Original Research Article

Performance of pearl millet and pulses based intercropping system under rainfed condition

ABSTRACT:

A field experiment was conducted during *rabi* season of (2022) at Karunya Institute of Technology and Sciences, Coimbatore to study the performance of different pearl millet-based intercropping with legumes under rainfed condition. Greengram (*Vigna radiata*), cowpea (*Vigna unguiculata*) and redgram (*Cajanus Cajan)* were sown as intercrops in replacement series of 4:1 and 6:1 row ratio. The result of the study indicated that intercropping of blackgram and redgram with pearl millet in 4:1 gave higher total grain yield (25503.0 kg/ha) and stover yield (4927.1 kg/ha) compared to the sole cropping of pearl millet under rainfed condition. Other intercropping indices like grain equivalent yield, land equivalent ratio, relative crowding coefficient, competition index and income equivalent ratio were calculated. Intercropping system of pearl millet + blackgram (4:1) recorded the higher net return (Rs/ha 81,621) and B:C ratio (2.42).

Key words: Intercropping, Yield, GEY, LER, RCC

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1.INTRODUCTION

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Growing of crops as a sole crop found to be risky under rain fed condition due to low and erratic rainfall, which ultimately results in low productivity. Under such condition in order to achieve higher productivity, intensification and diversification of crops is essential. A strategy for stabilizing production of rainfed crops through commonly recognized practice of intercropping of compatible crops is considered viable to overcome the situation. Intercropping is a system of growing more than one crop species on the same piece of land at the same time. The major objectives of intercropping are to produce an additional crop, to optimize the use of natural resources and to stabilize the yield of crops and to overcome the risk.

Pearl millet is an important crop grown for food and fodder for human and livestock population in dryland areas. Pearl millet cultivation is mostly confined to rainfed lands, poor and impoverished soils under semi-arid tropics of Africa and India. In semiarid tropics the crop is mostly grown as mono crop under rain fed conditions without use of fertilizer. Yet its yields are high and more reliable than other possible tropical dry cereal crops such as Sorghum and Maize. Growing of pearl millet as a sole crop under this situation is risky and uneconomical. Intercropping is the best solution that can increase the production and productivity by better utilization of available resources and thereby helps to minimize the risks and brings stability under rainfed conditions.

2.Materials and Methods:

A field experiment was carried out during the *rabi* season 2022 to study the pearl millet-based intercropping with legumes under rainfed condition at Karunya Institute of Technology and Sciences, Coimbatore district of Tamil Nadu using randomized block design with seven treatments. The intercropping system treatments are., T_1- sole crop of pearl millet, T_2- pearl millet + blackgram (4:1), T_3- pearl millet + blackgram (6:1), T_4- pearl millet + cowpea (4:1), T_5- pearl millet + cowpea (6:1), T_6- pearl millet + cowpea (6:1) and T_7- pearl millet + redgram (6:1). The treatments were replicated thrice and sown in replacement series. All intercrops *viz*., blackgram, cowpea, redgram were raised separately adjacent to the treatment plots and the yields were recorded to work out indices related to biological efficiency of the intercropping system. The varieties tested in this experiment were pearl millet (Co 10), blackgram (VBN 8), cowpea (VBN 3) and redgram (Co (rg) 7).

Lal and Ray (1976) [1] proposed economics of crop by converting grain/seed/ fodder in terms of gross return for valid comparison as grain equivalent yield (GEY). Pearl millet equivalent yield (PMGEY) of intercropping system was calculated by the formula

$$\text{GEY (kg ha}^{-1}) = \frac{\textit{Yield of intercrop (Yi)} \times \textit{price of intercrop (Pi)}}{\textit{price of base crop (Pp)}}$$

LER (Land Equivalent Ratio) was worked out by using the formula of Willey (1979) [2]. It is actually the proportionate land area required under pure stand of crop species to yield the same produce as obtained under an intercropping at the same management level.

$$\text{LER} = \frac{Yab}{Yaa} + \frac{Yba}{Ybb}$$

Where, Yab is the yield of "a" crop grown in association with "b" crop and Yba is the yield of "b" crop grown in association with "a" crop. Yaa and Ybb represent the yields of "a" and "b" crops grown in pure stand and Zab and Zba are the sown proportion of crop "a" and "b" in intercropping, respectively. The value of LER greater than unity (1.0) indicates the advantages of the intercropping system (Ofori and Stern, 1987) [3].

