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Yield and economics of pigeonpea-millet intercropping systems as influenced by integrated nutrient management

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Abstract
A field experiment was conducted during the rainy (kharif) seasons of 2023-24 and 2024-25 at experiment farm of Regional Agricultural Research Station, Warangal, Telangana on sandy loam soils, to evaluate the effect of pigeonpea-based millet intercropping systems and integrated nutrient management on yield and economics of pigeonpea. The experiment comprised four intercropping systems sole pigeonpea, pigeonpea + finger millet, pigeonpea + foxtail millet and pigeonpea + browntop millet (1:4) in main plot treatments and four nutrient management practices involving different levels and sources of nitrogen in subplot treatments. Results revealed that sole pigeonpea recorded significantly higher seed yield (1610.84 kg ha^{-1}) and stalk yield (4099.73 kg ha^{-1}) with the highest benefit cost ratio (3.50), while intercropping reduced pigeonpea yield due to inter-specific competition. However, pigeonpea + finger millet (1:4) intercropping system produced the highest gross (₹171,331.89 ha^{-1}) and net returns (₹114,786.78 ha^{-1}), indicating its economic superiority. Among nutrient management practices, application of 125% recommended dose of nitrogen (RDN) through inorganic fertilizers resulted in significantly higher seed yield (1536.82 kg ha^{-1}), stalk yield (3913.65 kg ha^{-1}), net returns (₹111,427.42 ha^{-1}) and B:C ratio (3.46). Harvest index was not significantly influenced by either intercropping systems or nutrient management practices. Interaction effects were non-significant for all parameters studied. Pigeonpea + finger millet intercropping system offered higher system-level economic returns and application of 125% RDN through inorganic fertilizers enhanced productivity and profitability of pigeonpea-based systems.

Keywords: Intercropping system, nutrient management, pigeonpea, millets, economics

Introduction
Intercropping is growing of two or more crops simultaneously in the same piece of land and popular in rainfed agriculture with limited resources, because both the crops complement each other in exploiting resources. The main advantage of intercropping is yield stability over mono cropping which is most reliable. The important reason for intercropping non-legumes with legumes is that legumes can fix atmospheric nitrogen which may be available to the associated non-legumes and it is a common practice during rainy season in semi-arid tropics of India.
Pigeonpea is a widely grown pulse crop in India next to chickpea in an area of 50.02 lakh ha with the average productivity of 877 kg ha^{-1} (https://eands.dacnet.nic.in). It is an important constituent of the Indian diet and it contains 20-21% of protein. It is a widely spaced crop with initial slow growth. This can be taken as an advantage to introduce millets as intercrops in between the rows of redgram.
In recent years, energy crisis led to hike in the prices of the inorganic fertilizers and declining soil health and productivity necessitated the use of organic manures compulsorily in agricultural crop production. The continuous use of inorganic fertilizers under intensive cropping system has caused widespread deficiency of secondary and micronutrients in soil. As the nitrogen requirement of redgram and millets is very less compared to exhaustive crops like rice, wheat and maize, it is easier to opt for manures like poultry manure and urban compost, as they are readily available in the market, to supplement nutrients in integrated nutrient management. Usage of organic manures not only provide plant nutrients but also improve physical, chemical

and biological properties of soil and crop yield. Keping these in view, current investigation was taken up.

Materials and Methods

A field experiment was conducted during rainy (kharif)seasons of 2023-24 and 2024-25 at research Farm, Regional Agricultural Research Station, Warangal (15^0 05' N, 79^0 28' E and 268.5 m above mean sea level), under Central Agro-Climatic Zone of Telangana. The soil of the experimental field was sandy loam having slightly alkaline soil reaction (7.12), electrical conductivity 1.1 dS/m, medium in organic carbon (0.6%), low in available nitrogen (202.0 kg ha^{-1}), high in available phosphorus (43.5 kg) and potassium (434.5 kg ha^{-1}).

The treatment combinations comprised 4 intercropping systems (pigeonpea sole, pigeonpea + finger millet, pigeonpea + foxtail millet and pigeonpea + browntop millet) and 4 nutrient management levels 100% RDN through inorganic fertilizers, 125% RDN through inorganic fertilizers, 75% RDN through inorganic fertilizers + 25% RDN through poultry manure and 75% RDN through inorganic fertilizers + 25% RDN through urban compost. For pigeonpea and intercrops, INM treatments (S_1, S_2, S_3 and S4) were applied based on plant population. Irrespective of treatments, P and K were applied based on recommended dose on population basis.

