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IMPACT OF INTERCROPPING WITH SPECIALTY CORN AND PARCHING SORGHUM ON GROWTH, YIELD ATTRIBUTES AND SYSTEM PRODUCTIVITY OF PIGEON PEA

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ABSTRACT

An investigation was carried out at 'K' Block, Zonal Agricultural Research Station, University of Agricultural Sciences, Gandhi Krishi Vignana Kendra, Bengaluru, during *Kharif* season of 2023 to study the effect of different intercrops on physiological growth, yield attributes, system productivity and economics of pigeon pea. The experiment laid out in Randomized Complete Block Design comprised of five treatments *viz.* T_1: Sole Pigeon pea, T_2: Pigeon pea + Field bean (1:2), T_3: Pigeon pea + Sweet corn (1:2), T_4: Pigeon pea + Baby corn (1:2) and T_5: Pigeon pea + Parching sorghum (1:2) with four replications. The results of the experiment demonstrated that among the different intercropping systems, pigeon pea + Field bean (1:2), pigeon pea recorded significantly higher plant height (158 cm), leaf area (2834.6 cm^2 $plant^{-1}$), total dry matter production (110.4 g $plant^{-1}$), number of pods per plant (90.4), pod yield per plant (56.72 g $plant^{-1}$), seed yield (885 kg ha^{-1}) and stalk yield (1593 kg ha^{-1}). Among the intercropping systems, pigeon pea + Sweet corn (1:2) recorded significantly higher pigeon pea equivalent yield (5450 kg ha^{-1}) and net returns (¹ 2,89,569 ha^{-1}).

Key words : Pigeon pea, Field bean, Sweet corn, Baby corn, Parching sorghum, Pigeon pea Equivalent Yield, Net returns.

Introduction

Agricultural intensification and sustainable resource utilization has become paramount in the context of increasing food demand, limited land availability and climatic uncertainties. Food and Agricultural Organization (FAO) estimates revealed that 50 per cent more food grains need to be produced by 2030 (Abrol *et al.*, 2008) to feed the growing population. Pulse production in the country is not keeping pace with demand driven by population because of diminishing land holding sizes and competition for land from cereals, commercial crops and horticulture crops. Scope of extending area under pulses as pure stand is blinking. In rainfed and semi-arid regions, intercropping has emerged as a reliable strategy for maximizing productivity, improving soil health, enhancing resource use efficiency and minimizing risk under variable environmental conditions. Thus, objective of intercropping is now more towards augmenting the total productivity per unit area of land per unit time by growing more than one crop in the same piece of land either simultaneously or sequentially for better utilization of environmental resources (Rajat and Singh, 1979). Among various cropping systems, intercropping of pigeon pea with high value crops (Sweet corn, Baby corn and parching

sorghum) and pulses (fieldbean and others) has shown promising results in terms of biological and economic efficiency (Akchaya *et al*., 2025).

Pigeon pea [*Cajanus cajan* (L.) Millsp.], a widely grown *Kharif* legume in tropical and subtropical regions occupies a prominent place in Indian dry land agriculture and serves as a crucial source of dietary protein, especially in vegetarian diet. It is also recognized for its deeper rhizosphere has the ability to overcome short intermittent dry spells and ability to improve soil fertility through biological nitrogen fixation. Morphological features like long duration and slow initial growth and elasticity nature of pigeon pea, accommodate more number of short duration crops and fast growing crops such as sweet corn, baby corn adds to increase number of products / crops / per unit area in same land in a year under rainfed situation due to positive below and above ground spatial annidation. In recent years, specialty corn varieties (such as sweet corn, baby corn) have gained popularity due to their market value, nutritional benefits and processing potential. Similarly, parching sorghum, used in traditional food preparations and snacks, has substantial demand in local markets. Integrating such high-value cereals with Pigeon pea not only ensures diversified production but also increases profitability for small and marginal farmers (Sharma *et al*., 2011).

The intercropping of pigeon pea with specialty corn and parching sorghum presents a strategic approach for optimizing land and time use. Pigeon pea is a relatively slow growing in its initial stage while, corn and sorghum exhibit fast initial growth and can efficiently utilize the available resources during the early phase of pigeon pea development. This complementary growth behaviour reduces competition and facilitates efficient utilization of sunlight, soil moisture and nutrients, leading to enhanced system productivity. Furthermore, such intercropping systems provide multiple harvests in a single season, offering better income stability to farmers. Specialty corn and sorghum are harvested earlier, leaving the the competition free condition for pigeon pea to grow and mature later, thereby reducing pressure on labour for harvesting and processing. The integration of legumes with cereals also supports the principles of sustainable agriculture, such as soil fertility enhancement, weed suppression and pest/disease diversification (Pagar *et al*., 2024).

