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Impact of Spacing Variability on Pigeon Pea Genotypes: A Study of Growth Evaluation, Productivity, Quality, and Profitability

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ABSTRACT: The field experiment was conducted to study the Pigeon Pea varieties AL 882 and Pusa Arhar 16 under different spacing in Amritsar region of Punjab during *kharif* 2019-2020 at Student's Research Farm, Department of Agriculture, Khalsa College, Amritsar, Punjab. Two varieties V_1 (Pusa Arhar 16) and V_2 (AL 882) were tested under different spacing S_1 (30 ×12.5), S_2 (40 × 12.5), S_3 (50 × 12.5), S_4 (30 × 25), S_5 (40×25), S_6 (50×25cm) in Factorial Randomized Block Design and replicated thrice. The primary limitations in pigeon pea cultivation in Punjab are cultivar selection and optimal spacing. The results revealed that cv. AL 882 performed better under spacing 30×12.5 cm for growth parameters such as plant height and LAI whereas dry matter accumulation, crop growth rate and number of primary and secondary branches were significantly higher in spacing 50×25 cm. Quality parameters recorded non-significant results under different spacing and varieties. Among yield parameters, seed yield, harvest index, net returns and benefit cost ratio were maximum in wider spacing 50×25cm and narrow spacing 30×12.5 cm with cv. AL 882 and cv. Pusa Arhar 16, respectively. However, both varieties produced highest stover yield and biological yield under narrow spacing 30×12.5 cm.

Keywords: Economics, Pigeon Pea, AL 882, Pusa Arhar 16, Spacing, Yield Attributes.

INTRODUCTION

Pulses, specifically pigeon pea (*Cajanus cajan (L.) Millsp*), are a primary dietary staple for vegetarians in the Indian subcontinent. India, a global leader in pulse production, accounts for approximately one-third of global pulse acreage and one-fourth of global pulse output (Anonymous, 2020). Pigeon pea is a versatile crop that is cultivated in a wide range of environmental conditions in tropical and sub-tropical regions worldwide as a monocrop or intercrop. This crop covers an area of 7.02 million hectares and yields 6.8 million tonnes globally (Anonymous, 2017).

Pigeon pea is a resilient plant that can thrive in challenging environments and withstand recurring droughts. The green pigeon pea pods are consumed as a vegetable in many regions, while dried seeds are used to make split dhal. This crop is also utilized as a feed for cattle, with its straw and green leaves serving as valuable fodder. Pigeon pea is a rich source of protein (68%), fiber, and low in fat, salt, and cholesterol (Wilson *et al.*, 2012).

India is the largest producer of pigeon pea, with 5.3 million hectares under cultivation, producing 4.8 million tonnes (Anonymous, 2017). However, despite this, the area covered by pulses is inadequate to meet the per capita need for pulse availability, resulting in a significant shortage of pulses in India and exacerbating malnutrition among the vegetarian population. Thus, there is enormous potential to enhance pulse productivity via various agronomic treatments (Mallikarjun *et al.*, 2014). Crop establishment is a significant barrier for crop productivity (Kumar *et al.*, 2023; Singh *et al.*, 2022).

In Punjab, pigeon pea cultivation is limited to 8,000 hectares, with a total yield of 7,000 tonnes and an average productivity of 875 kg/ha, providing significant opportunities for boosting productivity through various agronomic approaches (Anonymous, 2020a). The primary limitations in pigeon pea cultivation in Punjab are cultivar selection and optimal spacing. Traditional early pigeon pea varieties exhibit indeterminate growth, resulting in excessive vegetative growth. However, recent introductions of dwarf varieties, such as ICAR (Pusa Arhar 16) and PAU (AL 882), exhibit less leaf cover, higher yields, and shorter heights, making them ideal for close planting. Nonetheless, optimal spacing for these new varieties must be determined.