Relative crowding coefficient (RCC) indicates whether a crop, when grown in mixed population, has produced more or less yield than expected in pure stand. The value of RCC greater than unity (1.0) also indicates the advantages of the intercropping system.

$$\text{RCC} = \frac{Yab \times Zab}{(Yaa - Yab) \times Zab}$$

3.RESULTS AND DISCUSSION:

3.1. GROWTH AND YIELD OF PEARL MILLET BASED INTERCROPPING SYSTEM:

Growth attributes like plant height and dry matter production was significantly affected by intercropping. Plant height of pearl millet was found to be higher under the treatment T_2 - maize + blackgram at 4:1 ratio (189.66 cm at harvest) followed by pearl millet + redgram at 4:1 ratio (T_6) (185.46 cm at harvest) (Table 1). Among the various intercrops, pearl millet + redgram at 4:1 ratio (T_6) intercropping system produced higher dry matter production (6800 kg/ha). Similar results were also obtained by Sharmili *et al*. (2021) [4] in little millet based intercropping system with pulses.

Pearl millet sole crop registered the maximum grain yield and stover yield (2503.0 kg /ha and 4927.1 kg/ha) it was statistically on par with pearl millet + blackgram at 4:1 ratio (2485.3 kg/ha grain yield) and (4759.2 kg/ha respectively). (Table 1). The results are also in conformity with findings of Rawat (2017) [5].

3.2. EFFECT OF INTERCROPPING ON DIFFERENT COMPETITIVE INDICES

3.2.1. GRAIN EQUIVALENT YIELD:

The pearl millet grain equivalent yield (GEY) was estimated to compare various intercropping arrangements (Table 2). Among the intercropping system 4:1 row proportion of pearl millet + blackgram intercropping system produced the higher pearl millet grain equivalent yield (5467.7 kg/ha) and was closely followed by the 4:1 row proportion of pearl millet + redgram intercropping system. These were similar to the findings of Sharmili and Manoharan (2018) [6] in little millet based intercropping system and Kaushi and Sharma (2017) [7] in wheat intercropping system.

3.2.2. OTHER INTERCROPPING INDICES:

Among the intercropping systems, pearl millet + redgram 4:1 (1.23) intercropping system had the maximum land equivalent ratio, and it was closely followed by pearl millet + blackgram 4:1 (1.16). This increased value of LER was caused by improved intercrop yield, demonstrating the advantages of intercropping pearl millet in a 4:1 ratio. Similarly Sharmili *et al*., (2023) [4] reported significantly higher value of LER (1.46) little millet + pigeon pea (6:1) intercropping system.

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Pearl millet + blackgram at 4:1 ratio had higher RCC value of 1.97 compared to other intercropping systems. The combined RCC value greater than unity in this intercropping system denotes the advantage of intercropping (Table 2). Tripathi (2019) [8] reported pigeon pea + pearl millet has higher RCC.

3.4. ECONOMICS OF INTERCROPPING:

Pearl millet + blackgram 4:1 combination recorded higher gross return, net return and B:C ratio than other treatment studied (Rs.1,39,178/ha, Rs. 81,621/ha and 2.42, respectively). It was followed by pearl millet + redgram 4:1 (Rs. 1,36,007/ha, Rs. 78541/ha and 2.37, respectively). Intercropping was always beneficial and recorded higher B:C with respect to pearl millet monoculture. Renu *et al.* (2018) [9] observed similar results also reported that intercropping of pearl millet with mungbean recorded the highest net returns and B:C ratio over sole pearl millet.

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4.CONCLUSION:

Based on these findings, it can be infered that, in comparison to other intercrops, intercropping pearl millet with blackgram at 4:1 ratio reported higher productivity and per unit area. Therefore, under rainfed conditions, pearl millet + blackgram at 4:1 intercropping system may be suggested to get more productivity and net income. As an alternative, intercropping system of pearl millet + redgram in 4:1 can also be suggested.

