameters of cropping systems such as land equivalent ratio (LER), crop equivalent yield (CEY) and relative crowding coefficient (RCC) were calculated for the intercropping system. The results of the experiment were compiled and statistically analysed using Fisher's method of analysis of variance as discussed by (Gomez, K. A., & Gomez, A. A. 1984) [1]. Critical difference values at 5% of significance were applied for testing the significance of treatment effects.

The yield of different crops was converted into a single unit using Grain Equivalent Yield (GEY) for meaningful comparison. For reliable evaluation, Lal and Ray (1976) suggested expressing yields in terms of economic returns by converting them into equivalent yield based on market price.

$$GEY = \frac{\sum Y_i \times P_i}{P(b)}$$

Where,

ΣY_i - Yield of intercrop (kg/ha)

PI - Price of intercrop (₹/ha)

P(b) - Price of base crop (₹/ha)

The amount of land required to practice sole cropping in order to generate the yield in the intercrop mixture is referred to as the land equivalent ratio (LER). In actuality, it is the ratio land area required to produce the pure stand of crop species equivalent quantity of the produce as an intercropping at the same level of management. The formula used to determine the LER is,

$$LER = LER_a + LER_b$$

$$LER_a = \frac{Y_{ab}}{Y_{aa}}$$

$$LER_b = \frac{Y_{ba}}{Y_{bb}}$$

Where,

L_a - Land equivalent ratio of main crop

L_b - Land equivalent ratio of intercrop

Y_{ab} = Yield of "a" crop grown in association with "b" crop

Y_{aa} = Yield of "a" crop grown in pure stand

Y_{ba} = Yield of "b" crop grown in pure stand

Y_{bb} = Yield of "b" crop grown in association with "a" crop

Relative Crowding Coefficient concept (RCC) was proposed by (De Wit, C. T. 1960) [2]. It shows whether a crop which is grown on a mixed population has produced, more or less yield than what would have been forecasted in the pure stand.

$$RCC = \frac{Y_{ab} \times Z_{ba}}{(Y_{aa} - Y_{ab}) \times Z_{ab}}$$

Y_{ab} - Yield of 'a' intercropped with 'b'

Y_{aa} - Pure crop yield of 'a'

Z_{ab} - Sown proportion of 'a' in combination with 'b'

Z_{ba} - Sown proportion of 'b' in combination with 'a'

3. Results and Discussion

3.1 Effect of intercropping system on growth attributes of browntop millet

The growth attributes of browntop millet was influenced by various intercropping systems. In most instances, the growth parameters of browntop millet, under intercropping systems than under sole cropping were relatively lower as the component crops competed over resources like nutrients, moisture, light and space. The results in Table - 1 shows that at harvest stage, sole browntop millet recorded higher plant height (92.64 cm) followed by browntop millet + green gram in 4:2 row ratio (87.75 cm). This may be explained by the fact that the relatively higher plant height in such combinations could be due to the favourable complementation of cereal and legume crops leading to the enhancement of availability of nutrients Lithourgidis, A. S., *et al.* (2011) [3]. Growing browntop millet + sesame in 6:2 row ratio recorded lower plant height (55.97cm) which might be due to greater competition for nutrients and space under wider intercropping arrangements (Kotadiya, P. B., *et al.* 2023) [4], (Gowthami, D., *et al.* 2025) [5].

Total dry matter accumulation was also influenced by different intercropping systems. At harvest stage, sole browntop millet recorded the higher total dry matter accumulation (5373 kg/ha) followed by browntop millet + green gram (4945 kg/ha). The lower production of dry matter was observed in browntop millet + sesame at (6:2) row ratio (2600 kg/ha). This better performance of sole browntop millet crop is because of the absence of interspecific competition is because of allowing the crop to utilize available resources more efficiently. But still, certain intercropping combinations, particularly browntop millet with pulses in 4:2 row proportion, demonstrated similar development because of complimentary benefits like improved resource utilisation and nitrogen fixation Bezbaruah, (R., *et al.* 2025) [6].

3.2. Effect of intercropping system on yield of browntop millet

Millet-pulse intercropping is suggested to have a more positive effect on overall productivity by increasing its efficiency in

resources and improving the soil fertility (Derebe, B., *et al.* 2021) [7]. The data in Table 1 indicates that the higher grain yield and straw yield (2011 kg/ha) was recorded by sole crop of browntop millet (934 kg/ha) and it was followed by browntop millet + green gram at 4:2 row ratio (915 kg/ha). These treatments had a relatively better grain yield because of the complementary effect between cereal and legume crops, which increased nutrient availability increased resource use efficiency. The lower grain yield was obtained in browntop millet + sesame at 6:2 row ratio (636 kg/ha) straw yield (1278 kg/ha) and this may be due to the fact that the component crops develop more competition with other crops in the growth resources like nutrients, moisture and light. Similar results was observed in the intercropping system of finger millet-legume where the yield of the predominant crop was lower when taking into consideration some planting ratios because of more interspecific competition Bitew, (Bitew, Y., *et al.* (2019) [8].