MATERIALS AND METHODS

A field experiment was conducted at the Students' Farm located in the Department of Agriculture, Khalsa College, Amritsar, Punjab, during the kharif season of 2019 to investigate the growth, quality, and profitability of two pigeon pea varieties (Pusa Arhar 16 and AL 882) grown at varying spacings. The experimental site's climate falls under the subtropical category, and the total rainfall during the crop-growing season was 583.33 mm. The weekly maximum and minimum temperatures during the trial period ranged between 24.3°C to 43.6°C and 11.2°C to 28.9°C, respectively.

The experimental field's soil was sandy loam with low organic carbon (0.45%), available nitrogen (164 kg/ha), and available potassium (235 kg/ha). However, the accessible phosphorus was high (28.5 kg/ha), and the soil reaction was nearly neutral (pH 7.1), with an electrical conductivity of 0.26 dS/m.

The experimental design employed a factorial randomized block design with two varieties (V1: Pusa Arhar 16 and V2: AL 882) and 6 crop geometries (S1: 30×12.5; S2: 40×12.5; S3: 50×12.5; S4: 30×25; S5: 40×25; S6: 50×25cm). All treatment combinations were replicated thrice. The pigeon pea seeds were treated with Rhizobium culture and sown in well-prepared soil using a single-row hand-operated drill in a net plot area of 6.0×3.0m, with the amount of seeds varying as per the spacing. A uniform basal dose of 87.5 kg/ha P2O5 and 50 kg/ha K2O was applied through SSP and MOP before sowing the crop, respectively. Phosphorus and potassium were applied as basal dose at the time of sowing. One pre-sowing irrigation was applied to the crop seven days before sowing, and post-sowing irrigation was applied to the crop eight days after sowing. One spray of pendimethalin @ 450 g/ha at 1 DAS followed by one hoeing was done to control the emerged weeds at 50 DAS as per recommended package of practices. The crop was harvested manually with a sickle, tied in bundles with tags from each plot, and left for sun drying. Threshing operations were also performed plot-wise manually.

The growth parameters, such as plant height (cm), dry matter/plant (g/plant), LAI, CGR, and the number of primary and secondary branches at 30,60,90,120 DAS, were recorded. Yield attributes and yield, such as pods/plant, seeds/pod, 100 seed weight (g), seed yield (kg/ha), and stover yield (kg/ha) were recorded at the time of pigeon pea harvesting. The statistical analysis of the data was done using the EDA software developed by the Department of Mathematics and Statistics, PAU, Ludhiana.

RESULTS AND DISCUSSION

Growth analysis

Plant height. The observed differences in the height of plants did not reach statistical significance as indicated by the data presented in Figure 1 and Table 1. Nevertheless, a wider spacing of rows (50 cm x 25 cm) resulted in the greatest plant height throughout the plant's life cycle. Similar results were obtained by Ihsanullah *et al.,* (2002), but these findings conflict with those reported by Mehmud *et al.* (1997) who observed a reduction in plant height with increasing row spacing in black gram. Notably, cv. AL 882 exhibited substantially greater plant height than cv. Pusa Arhar 16, which could be attributed to inherent genetic differences between these cultivars. These observations are consistent with those reported by Mallikarjun *et al.,* (2015).

Leaf area index. The Leaf Area Index (LAI) exhibited significant variation depending on the spacing treatments, with the 30×12.5 cm spacing displaying the highest LAI, followed by the 40×12.5 cm, 50×12.5 cm, 30×25 cm, 40×25 cm, and 50×25 cm treatments (as shown in Figure 2 and Table 1). During the crop growth period, LAI differed considerably, although the S5 and S6 treatments were statistically equivalent. The elevated leaf area index observed in the narrower spacing treatments may be attributed to higher plant density. Similar results were reported by Saritha *et al.,* in 2012. The cultivars exhibited significant differences, with the AL 882 cultivar having a higher leaf area index than the Pusa Arhar 16 cultivar. This variation could be attributed to genetic differences between the two genotypes. These findings were consistent with those reported by Walelign *et al.* (2012).

