



Growth performance of pigeonpea as influenced by different row proportions of ricebean under rainfed vertisols

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Abstract

A field experiment was conducted during kharif 2025 at the College of Agriculture, Kalaburagi, University of Agricultural Sciences, Raichur, Karnataka, to evaluate the growth performance of pigeonpea as influenced by different row proportions of ricebean under rainfed vertisols. The experiment was laid out in a randomized complete block design with three replications and eight treatments comprising pigeonpea + ricebean in 1:1, 1:2, 1:3, 2:2 and 2:4 row proportions, pigeonpea + foxtail millet (1:2), sole pigeonpea and sole ricebean. Growth parameters viz., plant height, primary branches, secondary branches, total dry production, leaf area and leaf area index were recorded at harvest. Sole pigeonpea recorded significantly higher values for growth parameters of crop. However, pigeonpea + ricebean in 1:1 and 2:4 row proportions remained statistically on par with sole pigeonpea. Sole pigeonpea recorded 177.7 cm plant height, 14.6 primary branches, 15.4 secondary branches and 213.5 g plant⁻¹ total dry matter at harvest. Pigeonpea + ricebean (1:1) recorded 165.5 cm plant height, 13.4 primary branches, 14.4 secondary branches and 203.4 g plant⁻¹ total dry matter, while pigeonpea + ricebean (2:4) recorded 197.4 g plant⁻¹. Leaf area and leaf area index also followed a similar trend.

Keywords: Pigeonpea, ricebean, row proportion, plant height, dry matter, vertisols

Introduction

Pigeonpea (*Cajanus cajan* L.) is an important pulse crop cultivated predominantly under rainfed conditions in India. In Karnataka, pigeonpea forms an important component of dryland farming systems because of its adaptation to moisture-limited environments and its ability to produce grain under variable rainfall conditions. However, its slow initial growth and wider row spacing provide an opportunity for efficient utilization of inter-row space through intercropping with suitable short-duration crops. Ricebean (*Vigna umbellata* L.) is a short-duration pulse crop with potential for integration into pigeonpea-based intercropping systems. The contrasting growth habits and duration of pigeonpea and ricebean provide scope for complementary utilization of available resources. However, the productivity and growth of the component crops are strongly influenced by their spatial arrangement. Intercropping, the practice of growing two or more crops together, offers a sustainable solution to improve land productivity and resource use (Rao and Willey, 2017) [11]. This method enhances soil health, diversifies production, reduces pests and diseases and increases yield stability compared to growing a single crop (Lithourgidis *et al.*, 2011) [7]. Additionally, intercropping can help to reduce climate risks by optimizing the use of light, water and nutrients. Intercropping of pigeonpea (*Cajanus cajan*) with varying row proportions significantly influences crop yield and resource use efficiency. Row proportion determines the relative plant population and distribution of the component crops and consequently modifies competition for light, soil moisture, nutrients and growing space. An excessive proportion of the intercrop may suppress pigeonpea growth, whereas an appropriate

row proportion may allow better resource utilization without severely affecting the growth of the base crop. The growth characteristics of pigeonpea are important indicators of its ability to withstand interspecific competition and maintain productivity under intercropping. Therefore, the present investigation was undertaken to study the influence of different row proportions of ricebean on growth parameters of pigeonpea under rainfed Vertisols.

Material and methods

The experiment was conducted during *kharif* season of 2025 at College of Agriculture, Kalaburagi, University of Agricultural Sciences, Raichur (Karnataka), which is situated at a latitude of 17° 34' N, longitude of 76° 79' E and at an elevation of 478 meters above mean sea level and it falls under North-Eastern dry zone of Karnataka (Zone II). The meteorological data was recorded at meteorological observatory, Zonal Agricultural research station, Kalaburagi for the year 2025. The average rainfall of the region is 759 mm of which nearly 75 per cent of the rainfall occurs during South-West monsoon (June to September). During experimentation (2025), the mean annual rainfall received was 1093.60 mm with 81 rainy days. September month received a maximum rainfall of 345.80 mm and August 270.80 mm and the maximum temperature was 38.29 °C in December and minimum was 17.77 °C in January. The experiment comprised of eight treatments pigeonpea + ricebean in 1:1, 1:2, 1:3, 2:2 and 2:4 row proportions, pigeonpea + foxtail millet (1:2), sole pigeonpea and sole ricebean where pigeonpea spacing 90 x 30 cm in 1:1, 1:2, 1:3 row proportions and paired row (60-120 cm x 30 cm) in 2:2 and 2:4 row proportions.

