LR-5399
[1-7]

RESEARCH ARTICLE

Legume Research- An International Journal

Econometric Analysis and Intercropping Nutri-Cereals with Legumes (Urad Bean, Arhar) on Climate Resilience in North Eastern Zone of Tamil Nadu

K. Sathiya[1], A. Nirmalakumari[2], S.R. Shri Rangasami[3], C. Vanitha[4], C. Harisudan[5], P. Ayyadurai[6], R. Karthikeyan[7], R. Ajaykumar[8]

10.18805/LR-5399

ABSTRACT

Background: Nutri cereal - Legume intercrop systems are particularly beneficial in North Eastern Zone of Tamil Nadu, which are characterized by high levels of malnutrition, resource limitation and rainfall variability. These conditions are further exacerbated by climate-related risks and uncertainty. Apart from enhancing water and nutrient use efficiency, improving soil fertility and financial gains, Millet-legume intercrop systems have become a better bet for increased food and nutrition security in marginal farming communities.

Methods: A study conducted during the year of 2022 to 2024 at the Center of Excellence in Millet, Tamil Nadu Agricultural University, Athiyandal, Tamil Nadu. The study evaluated various intercropping ratios of finger millet with black gram and red gram across seven treatments, focusing on productivity, compatibility and economic viability.

Result: Results indicated that intercropping finger millet with black gram at a 4:1 ratio produced taller plants (92.7 cm), more protective tillers (5.7 per plant), extensive root systems (19.9 cm), and higher chlorophyll content (3.67 mg/g). This combination resulted in the highest equivalent grain yield (2895 kg/ha) and demonstrated a favourable benefit-to-cost ratio (2.84), highlighting its potential for improving profitability and soil fertility. Conversely, intercropping with red gram yielded lower finger millet yields and less favourable economic returns, underscoring the importance of selecting suitable intercrops to maximize agricultural productivity and sustainability.

Key words: Aggresivity, Blackgram, Finger millet, Intercropping system, Redgram, Relative production efficiency.

INTRODUCTION

Leguminous crops such as blackgram (*Vigna mungo* L.) and redgram (*Cajanus cajan* L.) are valuable in intercropping due to their structural features like root nodules for nitrogen fixation, complementary root systems and diverse canopy architectures. These features enhance crop yields and contribute to ecological balance and long-term soil health. Nutri cereals (Finger millet) relatively open canopy structure allows sunlight to reach lower levels, making it compatible with taller or more shade-tolerant companion crops (Anit Kumar *et al*., 2019). Its fibrous root system efficiently utilizes water and nutrients without aggressive competition facilitating coexistence with other crops. This characteristic supports its efficient resource use, making it an ideal parameter for intercropping systems.

In the context of contemporary agriculture, intercropping is essential for promoting sustainability and resilience against climate variability. Modern farming faces challenges such as soil degradation, water scarcity, pest resistance, and market volatility. Intercropping addresses these challenges by optimizing resource use, boosting soil health, and decreasing reliance on chemical inputs. The strategic pairing of crops with different growth habits optimizes sunlight, water and nutrient utilization, thereby boosting overall productivity. Leguminous crops enhance soil fertility through nitrogen fixation, reducing the necessity

[1]Department of Agronomy, Oil Seed Research Station, Tindivanam-604 001, Tamil Nadu, India.
[2]Department of Plant Breeding and Genetics, Centre of Excellence in Millets, Athiyandal-606 603, Thiruvannamalai Tamil Nadu, India.
[3]Department of Forage Crops, Tamil Nadu Agricultural University, Coimbatore-641 003, Tamil Nadu, India.
[4]Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore-641 003, Tamil Nadu, India.
[5]Department of Agronomy, Regional Research Station, Vridhachalam-606 001, Tamil Nadu, India.
[6]Department of Agronomy, Centre of Excellence in Millets, Athiyandal, Thiruvannamalai-606 603, Tamil Nadu, India.
[7]Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore-641 003, Tamil Nadu, India.
[8]Department of Agronomy, Vanavarayar Institute of Agriculture, Pollachi-642 103, Tamil Nadu, India.