The performance of any intercropping system is best evaluated through system-based parameter such as Pigeon pea Equivalent Yield (PEY). These indices help determine the biological efficiency and economic viability of intercropping systems compared to sole cropping (Rathod *et al*., 2004). The present study evaluating the influence of intercropping pigeon pea with specialty corn and parching sorghum on growth, yield attributes and system productivity is crucial for developing region-specific recommendations. This study aims to understand the interaction effects among the component crops and to quantify the advantages in terms of resource use efficiency, system yield and economic returns. The results can contribute significantly to designing resilient cropping systems that are adaptable to climate variability and resource constraints.

Materials and Methods

The field experiment was conducted in *Kharif* 2023 at K Block, Zonal Agricultural Research Station, University of Agricultural Sciences, Gandhi Krishi Vignana Kendra, Bengaluru, which is situated in the Agro-Climatic Zone V (Eastern Dry Zone) of Karnataka at 13^0 08' N latitude and 77^0 57' E longitude and at an altitude of 924 meters above mean sea level. The experiment was laid out in Randomized Complete Block Design comprising five treatments *viz.* T_1: Sole Pigeon pea, T_2: Pigeon pea + Field bean (1:2), T_3: Pigeon pea + Sweet corn (1:2), T_4: Pigeon pea + Baby corn (1:2) and T_5: Pigeon pea + Parching sorghum (1:2) with four replications. Pigeon pea crop was used as main crop and the intercrops used were field bean, sweet corn, Baby corn and Parching sorghum.

The recommended dose of farm yard manure (8 t ha^{-1}) was applied to the experimental plots fifteen days prior to sowing. The recommended dose of fertilizers (NPK kg ha^{-1}) for the main (Pigeon pea- 25:50:25) and component crops (Field bean- 25:50:25, Sweet corn- 100:50:25, Baby corn- 150:75:40 and Sorghum- 65:40:40) was followed and full dose of the main crop and half recommended dose of the intercrops given in the form of urea, diammonium phosphate and muriate of potash as basal dose. Five plants from each plot were randomly selected from the net plot were tagged and used for recording the observations on different physiological growth and yield attributes. The plants from the gross plot for each treatment were cut above the ground and leaves were fed to leaf area meter for estimating the photosynthetically active area (leaf area). The same plants were oven dried at 65°C and the dry weight per plant was recorded.

Results and Discussion

Growth parameters of pigeon pea

The data pertaining to growth attributes of pigeon pea as influenced by different intercrops are presented in Table 1.

Table 1 : Growth parameters of pigeon pea as influenced by different intercrops in pigeon pea based cropping system.

Treatment	Plant height (cm)	Branches number plant^{-1}	Leaf area (cm^2 plant^{-1})	Total dry matter accumulation (g plant^{-1})
T_1: Sole Pigeon pea	165	14.8	3642.4	110.4
T_2: Pigeon pea + Field bean (1:2)	158	13.2	2834.6	96.6
T_3: Pigeon pea + Sweet corn (1:2)	135	7.4	2184.6	78.2
T_4: Pigeon pea + Baby corn (1:2)	141	8.1	2264.4	81.4
T_5: Pigeon pea + Parching sorghum (1:2)	147	9.6	2412.5	85.5
SEm±	4.02	0.75	56.36	1.76
CD @ 5%	12.40	2.31	161.65	5.05

Table 2 : Yield parameters of pigeon pea as influenced by different intercrops in pigeon pea based cropping system.

Treatment	No of pods plant^{-1}	No of seeds pod^{-1}	Pod yield (g plant^{-1})	Seed yield (g plant^{-1})	Test weight (g)
T_1: Sole Pigeon pea	94.2	5.2	60.19	43.7	16
T_2: Pigeon pea + Field bean (1:2)	90.4	5.0	56.72	40.5	16
T_3: Pigeon pea + Sweet corn (1:2)	54.4	4.5	51.31	33.2	14
T_4: Pigeon pea + Baby corn (1:2)	58.3	4.7	53.05	35.6	15
T_5: Pigeon pea + Parching sorghum (1:2)	61.5	4.8	54.4	37.4	15
SEm±	5.31	0.23	4.35	2.30	0.71
CD @ 5%	16.37	0.71	13.40	7.09	2.19

Among the intercropping systems, pigeon pea + field bean (1:2) recorded significantly higher values of growth contributing characters of Pigeon pea *viz*., plant height (158 cm), total number of branches per plant (13.2), leaf area (2834.6 cm^2 plant^{-1}) and total dry matter production (110.4 g plant^{-1}). Whereas, significantly lower values were noticed in pigeon pea + sweet corn (1:2) (T_9) intercropping system.