Data collection

Five randomly selected plants in the net plot area were tagged and used for making observations on various growth parameters at harvest. The height of the plant was measured from the base of the plant to the tip of main shoot of five plants and mean plant height was worked out and expressed in centimetre. The number of branches emerging directly from main stem was counted. Plant samples for dry matter studies were collected at each sampling, two plants were uprooted at random in each treatment and partitioned into leaf, stem. These samples were oven dried at 70° C in hot air oven for 72 hours till a constant dry weight. The dry weight of different plant parts was recorded, the dry matter production per plant was obtained with the summation of dry weight of all plant parts and was expressed on per plant basis (g plant⁻¹). The leaf area was worked out by disc method on dry weight basis as per the procedure suggested by Vivekanandan *et al.* (1972)^[17]

$$LA = \frac{Wa \times A}{Wd}$$

Where,

LA = Leaf area (dm² plant⁻¹)

WA = Oven dry weight of all leaves (inclusive of 10 disc weight)

WD = Oven dry weight of 10 discs in gram

A = Area of the 10 discs (dm²)

Leaf area index (LAI) was worked out by dividing the leaf area per plant by land area occupied by the plant (Sestak *et al.*, 1971)^[13]

$$LAI = \frac{\text{Leaf area (dm}^2\text{)}}{\text{Spacing (dm}^2\text{)}}$$

Statistical analysis

Prior to statistical analysis, the data were examined for normality of residuals and homogeneity of variances. All measured variables related to crop performance at different growth stages and at maturity were combined across years for analysis using a two-way analysis of variance (ANOVA) followed that described by Gomez and Gomez (1984)^[4]. Statistical significance for *F*- and *t*-tests was determined at an alpha level of *P* = 0.05. When the ANOVA indicated significant treatment effects, mean comparisons were performed using Fisher's protected least significant difference (LSD) test at the 5% probability level. All tests were as per split-plot design replicated thrice and the statistical analysis was carried out in OPSTAT Software (O. P. Sheoran, a computer programmer at CCS HAU, Hisar, India) to determine the level of significance.

Results and Discussion

Growth parameters of pigeonpea

Plant height (cm)

The data on pigeonpea plant height at harvest as influenced by intercropping with different row proportions are presented in Table 1. The plant height of pigeonpea increased progressively with advancement of crop growth. Sole pigeonpea recorded significantly higher plant height 177.7 cm at harvest. However, it was found to be on par with pigeonpea + ricebean (1:1) 165.5 cm and pigeonpea + ricebean (2:4) 160.1 cm at harvest. Whereas, pigeonpea +

foxtail millet (1:2) recorded the lower plant height 137.3 cm at harvest. Sole pigeonpea recorded significantly greater plant height at harvest compared to the intercropped pigeonpea. Among the intercropping systems, pigeonpea + ricebean (1:1) and (2:4) recorded significantly taller plants than other combinations. The better growth under sole pigeonpea might be attributed to reduced competition for light, moisture and nutrients, which favoured photosynthetic activity and vegetative development. The comparatively better plant height of pigeonpea with ricebean in 1:1 and 2:4 row proportion, resulted from a favourable spatial arrangement and better utilization of available growth resources. The consistently short stature under pigeonpea + foxtail millet (1:2) points to intense competition from the quick-growing, densely tillering foxtail millet, which likely intercepted a disproportionate share of incident light relative to its sown proportion, suppressing pigeonpea plant growth. Similar variation in pigeonpea growth due to planting geometry and intercropping systems was reported by Laxman *et al.* (2026)^[6] under the eastern dry zone of Karnataka and Patidar *et al.* (2024)^[9] under different planting patterns of pigeonpea-based intercropping systems.