Corresponding Author: S.R. Shri Rangasami, Department of Forage Crops, Tamil Nadu Agricultural University, Coimbatore-641 003, Tamil Nadu, India. Email: shrirangasamisr@tnau.ac.in

How to cite this article: Sathiya, K., Nirmalakumari, A., Shri Rangasami, S.R., Vanitha, C., Harisudan, C., Ayyadurai, P., Karthikeyan, R. and Ajaykumar, R. (2024). Econometric Analysis and Intercropping Nutri-Cereals with Legumes (Urad Bean, Arhar) on Climate Resilience in North Eastern Zone of Tamil Nadu. Legume Research. doi: 10.18805/LR-5399.

Submitted: 12-08-2024 **Accepted:** 10-09-2024 **Online**: 07-10-2024

for synthetic fertilizers. This diverse planting system naturally manages pests and diseases, reducing pesticide requirements. Economically, intercropping provides farmers with diversified income streams, lowering risks associated with market fluctuations and crop failures. Studies by Bhagat *et al*. (2019) and Shalini *et al*. (2019) demonstrate that intercropping achieves higher land equivalent ratios (LER) and favorable benefit-cost ratios. By optimizing solar energy, moisture and nutrient use, intercropping ensures greater productivity and stability, as evidenced by Das and Sudhisri (2010). Moreover, contour cultivation with blackgram and redgram reduces runoff, soil erosion and nutrient loss, thereby enhancing soil fertility.

Based on these advantages, this study aims to evaluate the productivity, economic benefits and soil health impacts of intercropping finger millet with blackgram and redgram, providing a comprehensive approach to addressing modern agricultural challenges.

MATERIALS AND METHODS

The main field experiment took place at the Centre of Excellence in Millets, Tamil Nadu Agricultural University, Athiyandal, during the year of 2022 to 2024. The general climatic conditions of the experimental location had an average maximum temperature of 36°C and a average minimum temperature of 18°C, with relative humidity ranging from 67% to 86%. The initial soil analysis revealed a soil pH of 7.2, low levels of available nitrogen (135.0 kg/ha), high levels of available phosphorus (30.4 kg/ha) and medium levels of potassium (147.0 kg/ha).

The field was thoroughly prepared using tractor-drawn disc plough, cultivator and rotavator. Details of the finger millet, blackgram and redgram varieties are provided in Table 1. In accordance with the treatment, different ratios of intercrops were sown in rows with a spacing of 30×10 cm. The treatment details are T_1- Sole finger millet in row planting, T_2- Finger millet with blackgram 3:1 ratio, T_3- Finger millet with blackgram 3:2 ratio, T_4- Finger millet with blackgram 4:1 ratio, T_5- Finger millet with blackgram 4:2 ratio, T_6- Finger millet with Redgram 6: 1 ratio, T_7- Finger millet with Redgram 8:1 ratio.

A fertilizer dose of 60:30:30 kg N, P, K per hectare was applied. Phosphorus was entirely applied as basal, while graded levels of nitrogen and potassium fertilizers were administered in three equal split doses at the basal, tillering stage and finger initiation stage. Initial irrigation was performed immediately after sowing, followed by subsequent irrigations based on the available soil moisture. Two rounds of hand weeding were carried out at 20 and 40 days after sowing. The recommended package of practices for individual plots was adhered to for the remaining management practices.

Table 1: Varietal characters of finger millet, blackgram and redgram.

Characters	Finger millet	Blackgram	Redgram
Variety	Co 15	VBN 8	VBN 3
Parentage	CO 11 × PR 202	Vamban 3 × BG 04-008	Vamban 1 × Gulbarga
Duration	120 - 125 days	65 -70	100-105
Season	Both rainfed and irrigated	Both rainfed and irrigated	Both rainfed and irrigated
Grain Yield (kg/ha)	2950	871	1530

Growth parameters like plant height were measured in different growth stages like maximum tillering, panicle initiation, flowering and harvest. Similarly, leaf area index (LAI), were measured during flowering stage. Yield parameters like number of productive tillers, finger length, 1000 seed weight, grain yield and straw yield were recorded. Additionally, several competitive functions such as land equivalent ratio (LER) aggressivity, relative production efficiency (RCC) and competitive ratio (CR) were computed using respective formulas. After completing the experiment, the collected data underwent statistical analysis following the guidelines outlined by Gomez and Gomez (2010). This analysis aimed to assess the effects of different treatments on the growth and yield characteristics of finger millet. Significant differences between treatments were determined using a probability level of five percent (0.05) to ensure robust interpretation of the results.