Periodic dry matter accumulation. During the period of plant growth, there was a significant increase in the accumulation of dry matter in the 50×25cm spacing treatment, followed by the 40×25, 30×25, 50×12.5, 40 cm × 12.5 cm, and 30×12.5cm treatments (as illustrated in Figure 3 and Table 1). At 60, 90, and 120 days after sowing (DAS), there were no significant differences in dry matter accumulation between S1 and S2, S3, and S4, between S2 and S3, S4, and S5, and between S3 and S4, S5, and S6, indicating that these treatments had similar results. This could be due to increased plant growth and improved exposure to solar radiation. In terms of plant varieties, cv. AL 882 showed significantly higher dry matter accumulation than cv. Pusa Arhar 16. This could be attributed to differences in their growth habits.

Crop growth rate (CGR). The Crop Growth Rate (CGR) exhibited an increasing trend until the crop reached a 90-day age, following which it demonstrated a decline as illustrated in Figure 4 and and Table 2. During the crop's growing period, the CGR showed non-significant findings at different spacing levels in pigeon pea except at the 60-day stage. S6 (50x25 cm) demonstrated the highest CGR, followed by S5 (40x25 cm), S4 (30x25 cm), S3 (50x12.5 cm), S2 (40x12.5 cm), and S1 (30x12.5 cm). This was reported by Suresh *et al.,* in 2012. Furthermore, the CGR was substantially greater in the AL 882 cultivar compared to the Pusa Arhar 16 cultivar. These differences in CGR may be related to varietal characteristics.

Number of branches per plant. The findings displayed in Table 2 indicate that spacing 50×25 cm exhibited a considerably greater number of primary and secondary branches compared to the other spacings of 40×25, 30×25, 50×12.5, 40×12.5, and 30×12.5 cm. Spacing S6 was found to be similar to S5 spacing and produced a substantially greater number of main branches than any other spacing. At 60, 90, and 120 days after sowing (DAS), S6 displayed 71.4%, 63.5%, and 43.3% more main branches than S1. Wider spacing generates more primary branches when compared to narrower spacing. This might be attributed to an increase in available horizontal space resulting in an improvement in plant geometry. Mula *et al.,* (2010) reported similar results, indicating that wider spacing and lower plant population density favor a higher number of branches.

Regarding the secondary branches, S6 produced significantly more secondary branches than all other spacings except for S5 at 90 DAS. However, at 120 DAS, S4 was also similar to S6. It was observed that S6 displayed 65.6% and 24.6% more secondary branches than S1 at 90 and 120 DAS, respectively. Wider spacing fosters the growth of a greater number of primary branches than narrower spacing due to the increased availability of horizontal space leading to improved plant geometry. Mula *et al.* (2010) reported similar findings, indicating that wider spacing and lower plant population density favor a greater number of branches.

Additionally, the variety cv. AL 882 exhibited 13.5%, 44.8%, and 26.1% more primary branches at 60, 90, and 120 DAS, respectively, as well as 19.6% and 13.1% more secondary branches than cv. Pusa Arhar 16 at 90 and 120 DAS, respectively. This could be due to the genetic potential and better resource utilization of cv. AL 882 compared to cv. Pusa Arhar 16. Kaur *et al.,* (2018) ; Chandrakar *et al.,* (2022); Bansal *et al.,* (2022) reported similar findings.

Yield parameters

Seed yield. The passage presents findings from an experiment conducted to determine the effect of spacing and variety on seed yield in two varieties of arhar (pigeon pea): cv. Pusa Arhar 16 and cv. AL 882 (Table 3). The results indicate that the maximum mean seed yield was recorded in the spacing of 30×12.5 cm, followed by 50×25, 50×12.5, 40×12.5, 40×25, and 30×25 cm. It was also observed that cv. AL 882 produced a significantly higher mean yield than cv. Pusa Arhar 16, showing 5.9% more seed yield (Kashyap *et al.*, 2003).