Number of primary branches per plant

The data on the number of primary branches per plant in pigeonpea at harvest as influenced by intercropping at various row proportions are presented in Table 1. Sole pigeonpea recorded the higher number of primary branches 14.6 at harvest, which was statistically on par with pigeonpea + ricebean (1:1) 13.4 primary branches and pigeonpea + ricebean (2:4) 12.8 primary branches at harvest, whereas, pigeonpea + foxtail millet (1:2) recorded the lower number of primary branches 10.1 at harvest. The greater development of primary branches under sole pigeonpea as compared to intercropped treatments. This might be minimized competition for essential resources such as light, water, nutrients and growing space which promote better branching at vegetative development. Among the intercropping systems, relatively better branching under pigeonpea + ricebean (1:1) and (2:4) might be related to its favourable row proportion and efficient use of available growth resources. In contrast, the lower branching under pigeonpea + foxtail millet (1:2) resulted from greater competition for resources, thereby restricting vegetative growth and branch development. Similar variation in branching behaviour of pigeonpea under different intercropping systems and planting arrangements was reported by Kumar and patel (2023)^[5] in pigeonpea + maize intercropping, Navi *et al.* (2024)^[8] under different planting geometries of pigeonpea.

Number of secondary branches per plant

The observations on the number of secondary branches per plant in pigeonpea at harvest, as affected by intercropping with varying row proportions are summarized in Table 1 the number of secondary branches per plant increased with advancement of crop growth. Sole pigeonpea recorded a significantly higher number of secondary branches plant⁻¹ 15.4 at at harvest, pigeonpea + ricebean (1:1) 14.4 secondary branches and pigeonpea + ricebean (2:4) 13.4 secondary branches at harvest, both treatments statistically on par with sole pigeonpea. However, the lower number of secondary branches was observed under pigeonpea + foxtail millet (1:2) 9.3 at harvest. The production of secondary

branches was significantly higher in sole pigeonpea at harvest than in the intercropped treatments. Among the intercropping systems, pigeonpea + ricebean (1:1) and (2:4) maintained better secondary branches per plant, which was associated with a favourable micro environment and reduced competition. In contrast, pigeonpea + foxtail millet (1:2) recorded lower secondary branches, which was associated with greater competition for available growth resources and restricted branch development. These observations are in line with the results reported by Tripathi *et al.* (2021) ^[16] in pigeonpea + soyabean intercropping system, Prakash *et al.* (2023) ^[10] in pigeonpea + sorghum intercropping system, who also noted improved branching under conditions of reduced competition and better resource availability.

Total dry matter production (g plant⁻¹)

The total dry matter production of pigeonpea at various growth as affected by intercropping with different row proportions presented in Table 2. Sole pigeonpea recorded significantly higher total dry matter production 213.5 g plant⁻¹ at harvest. However, it was found to be on par with pigeonpea + ricebean (1:1) 203.4 g plant⁻¹ and pigeonpea + ricebean (2:4) 197.4 g plant⁻¹ at harvest. The lower total dry matter production was recorded under pigeonpea + foxtail millet (1:2) 151.1 g plant⁻¹ at harvest. The production of total dry matter was significantly higher under sole pigeonpea throughout the crop growth period compared to other treatments. This higher biomass accumulation was associated with higher photosynthetic activity, efficient interception of solar radiation which favoured better development of leaves, stems and pods, which promote greater accumulation of photosynthates. Among the intercropping systems, pigeonpea + ricebean (1:1) and (2:4) recorded comparatively higher total dry matter production, indicating better utilization of available growth resources under this row proportion. The lower biomass production under pigeonpea + foxtail millet (1:2) was associated with higher competition for essential resources, restrict development of leaf area and thereby produced lower dry matter accumulation. The present findings are in agreement with Das *et al.* (2022) ^[3] in pigeonpea + groundnut intercropping and Ravichandran *et al.* (2022) ^[12] in pigeonpea + field pea intercropping, who reported variation in biomass production of pigeonpea under different intercropping systems.

Leaf area (dm² plant⁻¹)

The data pertaining to leaf area of pigeonpea at harvest as influenced by intercropping with different row proportions is detailed in Table 2. Sole pigeonpea recorded significantly higher leaf area 76.8 dm² plant⁻¹ at harvest, which was statistically on par with pigeonpea + ricebean (1:1) 71.2 dm² plant⁻¹ and pigeonpea + ricebean (2:4) 64.8 dm² plant⁻¹ at harvest. The lower leaf area was recorded under pigeonpea + foxtail millet (1:2) 50.3 dm² plant⁻¹ at harvest. The

significantly greater leaf area under sole pigeonpea is recorded throughout the crop growth period. This might be greater availability of essential resources and less competition, which favoured leaf expansion and canopy development. Among the intercropping systems, pigeonpea + ricebean (1:1) and (2:4) maintained better leaf area, indicating effective utilization of available light, soil moisture and micro environment under this row proportion. The comparatively smaller leaf area under pigeonpea + foxtail millet (1:2) was associated with greater competition within the intercropping arrangement, which restricted leaf development. The present findings are in agreement with Anjali *et al.* (2020) ^[1] in pigeonpea + groundnut, Singh *et al.* (2021) ^[14] in pigeonpea + soybean intercropping systems, where variation in leaf development was observed under different crop combinations and resource conditions.