Econometric analysis

The research design incorporated both correlation analysis and multiple linear regressions to examine the interplay between plant parameters and pod yield. Correlation analysis was employed to assess the degree of association between different variables (Ravi *et al*., 2023). Specifically, the Pearson Correlation Coefficient (PCC) was used to quantify the strength and direction of these relationships. The PCC is widely recognized and establishes a link between expected and observed values, enhancing our understanding of their concordance. The correlation coefficient formula enables the calculation of the connection between two variables and the resulting number describes the accuracy of the expected and actual values. In this article, correlation was employed to identify the relations among grain yield, plant height, number of branches plant^{-1}, number of pods plant^{-1}, DMP, number of seeds pod^{-1}, test weight (g) (Ajaykumar *et al*., 2022). It was computed using the equation:

$$r_{xy} = \frac{S_{xy}}{S_x S_y} = \frac{\sum(\bar{x}_i - x)(\bar{y}_i - y)}{\sqrt{(\sum(x_i - \bar{x})^2)(\sum(y_i - \bar{y})^2)}}$$

Where,

r_{xy}= Coefficient of the linear relationship between the variables x and y.

S_x and S_y= Sample standard deviation.

S_{xy} = Sample covariance.

x_i and y_i= Values of x and y variables in the sample of the population.

x and y= Sample mean (Ajaykumar *et al*., 2023).

Another econometric tool used in this study was regression which examines the relationship between a dependent variable and a collection of independent variables (Pillai *et al.*, 2010). Regression was estimated by

$$Y_i = \alpha + \beta X_i + u_i$$

Where,

y_i= Dependent variable (grain yield).

x_i= Independent variable (plant height, number of branches plant^{-1}, number of pods plant^{-1}, number of seeds pod^{-1},1000 seed weight); is the slope coefficient of the respective independent variable.

α= Constant or intercept term and is the error term.

This formal mode of regression equation could be rewritten as:

Grain yield=

$$\alpha + \beta_1 \text{ Plant height (cm)} + \beta_2 \text{ No. of branches plant}^{-1} + \beta_3 \text{ DMP Kg /ha} + \beta_4 \text{ No. of pods plant}^{-1} + \beta_5 \text{ No. of seeds pod}^{-1} + \beta_6 \text{ 1000 seed weight (g)} + u_i$$

RESULTS AND DISCUSSION

Effect of finger millet + blackgram / redgram intercropping on growth attributes

The growth parameters of finger millet were evaluated under various intercropping treatments with blackgram and redgram, revealing notable differences in plant development (Table 2). Sole finger millet exhibited robust growth with a plant height of 92.7 cm, 5.7 productive tillers (Yadav and Yadav, 2018), a root length of 11.9 cm and the highest total dry matter per plant at 41.8 g. When intercropped with blackgram, especially at a 4:1 ratio, finger millet maintained its height (92.7 cm) and number of tillers (5.7) but showed a significant increase in root length (19.9 cm), which likely contributed to efficient nutrient and water uptake (Patil and Sheelavantar, 2006), resulting in a total dry matter of 40.5 g per plant (Kumar *et al.*, 2018). Other black gram ratios (3:1, 3:2, and 4:2) also enhanced root length (ranging from 15.7 to 16.2 cm) and supported reasonable dry matter production (38.5 to 40.3 g per plant), albeit slightly lower than the 4:1 ratio. Conversely, intercropping with redgram (6:1 and 8:1 ratios) led to a substantial reduction in plant height (down to 84.8 cm), fewer productive tillers (as low as 3.8) and minimal increases in root length (up to 12.6 cm). These treatments also resulted in the lowest total dry matter values (35.5 to 36.9 g per plant), indicating that redgram intercropping poses more competitive stress on finger millet (Bitew *et al.*, 2021). Overall, intercropping with blackgram, particularly in a 4:1 ratio, proves more beneficial for optimizing growth, while intercropping with redgram tends to hinder finger millet development. These findings suggest that choosing compatible crop pairings and ratios is crucial for enhancing finger millet productivity in intercropping systems (Sharma and Mittra, 2004).