The interaction between varieties and spacing was found to be significant, with cv. Pusa Arhar 16 producing the highest yield at 30 cm × 12.5 cm, and cv. AL 882 producing the highest yield at 50×25 cm (Table 4) . Interestingly, cv. Pusa Arhar 16 showed a 3.1% more seed yield than cv. AL 882 at 30×12.5 cm, while cv. Pusa Arhar 16 produced 98.8% less seed yield as spacing increased from S1 to S6, and cv. AL 882 produced 63.6% more yield under S6 than S1. The difference in yield between the two varieties at different spacing might be attributed to the genetic characteristics of each variety. Additionally, the dwarf nature of cv. Pusa Arhar 16 may have contributed to its higher yield at closer spacing, as it requires less space per plant than cv. AL 882.These findings align with previous studies conducted by Mallikarjun *et al.* (2015); Umesh *et al.* (2012).

Biological yield. The data presented in Table 3 demonstrates the impact of different spacing and varieties on the biological yield. The spacing of 30×12.5 cm resulted in a slightly higher biological yield than other spacing options, such as 40×12.5 cm, 50×12.5 cm, 30×25 cm, 40×25 cm, and 50×25 cm. The spacing treatments S1 (30×12.5) with S2 (40×12.5), S2 with S3 (50×12.5), S3 with S4 (30x25), S5 (40x25) with S4, and S4 with S6 (50×25 cm) were not significantly different from one another. Narrow spacing provides a greater number of plants per unit area and more stover yield, which may lead to higher biological yield per unit area. Among the varietal treatments, cv. AL 882 performed significantly better than the dwarf variety cv. Pusa Arhar 16 in terms of yield component values due to higher growth parameters and seed and stover yield.

Harvest Index. The study found that the highest harvest index of 21.12% was achieved with a spacing of 50×25 cm, followed by 40x25 (19.67%), 50×12.5 (19.59%), 30×25 (18.68%), 40×12.5 (18.61%) and 30×12.5 cm (18.39%). The spacing S6 (50×25) exhibited significantly higher harvest index than all other spacing types. This could be attributed to increased accumulation of dry matter, greater number of seeds per pod, and higher 100-seed weight at wider spacing (Table 3).

No significant difference was observed between the varieties tested, although cv. AL 882 (16.15%) showed a lower harvest index compared to cv. Pusa Arhar 16 (22.53%). This could be attributed to the dwarf character of cv. Pusa Arhar 16, which produces more grain to stover ratio.

The study found that the interaction between spacing and varieties was significant, with cv. Pusa Arhar 16 exhibiting the maximum harvest index of 25.38% at a spacing of 30×12.5 cm, whereas cv. AL 882 exhibited the highest harvest index of 21.75% at a spacing of 50×25cm. The harvest index of cv. Pusa Arhar 16 at 30×12.5 cm was 14.30% higher than that of cv. AL 882 at 50×25cm (Table 5) . These differences may be attributed to varietal differences in yield attributes.

Nutrient content in seed and stover at harvest. The study found that the levels of nitrogen (N), phosphorus (P), and potassium (K) in the seeds and stems of the plants were not significantly affected by different spacing methods. The numerical data in Table 3 shows that the highest levels of these nutrients were observed in plants grown with a spacing of 50×25 cm, followed by those grown with a spacing of 40×25, 30×25, 50×12.5, 40×12.5, and 30×12.5 cm, respectively.

Furthermore, the nitrogen (N), phosphorus (P), and potassium (K) content in the seeds and stems of the AL 882 variety did not differ significantly from that of the Pusa Arhar 16 variety. This similarity in nutrient uptake may be due to the comparable growth of both the shoot and root systems, allowing for comparable nutrient absorption from the soil. These findings are consistent with those published by Goud *et al.* (2012).

