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Assessment of Pigeonpea (*Cajanus cajan*) Based Intercropping System under Varying Planting Patterns

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Pigeonpea (*Cajanus cajan* (L.) Millsp.), one of the main grain legume crops grown in tropical and subtropical countries, is mostly grown under rainfed conditions. After chickpea, pigeonpea is India's second most significant crop in terms of area and yield. It makes up 23 per cent of all pulse production (3.33 million tons) and 1.76 per cent of the nation's gross planted land (3.88 million hectares). When grown as a lone crop, pigeonpea is not a highly efficient crop Willey et al., 1980 due to its low harvest index and delayed start growth rate. It is therefore grown as an intercrop, helping to increase productivity and profit by making efficient use of available resources. The field

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experiment was conducted at the Rajola Farm, Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalay Chitrakoot, Satna, Madhya Pradesh-4853 (M.P.) during the *kharif* season of 2014. In the treatments, cropping patterns and intercropping systems could be combined in seven different ways. The experiment was set up using a randomized block design with three replications. Our study revealed that in all intercrop cropping systems, the pigeonpea equivalent yield (PEY), LER, and ATER were significantly higher than under the pigeonpea sole system. PEY was found to be significantly maximum under T6: PP + Sesame alternate row (20.75 q ha^{-1}) followed by T7: PP + Sesame paired row planting (19.54 q ha^{-1}) and T4: PP + BG alternate row (19.51 q ha^{-1}). However, LER and ATER were calculated significantly higher under T4: PP + BG alternate row (1.74 and 1.32, respectively), T2: PP + GG alternate row (1.73 and 1.31, respectively) and T6: PP + Sesame alternate row (1.71 and 1.29, respectively). The lowest values of PEY, LER, and ATER were found under pigeonpea sole system.

Keywords: Pigeonpea; intercropping; blackgram; greengram; sesame.

1. INTRODUCTION

One of the principal grain legume crops of the tropical and subtropical regions, pigeonpea (*Cajanus cajan* (L.) Millsp.) is mostly cultivated in rainfed circumstances. Pigeonpea is the second most important crop in terms of area and output in India, after chickpea, accounting for 1.76 per cent of the country's gross cropped area (3.88 million hectares) and 23 per cent of all pulse production (3.33 million tons). Due to its slow initial growth rate and low harvest index, pigeonpea is very inefficient when grown as a solitary crop (Willey et al., 1980). As a result, it is produced as an intercrop, which aids in the efficient use of available resources to increase productivity and profit (Kaggod et al., 2024; Pawar, 2024). To boost productivity and preserve soil fertility, pigeonpea can be interplanted with a variety of crops, including cotton, sorghum, pearl millet, greengram, blackgram, maize, soybean, and groundnut. Pigeonpeas' deep roots and initial moderate growth rate make them an excellent candidate for intercropping with crops that develop quickly, mature quickly, and have shallow roots (Ramamoorthy et al., 2004). The current study was conducted with all of the aforementioned factors considered in an effort to determine the best intercropping system and planting strategy for raising the yield of pulses per unit area per unit time in order to meet the stated goal.

2. MATERIALS AND METHODS

The field experiment was conducted at the Rajola Farm, MGCGVV, Chitrakoot, Satna (M.P.) during *kharif* season of 2014. The soil of the experimental field was sandy clay loam with pH value 7.44 to 7.46, electrical conductivity 0.32 to 30 dSm^{-1}, organic carbon 2.9 to 2.4 g kg^{-1}, available N, 193.42 to 201.6 kg ha^{-1}, available P_2O_5 16.72 to 20.11 kg ha^{-1} and available K_2O 207.28 to 201.5 kg ha^{-1}. The treatments comprised seven combinations of the intercropping systems and cropping patterns as T_1: Sole Pigeonpea (60 cm apart), T_2: PP + GG (1:1) alternate row 30 cm apart, T_3: PP + GG (2:2) paired row planting 30 cm apart, T_4: PP + BG (1:1) alternate row 30cm apart, T_5: PP + BG (2:2) paired planting 30 cm apart, T_6: PP + SS (1:1) alternate row 30cm apart and T_7: PP + SS (2:2) paired planting 30 cm apart (expand GG, BG and SS). The experiment was laid out in Randomized block design with three replications. Pigeonpea variety 'ICPL 88039', greengram variety 'PDM-139' blackgram variety 'Azad urd-1' and sesame variety 'Gujrat-1' were sown @ 15, 12, 15 and 4 kg seed per hectare, respectively. Recommended dose of N, P_2O_5 and K_2O (20-40- 20 kg ha^{-1}) was applied equally in all plots through inorganic fertilizers as basal. The optimum plant population was maintained by thinning and gap filling 10 days after germination to ensure the uniform plant population. All the data pertaining to the present investigation were statically analyzed as per the methods described by Panse and Sukhatme, (1967). The treatment differences were tested for significance by 'F' test and the data in which the treatment effects were found significant the appropriate standard error of mean and the critical different (C.D.) were worked out at 5% level of significance.