Leaf area index (LAI)

The data pertaining to leaf area index of pigeonpea at various growth stages as influenced by intercropping at different row proportions is detailed in Table 2. Sole pigeonpea recorded the higher leaf area index at harvest 2.84 which was statistically on par with pigeonpea + ricebean (1:1) 2.63 and pigeonpea + ricebean (2:4) 2.58 at harvest. Where, pigeonpea + foxtail millet (1:2) recorded the lower leaf area index 1.62 at harvest. The leaf area index of pigeonpea was higher under sole cropping throughout the crop growth period compared to the intercropped treatments. This could be attributed to the absence of competition more space per pigeonpea plant which favoured leaf development and canopy expansion. Among the intercropping systems, pigeonpea + ricebean (1:1) and (2:4) maintained higher leaf area index, which might be favourable row arrangement and better utilization of available growth resources. Lower LAI under pigeonpea + foxtail millet (1:2) might be narrow row spacings to restrict canopy development most likely through shading and competition for soil moisture during peak vegetative growth. Similar result were reported by Chaudhary *et al.* (2021) ^[2] in pigeonpea + maize and Sundaram *et al.* (2021) ^[15] in pigeonpea + sorghum intercropping systems.

Conclusion

The study revealed that different row proportions significantly influenced the growth performance of pigeonpea under rainfed *Vertisol* conditions. Sole pigeonpea recorded the higher values for most growth parameters. Among the intercropping systems, pigeonpea + ricebean (1:1) and pigeonpea + ricebean (2:4) maintained comparatively better plant height, branching, dry matter accumulation, leaf area and leaf area index and were statistically on par with sole pigeonpea for growth parameters. The comparatively poor growth under pigeonpea + foxtail millet (1:2) indicated stronger competition for growth resources.

Table 1: Plant height (cm), number of primary branches plant⁻¹ and secondary branches plant⁻¹ of pigeonpea at harvest as influenced by different row proportion of intercrops

Treatment	Plant height	Primary branches	Secondary branches
T ₁ : Pigeonpea + ricebean (1:1)	165.5	13.4	14.4
T ₂ : Pigeonpea + ricebean (1:2)	147.9	11.4	11.7
T ₃ : Pigeonpea + ricebean (1:3)	143.7	10.9	10.9
T ₄ : Pigeonpea + ricebean (2:2)	151.0	10.5	12.2

T ₅ : Pigeonpea + ricebean (2:4)	160.1	12.8	13.4
T ₆ : Pigeonpea + foxtail millet (1:2)	137.3	10.1	9.3
T ₇ : Sole pigeonpea	177.7	14.6	15.4
T ₈ : Sole ricebean	-	-	-
S.E.m.±	6.6	0.6	0.6
CD at 5%	19.4	1.8	2.1

Table 2: Total dry matter production (g plant⁻¹), Leaf area (dm² plant⁻¹) and Leaf area index of pigeonpea at harvest as influenced by different row proportion of intercrops.

Treatment	Total dry matter production	Leaf area	Leaf area index
T ₁ : Pigeonpea + ricebean (1:1)	203.4	71.2	2.63
T ₂ : Pigeonpea + ricebean (1:2)	170.7	54.2	2.10
T ₃ : Pigeonpea + ricebean (1:3)	164.4	51.5	1.90
T ₄ : Pigeonpea + ricebean (2:2)	172.5	61.8	2.29
T ₅ : Pigeonpea + ricebean (2:4)	197.4	69.8	2.58
T ₆ : Pigeonpea + foxtail millet (1:2)	151.1	50.3	1.62
T ₇ : Sole pigeonpea	213.5	76.8	2.84
T ₈ : Sole ricebean	-	-	-
S.E.m.±	6.3	2.5	0.06
CD at 5%	19.1	7.9	0.21

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