Effect of finger millet + blackgram / redgram on yield attributes and yield

The yield parameters and overall yield of finger millet were assessed under different intercropping treatments with

Table 2: Growth parameters of finger millet as influenced by finger millet + blackgram, redgram intercropping.

Treatments	Plant height harvest (cm)	Number of productive tillers	Root length (cm)	Total dry matter (g/plant)
Sole finger millet in row planting	92.7	5.7	11.9	41.8
Finger millet with blackgram 3: 1 ratio	92.7	5.5	16.2	40.3
Finger millet with blackgram 3: 2 ratio	92.3	5.2	15.7	39.9
Finger millet with blackgram 4: 1 ratio	92.7	5.7	19.9	40.5
Finger millet with blackgram 4: 2 ratio	90.3	5.4	15.9	38.5
Finger millet with redgram 6: 1 ratio	84.8	4.9	12.6	36.9
Finger millet with redgram 8: 1 ratio	85.7	3.8	12	35.5
S.Ed.(±)	1.6	0.17	0.39	0.99
CD (p=0.05)	3.49	0.38	0.82	2.17

Table 3: Yield parameters and yield of finger millet as influenced by finger millet + blackgram, redgram intercropping.

Treatments	Finger length(cm)	Grain yield (kg/ha)	Straw yield (kg/ha)	Gross income (Rs./ha)	FMEY (kg/ha)	B: C ratio
Sole finger millet in row planting	8.7	2582	3591	2582	85875	2.63
Finger millet with blackgram 3:1 ratio	9.0	2072	2892	2843	84335	2.75
Finger millet with blackgram 3:2 ratio	9.2	1903	2583	2837	82167	2.66
Finger millet with blackgram 4:1 ratio	9.6	2199	2987	2895	87028	2.84
Finger millet with blackgram 4:2 ratio	9.4	1955	2679	2786	81845	2.66
Finger millet with redgram 6:1 ratio	8.6	1819	2478	2206	68265	2.24
Finger millet with redgram 8:1 ratio	7.3	1863	2558	2229	69328	2.28
S.Ed.(±)	0.34	33.8	88.02	-	-	-
CD (p=0.05)	0.76	73.65	191.78	-	-	-

Table 4: Growth, yield parameters and yield of inter crop blackgram influenced by finger millet intercropping.

Treatments	Plant height at harvest (cm)	Number of branches	No. of pods/plant	No. of seeds/pod	1000 (g) seed weight	Seed yield (kg/ha)
Finger millet with blackgram 3:1 ratio	28.5	6.5	10.9	7.7	3.8	412.7
Finger millet with blackgram 3:2 ratio	29.6	5.7	12.2	8.2	3.9	515.3
Finger millet with blackgram 4:1 ratio	28.8	6.5	11.2	8.2	4.1	373.7
Finger millet with blackgram 4:2 ratio	30.4	6.1	13.2	7.6	4.0	450.7

Table 5: Growth, yield parameters and yield of inter crop redgram influenced by finger millet intercropping.

Treatments	Plant height at harvest (cm)	Number of branches	Number of pods/plant	No. of seeds/pod	100 seed weight (g)	Seed yield (Kg/ha)
Finger millet with redgram 6:1 ratio	180.3	5.5	118.3	3.7	10.3	206.0
Finger millet with redgram 8:1 ratio	190.7	5.6	110.3	3.5	10.1	194.7

blackgram and redgram, indicating significant variations in performance and economic returns (Table 3). The sole finger millet crop, cultivated in row planting, exhibited a grain yield of 2582 kg/ha, a straw yield of 3591 kg/ha and a finger millet equivalent yield (FMEY) of 2582 kg/ha. This high yields are attributed to the absence of competition for resources, leading to optimized growth and productivity (Nirmal, 2021).