The experiment was laid out in split plot design with four main plots and four subplot treatments so the total number of treatments were sixteen treatments replicated thrice. Sole cropping of finger millet, foxtail millet and browntop millet with four INM treatments were taken separately and they were replicated thrice. Nitrogen content (%) in poultry manure and urban compost were analyzed chemically in both the years of experimentation and the Quantities of poultry manure and urban compost to be applied to S_3 and S_4 INM treatments were decided by the content of N in poultry manure and urban compost. 25% of RDN was met with poultry manure and urban compost in S_3 and S_4 INM treatments respectively in all the main plots. These manures were applied 10 days before sowing after making layout in the field to overcome the immobilization of nutrients in the field.

The pigeonpea and the intercrops were sown manually in both the years. Pigeonpea was sown with 150 cm of row spacing and in between two pigeonpea rows, four rows of intercrops were sown with the row spacing of 30 cm in all the millet intercrops. The recommended dose of fertilizers was given for (pigeonpea 20: 50: 00, finger millet 50: 30: 30, foxtail millet 40:20:00 and browntop millet 40:20:00 kg of N: P_2O_5: K_2O ha^{-1}) in the form of urea, single super phosphate and muriate of potash. WRGE-97, PRS-38, SIA-3156 and GPUBT-6 varieties of pigeonpea, finger millet, foxtail millet and browntop millets were used respectively for the study. In case of intercropping treatments, fertilizers were applied in proportionate to the sole optimum population for main crop and intercrop, separately. The seed rate of the crops used were 8 kg ha^{-1} (pigeonpea), 8 kg ha^{-1} (finger millet), 5 kg ha^{-1} (foxtail millet) and 5 kg ha^{-1} (browntop millet). Weeding and plant-protection measures were undertaken as per their need and the required plant population was maintained. The crops were harvested at their physiological maturity. Standard procedures were used to measure the growth parameters, yield attributes, yield and economics.

Results and Discussion

Seed yield, stalk yield and harvest index of pigeonpea

Seed yield, stalk yield and harvest index of pigeonpea were significantly influenced by pigeonpea-based millet intercropping systems, whereas integrated nutrient management treatments showed significant effects on seed and stalk yield but not on harvest index (Table 1). The interaction effects were found to be non-significant for all yield parameters.

Among the intercropping systems, sole pigeonpea (M_1) recorded significantly higher seed yield during both the years (1550.43 and 1671.24 kg ha^{-1}) with a pooled mean of 1610.84 kg ha^{-1}, which was superior to all intercropping treatments. This was followed by pigeonpea intercropped with finger millet (M_2), foxtail millet (M_3) and browntop millet (M_4), with mean seed yields of 1405.44, 1381.71 and 1365.29 kg ha^{-1}, respectively. A similar trend was observed for stalk yield, where sole pigeonpea recorded the highest pooled mean stalk yield (4099.73 kg ha^{-1}). The reduction in seed and stalk yields under intercropping systems could be attributed to inter-specific competition for light, moisture and nutrients, particularly during the critical growth stages of pigeonpea.

Harvest index did not differ significantly among intercropping systems, though numerically higher values were observed under sole pigeonpea (28.87%). This indicates that intercropping mainly influenced total biomass production rather than dry matter partitioning towards economic yield.

With respect to integrated nutrient management, application of 125% RDN through inorganic fertilizers (S_2) resulted in significantly higher seed yield (1536.82 kg ha^{-1}) and stalk yield (3913.65 kg ha^{-1}) compared to other nutrient management treatments. This was followed by 75% RDN through inorganic fertilizers + 25% RDN through poultry manure (S_3). The higher yields under S_2 may be attributed to adequate and readily available nitrogen throughout the crop growth period, leading to enhanced vegetative growth, photosynthetic activity and assimilate translocation. Harvest index remained non-significant across nutrient treatments, indicating balanced growth under different nutrient management practices. The results are in in line with Patil *et al* (2010) [9] and Jagadeesha *et al* (2019) [6].

Economics of pigeonpea-based millet intercropping systems

Economic analysis revealed substantial variation in cost of cultivation, gross returns, net returns and benefit-cost ratio due to intercropping systems and nutrient management practices (Table 2).

Among intercropping systems, pigeonpea + finger millet (1:4) intercropping (M_2) recorded the highest pooled mean gross returns (₹171,331.89 ha^{-1}) and net returns (₹114,786.78 ha^{-1}), owing to the additional economic yield from finger millet despite higher cost of cultivation. However, the highest pooled mean B:C ratio (3.50) was observed under sole pigeonpea (M_1), mainly due to lower cultivation cost and reasonably high seed yield. Browntop millet intercropping (M_4) recorded the lowest gross returns, net returns and B:C ratio, indicating its comparatively lower economic advantage.