Protein content in seed. The determination of seed quality is significantly influenced by the protein content present in seeds. Analysis of Table 3 data revealed that the protein content in pigeon pea seeds was not significantly affected by either the spacing or the variety used. The highest protein content (22.5 %) was observed in seeds from a spacing of 50×25 and 40×25cm, followed by spacing of 30×25 and 50×12.5 cm (21.8 %), and finally 40×12.5 and 30×12.5 cm (21.2 %). The difference in protein content between narrow and wide spacing was insignificant, and the increase in protein content could be attributed to the heightened protein synthesis activity of enzymes involved at various spacing levels. The protein content in cv. Pusa Arhar 16 and cv. AL 882 pigeon pea seeds did not vary significantly due to their similar plant morphology. These findings align with previous studies conducted by Babu *et al.* (2014) and Saxena *et al.* (2002).

Economics. Table 6 and 7 reports that AL 882 at a planting density of 50×12.5 cm resulted in significantly greater net returns compared to cv. Pusa Arhar 16 at a density of 30×12.5 cm. This is attributed to the higher stover yield of AL 882 when grown at wider spacing S6, which resulted in slightly greater net returns compared to Pusa Arhar 16 grown at wider spacing S1. Additionally, Table 6 and 7 shows that the highest mean net returns and benefit cost ratio were observed at a planting density of 30×12.5 cm, followed by 50×25, 50×12.5, 40×12.5, 40×25, and 30×25 cm. Among the two cultivars, AL 882 outperformed Pusa Arhar 16 in terms of yield and profitability. These findings align with previous studies conducted by Babu *et al.* (2014); Tuppad *et al.* (2012).

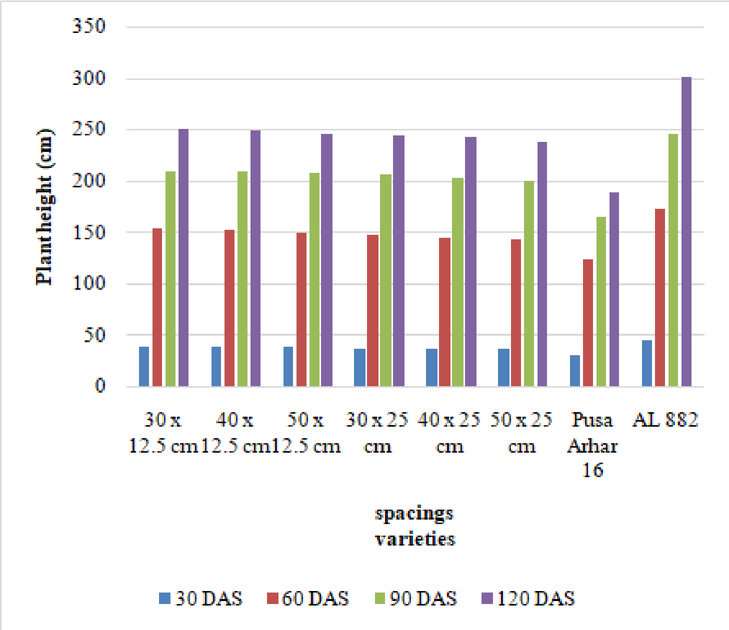

Fig. 1. Periodic plant height (cm) as affected by different spacings and varieties of Pigeon Pea.

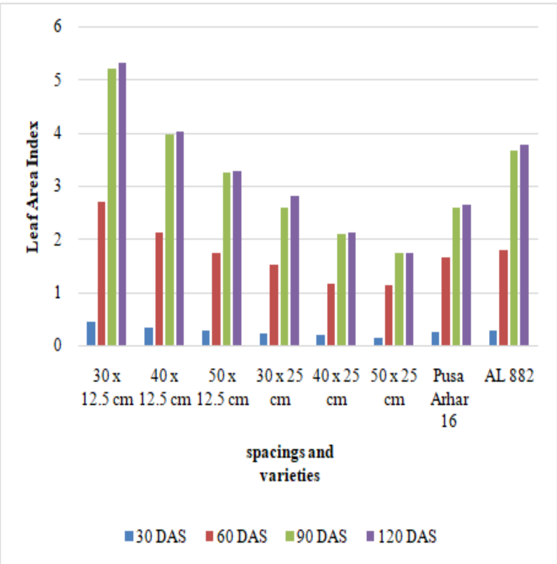

Fig. 2. Periodical Leaf Area Index (LAI) as affected by different spacings and varieties of Pigeon Pea.