When intercropped with blackgram, the finger millet demonstrated varying responses based on the intercropping ratios. At a 4:1 ratio, finger millet with blackgram achieved the highest grain yield among intercropped treatments (2199 kg/ha), straw yield (2987 kg/ha) and FMEY (2895 kg/ha). The enhanced performance can be attributed to the efficient utilization of resources and reduced competition due to the optimized intercropping ratio, which allowed for better light interception and nutrient use (Ahmed *et al*., 2019). In contrast, intercropping at a 3:1 ratio, while yielding a lower grain yield (2072 kg/ha), still achieved a notable FMEY (2843 kg/ha) demonstrating the effectiveness of this combination in maximizing resource use efficiency (Patel *et al*., 2020). The 3:2 and 4:2 ratios also provided substantial benefits, though slightly lower with grain yields of 1903 kg/ha and 1955 kg/ha, respectively, and similar economic returns, indicating that these ratios still offer good resource optimization and economic viability (Rao and Rajesh, 2020).

Intercropping with redgram, particularly at higher ratios (6:1 and 8:1), resulted in diminished grain yields (1819 kg/ha and 1863 kg/ha, respectively), lower straw yields (2478 kg/ha and 2558 kg/ha) and reduced FMEY (2206 kg/ha and 2229 kg/ha). The reduced yields are likely due to the increased competition for resources such as light and nutrients, as redgram's growth habit and root structure might not complement finger millet as effectively as blackgram (Kumar *et al*., 2018). Intercropping finger millet with blackgram, especially at a 4:1 ratio, proves to be the more beneficial in terms of yield, resource use efficiency and economic returns. Conversely, redgram intercropping, while still beneficial in certain respects, does not perform as well as blackgram combinations, necessitating further research and optimization for better integration into finger millet-based systems (Sharma *et al*., 2017).

Effect of finger millet + blackgram intercropping on yield of blackgram

The impact of different finger millet-blackgram intercropping ratios on blackgram growth and yield (Table 4). The highest seed yield (515.3 kg/ha) was observed in the 3:2 ratio, demonstrating that this combination provides an optimal balance of light, nutrients and water, minimizing competition and enhancing growth parameters such as the number of pods per plant (12.2) and seeds per pod (8.2). It's mainly due to the more number of blackgram rows compare to other treatmetns. Conversely, the 4:1 ratio resulted in the lowest seed yield (373.7 kg/ha), likely due to lesser number of rows allocated in this treatment, despite having a significant number of branches (6.5). This finding aligns with Patel *et al.* (2020), who reported that appropriate intercropping ratios maximize yield by balancing resource use.

Effect of finger millet + redgram intercropping on yield of Redgram

The influence of different finger millet intercropping ratios on the growth and yield parameters of redgram (Table 5). The 8:1 ratio exhibited taller plants (190.7 cm) compared to the 6:1 ratio (180.3 cm), suggesting that higher densities of finger millet may provide some structural support to redgram plants. However, despite the taller height, the 8:1 ratio resulted in a slightly lower number of pods per plant (110.3) and pod yield (194.7 kg/ha) compared to the 6:1 ratio (118.3 pods/plant and 206.0 kg/ha, respectively). This could be attributed to increased competition for light and nutrients in the denser intercropping ratio, which aligns with findings by Kumar *et al*. (2018) on legume-cereal intercropping. Optimal ratios in intercropping systems are crucial for balancing competition and cooperation between crops to maximize overall productivity, as supported by Rangasami *et al.* (2024). Adjusting planting densities and ratios can enhance resource use efficiency and yield stability in mixed cropping systems, contributing to sustainable agricultural practices and food security.

Table 6: Land equivalent ratio, area time equivalent ratio and aggressively of finger millet intercropping system.

Treatments	Land equivalent ratio	Relative production efficiency	Aggresivity	Competitive ratio
Finger millet with blackgram 3:1 ratio	1.25	10.1	-0.18	0.60
Finger millet with blackgram 3:2 ratio	1.30	9.9	-0.03	0.88
Finger millet with blackgram 4:1 ratio	1.26	12.1	-0.19	0.52
Finger millet with blackgram 4:2 ratio	1.25	7.9	-0.06	0.77
Finger millet with Redgram 6:1 ratio	0.89	-14.6	-0.07	0.64
Finger millet with Redgram 8:1 ratio	0.90	-13.7	-0.08	0.52

Table 7: Correlation between yield attributes and yield (Pooled data).