3. RESULTS AND DISCUSSION

Growth and Growth Attributes: Growth parameters *viz.* plant height, trifoliate per plant and dry matter per plant were significantly influenced due to intercropping and planting pattern (Table 1). Sole pigeonpea was recorded significantly superior plant height, trifoliate per plant at all the stages and dry weight per plant at 90 DAS over rest of intercropped treatments.

Among the intercropping systems, T_6: PP + Sesame (1:1) alternate row treatment was observed significantly maximum plant height at 60 and 90 DAS, trifoliate per plant and dry matter per plant at 90 DAS. However, dry matter was recorded marginally higher under T_6: PP + Sesame (1:1) alternate row treatment. It might be attributed to more development of individual plant as more side space was availed by each plant sown in single rows which was properly utilized by plants by availing proper sunlight and space. After harvesting of intercropped, the competitions are completely removed for pigeonpea which grow independently. The present findings are in-close agreement with those of Shanwad et al. (2009) ; Pandey et al. (2013) and Dhandayuthapani et al. (2015).

The root length, root spread and root dry matter were increased with the advancement of crop growth stage, and influenced significantly by intercropping system and planting pattern treatments. These parameters found superior with pigeonpea sole than that of intercropping and planting pattern (Table 2). Among the intercropping T_4: PP + BG (1:1) alternate row 30 cm apart treatment and T_6: PP + Sesame (1:1) alternate row 30 cm apart treatment was observed significantly maximum root length, root spread and root dry matter at 60 and 90 DAS. It might be due to increased competition between roots of component crop in paired row planting which restricted the horizontal expansion and geotropical root growth. As regards pigeonpea sole resulted in wide spread and lengthy root system than other intercropping system it might be due to proper nourishment of crop plants which improved over all plant growth.

Yield and Yield attributes: When pigeonpea was grown alone as opposed to in an intercropped system, the yield parameters of number of pods per plant, seed weight per plant, and hundred seed weight were much greater. The intercropping treatments that yielded the highest number of pods per plant and seed weight per plant were T4: PP + BG (1:1) alternate row spaced 30 cm apart and T6: PP + Sesame (1:1) alternate row spaced 30 cm apart. But a similar pattern was observed in the maximum seed weight under T2: PP + GG (2:2) alternate row spaced 30 cm apart. T4: BG (1:1) and PP (1:1) alternate rows spaced 30 centimeters apart, and T6: PP and sesame (1:1) alternate rows spaced 30 cm apart. This could be explained by the fact that each plant has more branches, which may have given the plants more axil locations for the production of pods and, eventually, higher seed weight per plant. This rise in yield attributes may have been caused by higher growth parameters and the production of more root nodules, which may have encouraged the formation of higher yield attribute parameters. Similar findings have also been reported by Srinivasulu et al (2000); Dutta et al. (2006); Kumar et al. (2012) and Pandey et al. (2013).

