

Assessment of pigeonpea (*Cajanus cajan*) based intercropping system under varying planting patterns

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 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.

Key words: Pigeonpea, Intercropping, Blackgram, Greengram, Sesame

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) (add reference). Due to its slow initial growth rate and low harvest index, pigeonpea is very inefficient when grown as a solitary crop (Willey et al., *italics* 1980). As a result, it is produced as an intercrop, which aids in the efficient use of available resources to increase productivity and profit. 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., *italics* 2004). The current study was conducted with all of the aforementioned factors taken into account 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.

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 P₂O₅ 16.72 to 20.11 kg ha⁻¹ and available K₂O 207.28 to 201.5 kg ha⁻¹. The treatments comprised seven combinations of the intercropping systems and cropping patterns as T₁: Sole Pigeonpea (60 cm apart), T₂: PP + GG (1:1) alternate row 30 cm apart, T₃: PP + GG (2:2) paired row planting 30 cm apart, T₄: PP + BG (1:1) alternate row 30cm apart, T₅: PP + BG (2:2) paired planting 30 cm apart, T₆: PP + SS (1:1) alternate row 30cm apart and T₇: 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, P₂O₅ and K₂O (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.

RESULTS AND DISCUSSION

Growth and Growth Attributes: Growth parameters viz. plant height, trifoliolate 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, trifoliolate per plant at all the stages and dry weight per plant at 90 DAS over rest of intercropped treatments. ~~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.~~ Among the intercropping systems, T₆: PP + Sesame (1:1) alternate row treatment was observed significantly maximum plant height at 60 and 90 DAS, trifoliolate per plant and dry matter per plant at 90 DAS (**rewrite statement once again some tables values (T2 and T4) are higher than T6 treatment**). However, dry matter was recorded marginally higher under T₆: 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 T₄: PP

+ BG (1:1) alternate row 30 cm apart treatment and T₆: PP + Sesame (1:1) alternate row 30 cm (clearly mention which treatment is significantly higher and which in on par or followedby) 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 (add any reference).

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 (clearly mention which treatment is significantly higher and which in on par or followedby). 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 primordia which resulted the higher biological and seed yield. Among the intercropping, T₆: PP + Sesame (1:1) alternate row 30 cm apart followed by T₄: PP + Sesame (1:1) alternate row 30 cm (clearly mention which treatment is significantly higher and which in on par or followedby) 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) (correct the reference name) 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) (remove slash or make it superscript) 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).

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 (add increment percentage of yield values over 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.

All journal names should be in italics

Bold only volume number not issue number

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

Treatments	Plant height (cm) at			Number of trifoliolate 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

NS= Non significant

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

N.S.: Non significant.

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

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