	Grain yield (Kg/ha)	Plant height (Cm)	No. of branches Plant^{-1}	DMP (Kg/ha)	No. of pods plant^{-1}	No. of seeds pod^{-1}	1000 Seed weight(g)
Grain yield (kg/ha)	1						
Plant height (cm)	0.83	1					
No. of branches plant^{-1}	0.55	0.44	1				
DMP (kg/ha)	0.92	0.79	0.50	1			
No. of pods plant^{-1}	0.89	0.79	0.49	0.89	1		
No. of seeds pod^{-1}	0.89	0.81	0.47	0.86	0.85	1	
1000 seed weight (g)	0.81	0.68	0.57	0.82	0.81	0.80	1

Table 8: Multiple linear regression estimates the blackgram yield.

Variables	Coefficients	Std. Error	t-stat	P-value	Significance
Intercept	-101.07	8.16	-12.39	0.00	**
Plant height (cm)	1.11	0.69	1.61	0.15	NS
No. of branches plant^{-1}	0.83	0.12	6.92	0.00	**
DMP (kg/ha)	1.28	0.78	1.64	0.14	NS
No. of pods plant^{-1}	2.08	0.92	2.26	0.03	*
No. of seeds pod^{-1}	2.54	1.12	2.27	0.03	*
1000 seed weight (g)	0.07	0.03	2.33	0.03	*

Note: *significant at 5% level of significance; **significant at 1% level of significance.

NS- Non Significant.

Effect of finger millet intercropping on economics of intercropping

The economic performance of various intercropping systems involving finger millet with blackgram and redgram. The finger millet with blackgram at a 4:1 ratio achieved the highest gross income (Rs. 87,028/ha) and benefit-cost ratio (B:C ratio) of 2.84, indicating superior profitability among the treatments. This outcome can be attributed to the optimal balance between plant population and resource utilization, which aligns with findings from studies by Bhagat *et al*. (2019) showing that strategic intercropping can enhance economic returns by maximizing yields and minimizing costs. In contrast, intercropping with redgram, particularly at the 6:1 and 8:1 ratios, resulted in lower gross incomes (Rs. 68,265/ha and Rs. 69,328/ha, respectively) and B:C ratios (2.24 and 2.28), reflecting less favorable economic outcomes due to potential over-competition for resources, as supported by Kumar *et al*. (2018). The results underscore the importance of selecting appropriate crop combinations and ratios to optimize economic benefits, echoing the principles of diversified farming systems that enhance productivity and profitability through efficient resource use.

Effect of intercropping system on competitive functions

The Table 6 presents results from an intercropping study involving finger millet combined with blackgram or redgram at various ratios, focusing on four key metrics: land equivalent ratio (LER), relative production efficiency, aggressivity and competitive ratio. The land equivalent ratio measures the efficiency of land use in intercropping compared to sole cropping, with values above 1 indicating more efficient land utilization. For instance, finger millet with blackgram at a 3:1 ratio achieves an LER of 1.25 suggesting a 25% increase in land efficiency. Relative production efficiency reflects the productivity gain or loss from intercropping compared to sole cropping, where positive values indicate increased productivity. Notably, finger millet paired with blackgram at different ratios consistently shows positive efficiency gains (*e.g*., 10.1 at 3:1 ratio), whereas combinations with redgram result in negative efficiency values (*e.g*., -14.6 at 6:1 ratio), indicating decreased productivity. Aggressivity, indicating the competitive ability of crops within intercropping systems, reveals that finger millet generally exhibits lower aggressivity compared to both blackgram and redgram. Competitive ratios further highlight the dominance of one crop over another, with values closer to 1 indicating balanced competition. The findings underscore the potential benefits of intercropping with finger millet and blackgram for enhancing land use efficiency and productivity, contrasting with less favorable outcomes when redgram is intercropped, suggesting varying crop interactions and competitive dynamics influenced by crop ratios and combinations (Li *et al*., 2021).