Biological and seed yield was found significantly higher under pigeonpea sole than that of intercropped treatment. The least competition under sole pigeonpea as compared to intercropping could be facilitated the better growth and development of primodia which resulted the higher biological and seed yield. Among the intercropping, T_6: PP + Sesame (1:1) alternate row 30 cm apart followed by T_4: PP + Sesame (1:1) alternate row 30 cm apart treatment were observed significantly superior biological and seed yield. This could be ascribed due to greater value of growth parameters. Such trend might be due to better spatial arrangement of pigeonpea under intercropping systems with 1:1 row ratio. These results corroborate to the findings of Vyas et al. (2006); Shanwad et al. (2009), Kajur et al. (2010) and Kumar et al. (2012).

Productivity of the systems: Pigeonpea Equivalent Yield (PEY), Area Time Equivalent Ratio (ATER), and Land Equivalent Ratio (LER) were used to express the productivity of the intercropping systems. The area required for a lone crop to one of the intercropping systems at the same management level in order to provide an equivalent yield is known as the LER. Higher yield advantage in terms of LER was noted with T4: PP + BG (1:1) alternating row treatment spaced 30 cm apart (1.74). The treatment T6: PP + Sesame (1:1) alternating row 30 cm apart (20.75 q/ha-1) was recorded significantly higher pigeonpea equivalent yield (PEY). However, ATER values were greater in T4: PP + BG (1:1) alternate row spaced 30 cm apart (1.32), which may be because intercropping increases the yield of both component crops in the shortest amount of time. The improved planting geometry and geographical arrangements that may have prevented the concurrence of the peak growth period of the respective crops may be the cause of the increased LER under these intercropping systems. The results may be supported by the work of Chaudhary et al. (2005) ; Vyas et al. (2006) ; Kumar et al. (2012) and Pandey et al. (2013).

Table 1. Effect of various intercropping systems and planting patterns on growth parameters of pigeonpea

Treatments	Plant height (cm) at			Number of trifoliate leaves per plant at			Dry matter per plant (g) at		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T_1: Sole Pigeon pea (60cm apart)	35.38	97.16	114.00	10.53	63.70	104.87	0.57	5.51	24.91
T_2: PP + GG (1:1) alternate row 30cm apart	31.73	95.61	109.93	9.27	61.50	101.20	0.57	5.48	22.38
T_3: PP+ GG (2:2) paired planting 30cm apart	30.95	93.39	105.40	6.73	56.20	98.93	0.58	5.51	19.90
T_4: PP + BG (1:1) alternate row 30cm apart	32.22	95.11	109.73	8.93	61.50	101.67	0.57	5.47	22.14
T_5: PP + BG (2:2) paired planting 30cm apart	30.88	93.39	105.47	6.80	56.80	99.00	0.58	5.45	19.97
T_6: PP + SS (1:1) alternate row 30cm apart	31.85	95.75	109.87	8.73	60.80	101.80	0.58	5.52	22.77
T_7: PP + SS (2:2) paired planting 30cm apart	30.92	93.33	105.13	6.47	56.75	99.73	0.58	5.46	20.27
SEm ±	0.24	0.29	0.26	0.19	0.29	0.35	0.97	0.06	0.45
CD (P=0.05)	0.71	0.90	0.81	0.59	0.90	1.07	NS	NS	1.39
CV (%)	1.251	0.531	0.422	4.048	0.846	0.599	0.929	1.843	3.586

Table 2. Effect of various intercropping systems and planting patterns on root parameters of pigeonpea

Treatments	Root length (cm)		Root spread (cm)		Root dry wt (g)		Nodules /plant		Nodules wt/plant (g)	
	60 DAS	90 DAS	60 DAS	90 DAS	90 DAS	60 DAS	60 DAS	90 DAS	60 DAS	90 DAS
T_1: Sole Pigeonpea (60 cm apart)	17.72	25.94	12.97	17.72	25.94	12.97	10.73	17.88	0.322	0.77
T_2: PP + GG (1:1) alternate row 30 cm apart	15.58	23.00	10.26	15.58	23.00	10.26	9.97	16.66	0.305	0.68
T_3: PP + GG (2:2) paired planting 30 cm apart	15.95	20.73	10.79	15.95	20.73	10.79	9.20	16.55	0.279	0.59
T_4: PP + BG (1:1) alternate row 30 cm apart	16.49	23.13	12.08	16.49	23.13	12.08	10.20	15.88	0.314	0.68
T_5: PP + BG (2:2) paired planting 30 cm apart	16.07	21.70	10.42	16.07	21.70	10.42	9.63	15.33	0.301	0.63
T_6: PP + SS (1:1) alternate row 30 cm apart	16.03	23.18	11.12	16.03	23.18	11.12	9.97	16.33	0.314	0.65
T_7: PP + SS (2:2) paired planting 30cm apart	15.63	20.93	10.96	15.63	20.93	10.96	9.50	15.44	0.300	0.57
SEm ±	0.26	0.31	0.31	0.26	0.31	0.31	0.24	0.26	0.03	0.04
CD (P=0.05)	0.79	0.96	0.94	0.79	0.96	0.94	0.74	0.81	NS	0.13
CV (%)	2.759	2.413	4.751	2.759	2.413	4.751	4.182	2.804	6.32	7.702