Integrated nutrient management significantly influenced economic returns. Application of 125% RDN through inorganic fertilizers (S_2) resulted in the highest pooled mean gross returns (₹157,124.21 ha^{-1}), net returns (₹111,427.42 ha^{-1}) and B:C ratio (3.46). This was followed by S_1 (100% RDN through inorganic fertilizers). Although organic nutrient sources increased the cost of cultivation, their yields and returns were comparatively lower, particularly under urban compost application (S_4), resulting in the lowest B:C ratio.

The interaction effects between intercropping systems and nutrient management were non-significant, indicating that the relative performance of nutrient management practices remained consistent across different intercropping systems. These results are in line with the findings of Manjunath *et. al* (2018) [8] and Jagadeesha *et al* (2019) [6].

Table 1: Seed yield (kg ha^{-1}), stalk yield (kg ha^{-1}) and harvest index (%) of pigeonpea as influenced by pigeonpea based millet intercropping systems and integrated nutrient management during 2023-24 and 2024-25

Treatments	Seed yield (kg ha^{-1})			Stalk yield (kg ha^{-1})			Harvest index (%)		
	23-24	24-25	Mean	23-24	24-25	Mean	23-24	24-25	Mean
Intercropping system (M)									
M_1- Pigeonpea sole	1550.43	1671.24	1610.84	3908.25	4291.21	4099.73	29.71	28.03	28.87
M_2- Pigeonpea + Finger millet (1:4)	1347.40	1463.48	1405.44	3388.84	3740.80	3564.82	28.85	28.12	28.48
M_3- Pigeonpea + Foxtail millet (1:4)	1328.14	1435.28	1381.71	3354.41	3669.78	3512.10	28.04	28.12	28.08
M_4- Pigeonpea + Browntop millet (1:4)	1310.48	1420.10	1365.29	3308.85	3616.51	3462.68	27.07	28.20	27.63
S.Em±	30.60	36.57	-	77.09	84.68	-	0.73	0.04	-
CD (p=0.05)	105.87	126.54	-	266.76	293.02	-	NS	NS	-
Integrated nutrient management (S)									
S_1- 100% RDN through inorganic fertilizers	1375.08	1445.26	1410.17	3466.80	3696.41	3581.61	28.59	28.12	28.35
S_2- 125% RDN through inorganic fertilizers	1477.00	1596.64	1536.82	3739.16	4088.13	3913.65	28.68	28.08	28.38
S_3- 75% RDN through inorganic fertilizers + 25% RDN through poultry manure	1352.21	1489.50	1420.86	3392.89	3801.83	3597.36	28.34	28.15	28.25
S_4- 75% RDN through inorganic fertilizers + 25% RDN through urban compost	1332.15	1458.71	1395.43	3361.50	3731.92	3546.71	28.05	28.11	28.08
S.Em±	19.02	22.01	-	47.68	53.00	-	0.46	0.04	-
CD (p=0.05)	55.53	64.25	-	139.16	154.70	-	NS	NS	-
Interactions									
MxS									
S.Em±	38.05	44.02	-	95.35	106.00	-	0.93	0.09	-
CD (p=0.05)	NS	NS	-	NS	NS	-	NS	NS	-
SxM									
S.Em±	44.96	52.83	-	112.97	124.89	-	1.08	0.09	-
CD(p=0.05)	NS	9.65	-	NS	NS	-	NS	NS	-

RDN- Recommended dose of nitrogen through fertilizers

Table 2: Cost of cultivation, gross returns (₹. ha^{-1}), net returns (₹. ha^{-1}) and B:C ratio as influenced by pigeonpea based millet intercropping systems and integrated nutrient management during 2023-24 and 2024-25