Econometric Analysis

The correlation results were represented in Table 7. Its results revealed that all the variables included in the model were positively significant at one percent level of significance and these signs emphasize all the variables would attribute to the grain yield of the black gram. The correlation coefficients of the grain yield with plant height (0.83), number of branches plant^{-1} (0.55), DMP (0.92), number of pods plant^{-1} (0.89), number of seeds pod^{-1} (0.89), 1000 seed weight (0.81) show that all the attributes were positively related and that strongly proves when there is an increment in these variables, there would be an increase in the yield of the blackgram. So, all these variables are included as the independent variables in the multiple linear regression model (Ajaykumar *et al*., 2024). The multiple linear regressions were estimated to measure the relationship and the change in magnitude of the grain yield due to the other prescribed parameters (Table 5). The multiple linear regression equation could be written as:

Grain yield=

-101.07 + 1.11 Plant height + 0.83 No. of branches plant^{-1} + 1.28 DMP Kg ha^{-1} + 2.08 No. of pods plant^{-1} + 2.54 No. of seeds pod^{-1} + 0.07 Test weight(g)

The R^2 (0.81) depicts a good sign of model fit which implies that 81 percent of the grain yield was caused by the independent variables. All the variables except plant height except plant height and DMP were found statistically significant (Table 8). The slope coefficient of the number of branches has shown that when there is one percent increase number of branches, there would be a significant increase in the grain yield by 0.83 percent, other variables being held constant. Likewise, when there is a one percent increase in the variables *viz*., number of pods plant^{-1}, number of seeds pod^{-1} and test weight, there would an increase in the yield by 0.19, 2.08, 2.54 and 0.07 percent respectively (Ravi *et al*., 2024). There is strong econometric evidence that the number of branches and pod weight have a significant impact on the grain production of black gram.

CONCLUSION

Both the years of experiments concluded that Intercropping finger millet with blackgram in a 4:1 ratio resulted in a notable increase in equivalent yield, reaching 2895 kg/ha. This enhancement can be attributed to the synergistic interactions between the two crops, which likely optimized nutrient uptake and resource utilization. Additionally, the presence of blackgram provided a protective environment for the finger millet plants, contributing to their overall vigor and productivity. From an economic perspective, this intercropping system demonstrated a higher benefit-to-cost (B:C) ratio of 2.84. Conversely, finger millet intercropped with redgram yielded lower B:C ratios, primarily due to the reduced finger millet yields in these systems.

Conflict of Interest

All authors declare that they have no conflicts of interest.

REFERENCES

Ahmed, R., Azeem, M., and Chaudhry, S. (2019). Impact of intercropping on resource use efficiency and economic returns in cereal-legume systems. Agricultural Sciences. 10(2): 126-134.

Ajaykumar, R., Harishankar, K. and Rangasami, S.S. (2024). Growth performance, quantitative analysis and economics of broiler chickens as influenced by herbal dietary additives as alternative growth booster. Indian Journal of Animal Research. 58(7): 1139-1147. doi: 10.18805/IJAR.B-5326.

Ajaykumar, R., Harishankar, K., Chandrasekaran, P., Navinkumar, C., Sekar, S., Sabarinathan, C. and Reddy, B.K.K. (2023). Principle component analysis (PCA) and character interrelationship of irrigated blackgram [*Vigna mungo (L.) Hepper]* influenced by liquid organic biostimulants in Western Zone of Tamil Nadu. Legume Research-An International Journal. 46(3): 346-352. doi: 10.18805/LR-5038.

Ajaykumar, R., Selvakumar, S., Harishankar, K. and Sivasabari, K. (2022). Effect of pink-pigmented facultative methylotrophs, PGRs and nutrients on growth, yield and economics of irrigated blackgram [*Vigna mungo (L.) Hepper*]. Legume Research-An International Journal. 45(1): 52-57. doi: 10.18805/LR-4689.

Anit Kumar, H.S. Chawla, A.S. Jeena and Rohit. (2019). Morphological characterization of finger millet germplasm collected from Uttrakhand hills for qualitative traits. International Journal of Current Microbiology and Applied Sciences. 8(9): 2105-2109.