The significantly higher growth parameters of pigeon pea, such as plant height, number of branches per plant, leaf area and total dry matter production was observed in the pigeon pea + field bean (1:2) intercropping system can be attributed to several complementary interactions between the component crops. Field bean, being a low-growing legume, exhibits a spreading growth habit that minimizes competition for sunlight, thereby allowing pigeon pea to receive adequate light for enhanced photosynthesis and vegetative growth. Additionally, as a legume, fieldbean fixes atmospheric nitrogen through symbiotic association with *Rhizobium*, which enriches soil nitrogen levels and benefits the nitrogen pool for pigeon pea. This might have lead to better vegetative growth, increased leaf area and higher dry matter accumulation. The presence of two legumes in the system might have also improved the soil health by increasing organic matter and microbial activity, which further supports robust growth. The pigeon pea + sweet corn (1:2) system recorded significantly lower growth attributes due to the aggressive and fast-growing nature of sweet corn, which competes heavily for light, nutrients and moisture. Being a tall and nutrient-exhaustive cereal crop, sweet corn shades the pigeon pea canopy and limits its photosynthetic activity in the vegetative stage might have resulted in reduced branching, leaf development and dry matter production. Furthermore, sweet corn does not contribute to soil nitrogen, unlike field bean, thereby providing no additional nutrient advantage to pigeon pea. Thus, the superior performance of pigeon pea in the pigeon pea + field bean intercropping system is largely due to complementary growth habits, enhanced nitrogen availability and improved resource use efficiency. These results are in agreement with the findings of Mallikarjun *et al*. (2018) and Shivakumar *et al*. (2021).

Yield parameters of pigeon pea

The yield attributes like number of pods per plant (90.4), number of seeds per pod (5.0), pod yield per plant (56.72 g plant^{-1}) and seed yield per plant (40.5 g plant^{-1}) were significantly higher in pigeon pea + field bean (1:2) intercropping system compared to pigeon pea + sweet corn (Table 2).

The significantly higher yield attributes of Pigeon pea

Table 3 : Yield of pigeon pea as influenced by different intercrops in pigeon pea based cropping system.

Treatment	Seed yield (kg ha^{-1})	Stalk yield (kg ha^{-1})	Harvest index
T_1: Sole Pigeon pea	924	1755	0.34
T_2: Pigeon pea + Field bean (1:2)	885	1593	0.36
T_3: Pigeon pea + Sweet corn (1:2)	465	976	0.32
T_4: Pigeon pea + Baby corn (1:2)	545	1110	0.33
T_5: Pigeon pea + Parching sorghum (1:2)	605	1245	0.33
SEm ±	33.91	108.23	0.01
CD @ 5%	104.50	333.48	0.02

of pigeon pea in this intercropping system. The results are in line with findings of Vilas (2018) and Njira *et al*. (2021).

Yield of pigeon pea

The data relating to yield of pigeon pea that differed significantly due to influence of different intercrops are depicted in Table 3.

Pigeon pea + field bean (1:2) intercropping system produced significantly higher pigeon pea seed yield (885 kg ha^{-1}), stalk yield (1593 kg ha^{-1}) and harvest index (0.36) as compared to pigeon pea +sweet corn intercropping system (465 kg ha^{-1}, 976 kg ha^{-1} and 0.32, respectively).

This might be due to the greater crop compatibility and synergistic effects in the legume-legume association. Field bean, being a low-statured, less competitive legume, allows pigeon pea to receive ample sunlight and utilize water and nutrients more efficiently, thus enhancing both in the pigeon pea + field bean (1:2) intercropping system due to the extended stress-free environment created by the legume-legume association during reproductive stage. Fieldbean, being less aggressive in resource uptake and with a compatible phenological pattern, might have allowed pigeon pea to experience less physiological stress during critical stages such as flowering and pod filling. These favourable microenvironments led to reduced flower and pod drop and better seed set. Moreover, its ability to fix atmospheric nitrogen enhanced soil fertility provided a steady nitrogen supply, promoting efficient pod setting and seed development in pigeon pea. Whereas, sweet corn is a fast-growing cereal with high nutrient demand and greater competition for light, moisture and nutrients, which might have adversely affected flowering and pod development in pigeon pea, resulting in significantly lower yield attributes. Hence, the overall compatibility and stress-mitigating effects of field bean contribute significantly to the enhanced yield attributes vegetative and reproductive growth. Additionally, biological nitrogen fixation by field bean enriches the soil nitrogen pool, supporting better flowering, pod filling and seed development in pigeon pea. This led to higher biomass accumulation and improved photosynthates partitioning towards economic yield, reflected in a higher harvest index. These results were supported by Marer *et al*. (2007) and Araj *et al*. (2024).