Treatments	Cost of cultivation (₹. ha^{-1})			Gross returns (₹. ha^{-1})			Net returns (₹. ha^{-1})			B:C ratio		
	2023-24	2024--25	Mean	2023-24	2024--25	Mean	2023-24	2024--25	Mean	2023-24	2024--25	Mean
Intercropping system (M)												
M_1- Pigeonpea sole	33183.03	34359.13	33771.08	108530.10	126178.87	117354.49	75347.07	91819.74	83583.41	3.30	3.70	3.50
M_2- Pigeonpea + Finger millet (1:4)	56031.18	57059.04	56545.11	160424.96	182238.82	171331.89	104393.77	125179.78	114786.78	2.93	3.25	3.09
M_3- Pigeonpea + Foxtail millet (1:4)	53022.70	54079.84	53551.27	151596.41	171663.14	161629.77	98573.71	117583.30	108078.51	2.91	3.22	3.07
M_4- Pigeonpea + Browntop millet (1:4)	53022.70	54079.84	53551.27	127131.45	146721.69	136926.57	74108.75	92641.85	83375.30	2.44	2.76	2.60
S.Em±	-	-	-	1789.22	2507.15	-	1789.22	2507.15	-	0.05	0.07	-
CD(p=0.05)	-	-	-	6191.53	8675.87	-	6191.53	8675.87	-	0.18	0.23	-
Integrated nutrient management (S)												
S_1- 100% RDN through inorganic fertilizers	44937.83	46187.83	45562.83	136299.61	151078.94	143689.27	91361.78	104891.11	98126.44	3.07	3.31	3.19
S_2- 125% RDN through inorganic fertilizers	45071.79	46321.79	45696.79	146453.63	167794.79	157124.21	101381.84	121473.01	111427.42	3.28	3.65	3.46
S_3- 75% RDN through inorganic fertilizers + 25% RDN through poultry manure	45564.03	46799.06	46181.54	133377.06	155356.95	144367.00	87813.03	108557.89	98185.46	2.96	3.37	3.17
S_4- 75% RDN through inorganic fertilizers + 25% RDN through urban compost	59685.97	60269.17	59977.57	131552.62	152571.84	142062.23	71866.65	92302.67	82084.66	2.26	2.60	2.43
S.Em±	-	-	-	2235.29	2673.09	-	2235.29	2673.09	-	0.04	0.05	-
CD(p=0.05)	-	-	-	6524.35	7802.19	-	6524.35	7802.19	-	0.12	0.14	-
Interactions												
MxS												
S.Em±	-	-	-	4470.58	5346.17	-	4470.58	5346.17	-	0.08	0.10	-
CD(p=0.05)	-	-	-	NS	NS	-	NS	NS	-	NS	NS	-
SxM												
S.Em±	-	-	-	4265.08	5265.16	-	4265.08	5265.16	-	0.09	0.11	-
CD(p=0.05)	-	-	-	NS	NS	-	NS	NS	-	NS	NS	-

RDN-Recommended dose of nitrogen through fertilizers

Conclusion

The sole pigeonpea maximized biological yield and benefit-cost ratio, while pigeonpea + finger millet (1:4) was economically superior in terms of net returns due to system productivity. Among nutrient management practices, 125% RDN through inorganic fertilizers proved to be the most effective for enhancing yield and profitability of pigeonpea-based systems.

References

1. Directorate of Economics and Statistics, Department of Agriculture and Farmers Welfare, Government of India. New Delhi: Government of India. https://eands.dacnet.nic.in
2. Directorate of Economics and Statistics, Government of Telangana. Hyderabad: Government of Telangana. https://ecostat.telangana.gov.in
3. Amanullah, Khalid S, Khalil F, Soliman EM, Alshikh, Alwahibi MS, *et al*. Growth and dry matter partitioning response in cereal-legume intercropping under full and limited irrigation regimes. Sci Rep. 2021;11:1-15.
4. Himasree B, Chandrika V, Sarala NV, Prasanthi A. Evaluation of remunerative foxtail millet (*Setaria italica* L.) based intercropping systems under late sown conditions. Bull Environ Pharmacol Life Sci. 2017;6:306-308.
5. Jagadeesha N, Reddy VC, Krishnamurthy N, Sheshadri T. Effect of organic manures on productivity of finger millet and red gram intercropping system under protective irrigation. Int J Agric Sci. 2010;6(2):453-455.
6. Jagadeesha N, Srinivasulu GB, Ratnakar MS, Umesh MR, Gajanana K, Ravikumar B, *et al*. Effect of organic manures on physical, chemical and biological properties of soil and crop yield in finger millet-red gram intercropping system. Int J Curr Microbiol App Sci. 2019;8(5):1378-1386.
7. Mallikarjun, Koppalkar BG, Desai BK, Basavanneppa MA, Narayana Rao K, Swamy M. Performance of pigeonpea (*Cajanus cajan*) intercropping as influenced by row ratios and nutri-cereal crops. Int J Curr Microbiol App Sci. 2018;7(6):2653-2658.
8. Manjunath M, Vajjaramatti, Kalaghatagi SB. Performance of pigeonpea and millets in intercropping systems under rainfed conditions. J Farm Sci. 2018;31:199-201.
9. Patil NB, Halikatti SI, Sujay YH, Prasanna Kumar BH, Topagi SC, Pushpa V. Influence of intercropping on the growth and yield of little millet and pigeonpea. Int J Agric Sci. 2010;6:573-577.
10. Saharan K, Schütz L, Kahmen A, Wiemken A, Boller T, Mathimaran N. Finger millet growth and nutrient uptake is improved in intercropping with pigeon pea through biofertilization and bioirrigation mediated by arbuscular mycorrhizal fungi and plant growth promoting rhizobacteria. Front Environ Sci. 2018;6(46):1-11.