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TABLE 1. EFFECT OF INTERCROPPING ON GROWTH, YIELD AND ECONOMICS.

	Treatments	Plant height (cm)	Dry matter production (kg/ha)	Pearl millet (kg/ha)		Yield of intercrops (kg/ha)	Net income (Rs/ha)	B:C ratio
				Grain	Haulm			
T_1	Pearl millet sole crop	180.20	6925	2503.0	4927.1	-	75964	2.34
T_2	Pearl millet + blackgram (4:1)	189.66	6638	2485.3	4759.2	139.6	81621	2.42
T_3	Pearl millet + blackgram (6:1)	173.66	6480	2171.3	4917.9	57.4	62008	2.08
T_4	Pearl millet + cowpea (4:1)	152.80	5472	1807.8	4121.8	204.6	45035	1.78
T_5	Pearl millet + cowpea (6:1)	158.86	5146	2063.5	4504.8	136.7	56657	1.99
T_6	Pearl millet + redgram (4:1)	185.46	6800	2239.7	4621.8	309.1	78541	2.37
T_7	Pearl millet + redgram (6:1)	169.00	6421	2139.4	4770.0	172.7	68064	2.19
	Sed	12.14	611.70	216.1	310.3			
	CD (P=0.05)	25.36	1277.9	451.5	648.3			

TABLE 2. EFFECT OF INTERCROPPING ON VARIOUS COMPETITIVE ASSESSMENTS

	Treatments	Grain equivalent yield	Land equivalent ratio	Relative crowding coefficient
T_2	Pearl millet + blackgram (4:1)	5467.7	1.16	1.97
T_3	Pearl millet + blackgram (6:1)	4776.9	0.93	0.61
T_4	Pearl millet + cowpea (4:1)	2892.5	0.95	0.46
T_5	Pearl millet + cowpea (6:1)	3301.6	0.97	0.50
T_6	Pearl millet + redgram (4:1)	5105.3	1.23	1.00
T_7	Pearl millet + redgram (6:1)	4920.6	1.05	0.57
	Sed	354.07		
	CD (P=0.05)	739.68	*	*

*Data not statistically analysed

REFERENCE

1. Lal RB, Ray S. Economics of crop production of different intensities. Ind J Agric Sci. 1976;46: 93-96.
2. Willey RW. Intercropping its importance and research needs, part-I, competition and yield advantages. Field crop abstr. 1979;32: 1-10.
3. Ofori F, Stern W R. Cereal-legume intercropping systems. Adv. Agron. 1987;40: 41-90.
4. Sharmili K, Parasuraman P, Sivagamy K. Influence of inter and sequential cropping of pulses in little millet (*Panicum sumatranse* L.) based rainfed agroecosystem. Ecol. 2021;39 (4):1166-1170.
5. Rawat B, Kumar R, Kamboj NK, Gupta G, JainBT. Nutrient Management in Pearl Millet Based Intercropping Systems under Rainfed Situations. J. Prod. Agric. 2017;8(5), pp.1118-1121.
6. Sharmili K, Manoharan S. Studies on intercropping in rainfed little millet (*Panicum sumatrense*). Int.J. Curr.Microbiol. App.Sci. *2018;* 7(2): 323-327.
7. Kaushik SS, Sharma TD. Wheat and component intercrop yield, land equivalent ratio and monetary indices influenced by intercropping and row proportions. Int. j. curr. microbiol. appl. *Sci.* 2017; 6(7), pp.2626-31.
8. Tripathi AK, Kushwaha HS, Singh D, Praharaj CS. Nutrient management in pigeonpea [Cajanus cajan (L.) Millsp.] cereal intercropping system under rainfed environment of Bundelkhand region of India. Legume Res. 2019;*32*(3), pp.161-169.
9. Renu Kumar A, Kumar P. Performance of advance pearl millet hybrids and mungbean under sole cropping and intercropping systems under semi-arid environment. Pharmacogn. 2018; **7**(2): 1671-1675.

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