Table 4 : Pigeon pea equivalent yield as influenced by different intercrops in pigeon pea based cropping system.

Treatment	Pigeon pea seed yield (kg ha^{-1})	Inter crops grain/seed yield (kg ha^{-1})	Pigeon pea equivalent yield (kg ha^{-1})
T_1: Sole Pigeon pea	924	-	924
T_2: Pigeon pea + Field bean (1:2)	885	443.2	941
T_3: Pigeon pea + Sweet corn (1:2)	465	5400	5450
T_4: Pigeon pea + Baby corn (1:2)	545	198.6	912
T_5: Pigeon pea + Parching sorghum (1:2)	605	795.7	2439
SEm ±	33.91	-	33.66
CD @ 5%	104.50	-	96.53

Pigeon pea equivalent yield

The data relating to pigeon pea equivalent yield (PEY) differed significantly due to influence of different intercrops is depicted in Table 4.

Among the intercropping systems, pigeon pea +sweet corn (1:2) recorded significantly higher pigeon pea equivalent yield (5450 kg ha^{-1}) followed by pigeon pea + parching sorghum (2439 kg ha^{-1}) and it was lower in pigeon pea + baby corn (1:2) intercropping system (912 kg ha^{-1}).

Table 5 : Economics of pigeon pea as influenced by different intercrops in pigeon pea based cropping system.

Treatment	Cost of cultivation (Rs ha^{-1})	Gross returns (Rs ha^{-1})	Net returns (Rs ha^{-1})	B:C Ratio
T_1: Sole Pigeon pea	35,995	60938	24943	1.69
T_2: Pigeon pea + Field bean (1:2)	40893	61986	21093	1.52
T_3: Pigeon pea + Sweet corn (1:2)	65144	354713	289569	5.45
T_4: Pigeon pea + Baby corn (1:2)	51544	59788	8244	1.16
T_5: Pigeon pea + Parching sorghum (1:2)	37783	159303	121520	4.22

The significantly higher pigeon pea equivalent yield (PEY) recorded in the pigeon pea + sweet corn (1:2) intercropping system primarily might be due to the high market value and greater economic yield of sweet corn, which substantially contributed to the overall system productivity despite the lower pigeon pea seed yield in the combination. Sweet corn produced a sizable green cob yield within a short duration and its high price of the fresh cobs boosted the monetary return per unit area, thereby elevating the PEY. The results are in line with findings of Garud *et al*. (2018) and Pagar *et al*. (2024).

Economics of pigeon pea based intercropping system

The data pertaining to economics of pigeon pea based intercropping system as influenced different intercrops are depicted in Table 5.

Among different intercropping, the higher gross returns (` 3,54,713 ha$^{-1}$), net returns (` 2,89,569 ha^{-1}) were obtained with intercropping system pigeon pea + sweet corn (1:2) with benefit cost ratio (5.45) followed by treatment pigeon pea + parching sorghum (1:2) which recorded the gross returns (` 1,59,303 ha$^{-1}$), net returns (` 1,21,520 ha^{-1}) and benefit cost ratio (4.22).

It may be due to combined yield of both pigeon pea and sweet corn along with higher market price of the high value crop sweet corn. Even though pigeon pea faced competition from this crop for growth resources and reduction in its growth and yield but the higher income was obtained from better price of intercrop, thereby increased the system productivity. These results were supported by Kumar *et al*. (2017) and Yadav *et al*. (2021).

Conclusion

Based on the results of the present study, it can be concluded that the performance of pigeon pea in terms of growth, yield attributes and seed yield was significantly superior when intercropped with field bean (1:2) due to the compatible nature of the legume-legume system, reduced competition and improved soil fertility through biological nitrogen fixation. This combination enhanced the overall plant growth, reproductive success and biomass production of pigeon pea. However, in terms of system productivity and economic returns, the pigeon pea + sweet corn (1:2) intercropping system proved most profitable, recording the higher pigeon pea equivalent yield, gross and net returnsand benefit-cost ratio, primarily due to the high market value and economic yield of sweet corn. Despite the competitive effects of sweet corn on pigeon pea growth, the higher economic returns from the intercrop significantly contributed to the profitability of the system. Thus, for maximizing pigeon pea growth and seed yield, pigeon pea + field bean is ideal, whereas for maximizing total system productivity and profitability, pigeon pea + sweet corn is the most efficient intercropping system.

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Competing interests

Authors have declared that no competing interest exists.

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