N.S.: Non significant.

Table 3. Effect of various intercropping systems and planting patterns on yield attributes of pigeonpea

Treatments	No. of branches			No. of pods/plant	No. of seeds/pod	100-seed wt. (g)	Seed wt./plant g)
	Primary	Secondary	Tertiary				
T_1: Sole Pigeonpea (60 cm apart)	12.30	9.00	4.67	68.40	3.47	9.10	21.20
T_2: PP + GG (1:1) alternate row 30 cm apart	10.67	8.07	3.63	63.33	3.13	8.87	17.91
T_3: PP+ GG (2:2) paired planting 30 cm apart	9.87	7.57	3.15	60.40	2.87	8.53	15.50
T_4: PP + BG (1:1) alternate row 30 cm apart	11.37	8.27	3.53	63.93	3.00	8.73	18.09
T_5: PP + BG (2:2) paired planting 30 cm apart	10.47	7.33	3.00	59.73	3.33	8.53	14.96
T_6: PP + SS (1:1) alternate row 30 cm apart	11.27	7.73	3.63	62.47	3.27	8.67	18.30
T_7: PP + SS (2:2) paired planting 30 cm apart	9.80	7.03	3.07	59.20	3.33	8.43	15.11
SEm ±	0.14	0.09	0.11	0.52	0.15	0.08	0.44
CD (P=0.05)	0.43	0.29	0.34	1.58	NS	0.26	1.35
CV (%)	2.265	1.837	5.423	1.432	8.238	1.679	4.429

Table 4. Effect of various intercropping systems and planting patterns on yield of pigeonpea and productivity of the systems

Treatments	Yield			LER	ATER	PEY
	Seed yield (q/ha)	Stover yield (q/ha)	Harvest index (%)			
T_1: Sole Pigeonpea (60 cm apart)	11.09	47.03	19.08	1.00	1.00	11.09
T_2: PP + GG (1:1) alternate row 30 cm apart	10.02	45.80	17.95	1.73	1.31	18.74
T_3: PP+ GG (2:2) paired planting 30 cm apart	8.90	44.51	16.66	1.60	1.20	17.47
T_4: PP + BG (1:1) alternate row 30 cm apart	10.06	45.90	17.99	1.74	1.32	19.51
T_5: PP + BG (2:2) paired planting 30 cm apart	8.77	44.55	16.45	1.61	1.19	18.09
T_6: PP + SS (1:1) alternate row 30 cm apart	10.05	45.94	17.94	1.71	1.29	20.75
T_7: PP + SS (2:2) paired planting 30 cm apart	9.05	45.14	16.69	1.61	1.23	19.54
SEm ±	0.15	0.27	0.16	0.04	0.05	0.14
CD (P=0.05)	0.46	0.84	0.58	1.58	0.12	0.45
CV (%)	2.626	1.038	1.553	1.432	2.309	1.37

4. CONCLUSION

According to the study, all intercrop cropping systems considerably increased pigeonpea equivalent yield (PEY), LER, and ATER when compared to the pigeonpea sole system. In the kymore plateau of Madhya Pradesh, treatments T6 (PP + Sesame alternate row, 20.75 q ha-1) and T4 (PP + BG alternate row, 1.74 and 1.32) were determined to be the most profitable and productive.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

Chaudhary, S. K. and Thakur, S. K. (2005). Productivity of pigeonpea (*Cajanus cajan*)-based intercrops Indian Council of Agricultural Research, New Delhi, India, *Indian Journal of Agricultural Sciences*, 75(8): 496-497.