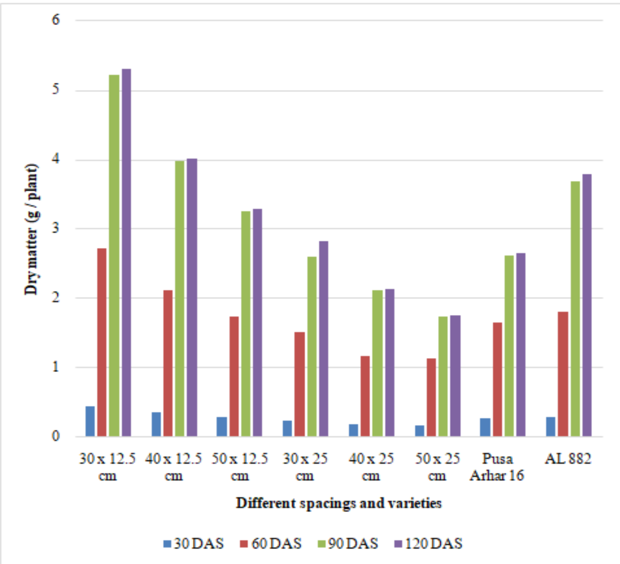

Fig 3. Dry matter (g/plant) as affected by different spacing and varieties of Pigeon Pea.

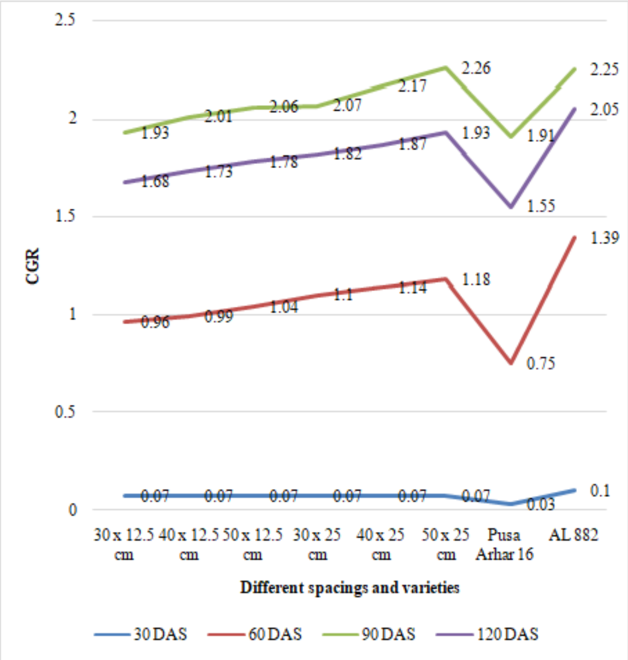

Fig. 4. CGR as affected by different spacings and varieties of Pigeon Pea.

Table 1: Periodic plant height (cm), Periodical leaf area index (LAI) and Dry matter (g/plant) as affected by different spacing and varieties of pigeon pea.