Bhagat, S., Rathore, V.S., Singh, R., Yadav, M. and Patil, N.S. (2019). Land equivalent ratio and economic analysis of intercropping systems. Journal of Crop Science. 59(4): 183-194.

Bitew, Y., Alemayehu, G., Adgo, E. and Assefa, A. (2021). Competition production efficiency and yield stability of finger millet and legume additive design intercropping. Renewable Agriculture and Food Systems. 36(1): 108-119.

Das, A., and Sudhisri, S. (2010). Resource utilization and productivity in intercropping systems. Indian Journal of Agricultural Sciences. 80(8): 695-700.

Gomez, K.A., Gomez, A.A. (2010). Statistical Procedures for Agricultural Research. Edn.2, John Wiley and Sons, New York.

Kumar, V., Mishra, J.P., and Kumar, R. (2018). Comparative performance of intercropping systems with millets in semi-arid regions. Journal of Agroecology. 22(3): 321-334.

Li, L., Tilman, D., Lambers, H., Zhang, F.S. (2021). Intercropping strategies that enhance agricultural productivity and sustainability.Nature Reviews Earth and Environment. 2(1): 25-39.

Nirmal, R. (2021). Evaluating monoculture and intercropping practices for finger millet productivity in varying agroclimatic conditions. Indian Journal of Crop Science. 11(1): 95-104.

Patel, J.S., Mehta, P.B. and Panchal, V.R. (2020). Optimizing legume and cereal intercropping ratios for sustainable agriculture. International Journal of Farming and Allied Sciences. 9(6): 441-450.

Patil, S.L. and M.N. Sheelavantar. (2006). Effect of moisture conservation practices, organic sources and nitrogen evels on yield, water use and root development of *rabi* sorghum (*Sorghum bicolor* (L.) Moench) in semi-arid tropics of India. Agricultural Water Management. 83(1-2): 1-10.

Pillai, M. A., Anandhi, K. and Selvi, B. (2010). Stability analysis of yield in blackgram. Legume Research-An International Journal. 33(2): 152-153.

Rangasami, S.R., Rani, S., Sivakumar, S.D., and Ganesan, K.N. (2024). Forage nutritive quality, yield and quantitative analysis of leguminous fodder cowpea-maize system as influenced by integrated nutrient management in southern zone of India. Legume Research. 47: 565-573 doi: 10.18805/LR-5277.

Rao, S. M. and Rajesh, M. (2020). Resource use efficiency and economic analysis of finger millet-legume intercropping systems. Agricultural Economics Research Review. 33(1): 45-58.

Ravi, S., Rangasami, S. R., Vadivel, N., Ajaykumar, R. and Harishankar, K. (2023). Growth and yield attributes of groundnut (*Arachis hypogaea* L.) as influenced by tank-mix application of early post emergence herbicides. Legume Research. 46(8): 1080-1086. doi: 10.18805/LR-5147.

Ravi, S., Rangasami, S.S., Ajaykumar, R., Sathiya, K. and Rajanbabu, V. (2024). Quantitative variables analysis, growth and yield of groundnut (*Arachis hypogaea* L.) under different weed management practices. Legume Research-An International Journal. 47: 1396-1403. doi: 10.18805/LR-5326.

Shalini, V., Rajkumar, D., Madhu, K., Sanjana, R. and Pradeep, A. (2019). Comparative study on intercropping efficiency. Field Crops Research. 229: 45-53.

Sharma, A.R. and B.N. Mittra. (2004). Influence of intercrop on the growth and yield of finger millet (*Eleusine coracana*). Indian Journal of Agronomy. *49*(3): 202-206.

Sharma, N., Khurana, P., and Singh, D. (2017). Crop yield responses and economic feasibility of intercropping finger millet with legumes. International Journal of Agricultural Sustainability. 15(4): 403-412.

Yadav, S. P. and L.R.Yadav. (2018). Performance of finger millet (*Eleusine coracana* (L.) Gaertn.) under different intercropping systems. International Journal of Current Microbiology and Applied Sciences. *7*(9): 2730-2735.