Dhandayuthapani, U.N. and Latha, K.R. (2015). Analysis of light transmission ratio and yield advantages of pigeonpea in relation to intercrop and different plant population. Academic Journals, Nairobi, Kenya, *African Journal of Agricultural Research*, 10(8):731-736.

Dutta, D. and Bandyopadhyay, P. (2006). Production potential of intercropping groundnut (Arachis hypogaea) with pigeonpea (*Cajanus cajan*) and maize (*Zea mays*) under various row proportions in rainfed Alfisols of West Bengal. *Indian Journal of Agronomy*, 51(2): 103-106

Kujur, S. Ahmed, S. Srivastava, G.P. and Singh, C.S. (2010). Performance of pigeonpea (*Cajanus cajan*) intercropping as influenced by row ratios and duration of finger millet (*Elusine coracana*) cultivars. *Indian Journal of Agronomy*, 55(3): 209-214.

Kumar, P., Rana, K.S. and Rana, D.S. (2012). Effect of planting systems and phosphorus with bio-fertilizer on the performance of sole and intercropped pigeonpea (*Cajanus cajan*) under rainfed conditions. *Indian Journal of Agronomy*, 57(2): 127-132

Pandey, I.B., Singh, S.K. and Tiwari, S. (2013). Integrated nutrient management for sustaining the productivity of pigeonpea (*Cajanus cajan*) based intercropping systems under rainfed condition. Indian *Journal of Agronomy*, 58(2): 192-197.

Panse, V.C. and Sukhatme, P.V. (1967). Statistical methods for agricultural workers. ICAR Publications, New Delhi.

Ramamoorthy, K., Christopher, A.L. Alagudurai, S. Kandasamy O.S and Murugappan, V. (2004). Intercropping pigeon pea (*Cajanus cajan*) in finger millet (*Eleusine coracana*) on productivity and soil fertility under rainfed condition. *Indian Journal of Agronomy*, 49: 28-30.

Shanwad, U.K., Rajkumar, S., Hulihalli, U.K., Mummigatti, U.V. and Arvind Kumar, B.N., (2009). Performance of maize + pigeonpea intercropping system under rainfed conditions of North Karnataka. *Current Advances in Agricultural Sciences*, 1(1): 21-23.

Srinivasulu, K. Singh, R. P. and Madhavi, K (2000). Performance of rainfed pigeonpea (*Cajanus cajan*) based intercropping systems under varying planting patterns. Crop Research, 20(1): 56-61.

Vyas, A.K., Billore, S.D. and Joshi, O.P. (2006). Productivity and economics of integrated nutrient management in soyabean (*Glycine max*) + pigeonpea (*Cajanus cajan*) intercropping system. *Indian Journal of Agricultural Sciences*, 76(1): 7-10.

Willey, R.W., Rao, M.R. and Natarajn, M. (1980). Traditional cropping systems with pigeonpea and their improvement. In: Proc. *International Workshop Pigeonpea*, December 15-19, 1980, ICRISAT, Patancheru, pp. 11-25

Kaggod, Anuradha, S. Rajendra Prasad, T. M. Ramanappa, M. N. Thimmegowda, Parashivamurty, and Mudalagiriyappa. 2024. “Optimization of Foliar Nutrition and Nipping for Quality of Pigeonpea [*Cajanus Cajan* (L). Millsp.]”. *International Journal of Plant & Soil Science* 36 (8):221-28. https://doi.org/10.9734/ijpss/2024/v36i84851.

Pawar, G.R., P. K. Waghmare, C.K. Bhadre, and D.N. Gokhale. 2024. “Evaluation of Yield Advantages, Competitiveness and Economic Benefits of Pigeonpea (*Cajanus*

Cajan L.) Based Intercropping Systems Under Different Date of Sowing". *International Journal of Environment and Climate Change* 14 (3):638-49. https://doi.org/10.9734/ijecc/2024/v14i34072.

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