3.3. Browntop millet & pulse intercropping association

The browntop millet equivalent yield (GEY) was significantly affected due to intercropping and the maximum was recorded with browntop millet + green gram at row ratio (4:2). The higher browntop millet equivalent yield with green gram intercropping (1353 kg/ha) performed better because of high additional yield of the grain and the market price of the green gram. Browntop millet + sesame 4:2 row ratio (1206 kg/ha) and browntop millet + groundnut 4:2 row ratio (1190 kg/ha) were also the ones that had higher equivalent yield meaning better productivity and economic benefits than other intercropping systems. This lower browntop millet equivalent yield may be due to lower in browntop millet + horse gram 6:2 row ratio which could have created intense competition with resources including nutrients, moisture, light and space among browntop millet and intercrops. The values of Land Equivalent Ratio (LER) of various intercropping systems showed the advantage compared to the raising browntop millet as sole crop. Most of the intercropping system reported LER values larger than unity, which indicates the effective utilization of the available land resources. Browntop millet + green gram had the higher LER of 1.31 followed by browntop millet + horse gram at row ratio 4:2 (1.24), which suggests that component crops in the treatments are more complementary and productive. The lower LER was observed in browntop millet + groundnut at row ratio 6:2 and in browntop millet + sesame at row ratio 6:2 (0.93) which implied a relatively low level of resource utilization (Yu, Y., *et al.* 2015)

[9].

The values of Relative Crowding Coefficient (RCC) were also evidence of the benefit of intercropping systems. The intercropping treatments were all found to have higher RCC values than unity which means that component crops in the intercropping system have a high yield performance. The maximum RCC value (1.67) was observed in browntop millet + green gram 4:2 row ratio followed by browntop millet + horse gram 4:2 row ratio (1.51), which implies that the competitive advantage and the more suitable compatibility of component crops could be observed. In browntop millet + groundnut 6:2 row ratio, the lower value of RCC (0.79) was obtained. This increased values of RCC determine that intercropping systems are better than sole cropping in the interaction of crops and yield benefit.

3.4. Effect of intercropping system on economics of Browntop millet

The economics of the browntop millet with various intercropping systems were examined according to net return and the benefit cost ratio (B:C) ratio. The results in Table -1 revealed that there were evident differences in profitability between the treatments. The higher net return of ₹39,573/ha was obtained in the treatment of browntop millet + green gram 4:2 row ratio at the B:C ratio of 2.18. Increased profitability of this system could be explained by the combined yield benefit of both base and intercrop as well as higher market price of green gram (₹65/kg). Inclusion of legume intercrop like green gram also could have been beneficial to the resource use as well as overall productivity of the system. Browntop millet + sesame 4:2 row ratio had the next best economic performance with a net return of ₹32,983/ha and a B: C ratio of 2.03. Equally, browntop millet + groundnut 4:2 row ratio generated net return of ₹31,772/ha with a ratio of B:C of 1.98. Increased profitability of these systems might be explained by the comparatively high market price of sesame (₹75/kg) and groundnut (₹65/kg) which led to higher gross returns. The sole farming of browntop millet reaped a net income of ₹23,280/ha with a B:C proportion of 1.82. The relatively low profitability of the sole crop implies that intercropping systems had greater economic values over monocropping which may be attributed to efficient utilization of resources and complementary interaction between component crops, particularly with the inclusion of legumes (Maitra, S., *et al.* 2021) [10].

Table 1: Effect of intercropping on growth, yield and economics of Browntop millet

Treatments	Plant height of Brown top millet (cm)	Total dry matter accumulation (kg/ha)	Grain yield (kg/ha)	Straw yield (kg/ha)	Net income (Rs/ha)	B:C ratio	LER	RCC	Grain Equivalent Yield (kg/ha)
T ₁ - Brown top millet + Green gram (4:2)	87.75	4945	915	1849	39573	2.18	1.31	1.67	1353
T ₂ - Brown top millet + Horse gram (4:2)	86.48	4604	857	1718	25959	1.79	1.24	1.51	1085
T ₃ - Brown top millet + Green gram (6:2)	80.21	3579	728	1418	23970	1.70	1.03	1.04	1078
T ₄ - Brown top millet + Horse gram (6:2)	78.43	3242	712	1364	13910	1.40	1.02	1.01	892
T ₅ - Brown top millet + Groundnut (4:2)	85.96	4261	800	1591	31772	1.98	1.18	1.3	1190
T ₆ - Brown top millet + Sesame (4:2)	80.93	3922	782	1477	32983	2.03	1.17	1.28	1206
T ₇ - Brown top millet + Groundnut (6:2)	77.72	2914	675	1306	18214	1.52	0.93	0.79	988
T ₈ - Brown top millet + Sesame (6:2)	77.01	2600	636	1278	16234	1.46	0.93	0.83	953
T ₉ - Brown top millet (sole crop)	92.64	5373	934	2011	23280	1.82	-	-	934
Mean	83.01	3937.75	782.05	1556.97	-	-	-	-	1075.28
SE(d)	4.17	357.08	69.10	80.72	-	-	-	-	98.90
CD (5%)	8.83	756.98	146.49	171.11	-	-	-	-	209.66

4. Conclusion

Based on the results of the present investigation, it is summarized that sole browntop millet recorded significantly higher growth parameters, yield attributes, grain yield and straw yield compared to all the intercropping systems due to the absence of interspecific competition. However, among the different intercropping systems, browntop millet + green gram 4:2 row ratio recorded comparatively higher growth, yield attributes and economic returns. Among the different row proportions, the 4:2 row proportion performed better than the 6:2 row proportion with all the intercrops. Therefore, it can be concluded that browntop millet + green gram 4:2 row ratio intercropping system is a suitable and economically viable cropping system under rainfed conditions of Coimbatore.

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Conflict of Interest

The authors state that they do not have any conflict of interest regarding this manuscript. The final copy of the manuscript is reviewed and approved by all the authors, and they do not disagree with its contents.

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