Treatments	Plant height (cm)				Leaf area index (LAI)				Dry matter (g / plant)			
	30 DAS	60 DAS	90 DAS	120 DAS	30 DAS	60 DAS	90 DAS	120 DAS	30 DAS	60 DAS	90 DAS	120 DAS
Spacing (cm)												
S_1 (30 x 12.5)	38.90	153.96	210.31	250.63	0.44	2.72	5.23	5.33	1.98	30.75	88.50	138.83
S_2 (40 x 12.5)	38.10	152.18	209.26	249.75	0.34	2.12	3.98	4.03	2.00	31.72	91.90	143.70
S_3 (50 x 12.5)	37.82	149.66	208.03	247.31	0.27	1.73	3.26	3.30	2.00	33.35	95.09	148.44
S_4 (30 x 25)	36.67	148.05	206.50	245.41	0.23	1.51	2.60	2.83	2.03	35.05	97.28	151.74
S_5 (40 x 25)	36.27	145.43	203.21	243.65	0.18	1.16	2.11	2.13	2.03	36.16	101.21	157.37
S_6 (50 x 25)	35.88	143.26	200.73	239.03	0.15	1.13	1.73	1.75	2.05	37.49	105.15	163.03
SEm ±	1.23	4.92	6.88	7.54	0.01	0.06	0.13	0.15	0.06	1.53	3.71	5.41
CD (p=0.05)	NS	NS	NS	NS	0.03	0.20	0.41	0.46	NS	4.49	10.87	15.88
Variety												
V_1 (Pusa Arhar 16)	30.26	123.75	165.82	190.11	0.26	1.65	2.61	2.66	0.95	23.47	80.86	127.23
V_2 (AL 882)	44.28	173.77	246.86	301.81	0.28	1.81	3.69	3.80	3.07	44.70	112.18	173.82
SEm ±	0.71	2.85	3.97	4.36	0.01	0.03	0.08	0.09	0.03	0.88	2.13	3.12
CD (p=0.05)	2.07	8.35	11.64	12.77	NS	0.11	0.23	0.27	0.11	2.59	6.27	9.17
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2: CGR (g plant^{-1} day^{-1}), Primary branches and Secondary branches as affected by different spacing and varieties of pigeon pea.

Treatments	CGR (g plant^{-1} day^{-1})				Primary branches			Secondary branches	
	30 DAS	60 DAS	90 DAS	120 DAS	60 DAS	90 DAS	120 DAS	90 DAS	120 DAS
Spacing (cm)									
S_1 (30 x 12.5)	0.07	0.96	1.93	1.68	3.50	7.67	15.00	4.83	12.17
S_2 (40 x 12.5)	0.07	0.99	2.01	1.73	4.17	8.50	16.33	5.33	12.50
S_3 (50 x 12.5)	0.07	1.04	2.06	1.78	4.67	9.17	17.67	5.67	13.17
S_4 (30 x 25)	0.07	1.10	2.07	1.82	5.00	10.00	18.83	6.50	13.83
S_5 (40 x 25)	0.07	1.14	2.17	1.87	5.50	11.33	20.17	7.00	14.50
S_6 (50 x 25)	0.07	1.18	2.26	1.93	6.00	12.50	21.5	8.00	15.17
SEm ±	0.00	0.05	0.11	0.06	0.24	0.49	0.63	0.29	0.56
CD (p=0.05)	NS	0.15	NS	NS	0.71	1.45	1.87	0.86	1.64
Variety									
V_1 (Pusa Arhar 16)	0.03	0.75	1.91	1.55	4.50	8.05	16.33	5.67	12.72
V_2 (AL 882)	0.10	1.39	2.25	2.05	5.11	11.66	20.16	6.78	14.39
SEm ±	0.00	0.03	0.07	0.03	0.14	0.28	0.36	0.16	0.32
CD (p=0.05)	NS	0.09	0.20	0.10	0.41	0.83	1.07	0.50	0.94
Interaction	NS	NS	NS	NS	1.84	NS	NS	NS	NS

Table 3: Effect of spacing and varieties on yield and N, P and K content and uptake of nutrients by seed, stover and seed protein (%) of pigeon pea.

Treatment	Seed yield (q/ha)	Stover yield (q/ha)	Biological yield (q ha^{-1})	Harvest index (%)	Nutrient content in Seed (%)			Nutrient content in Stover (%)			Seed protein content (%)
					N	P	K	N	P	K	
Spacing (cm)											
S_1 (30 x 12.5)	13.08	60.62	73.71	18.61	3.43 (39.47)	0.41 (4.68)	0.71 (8.27)	0.92 (43.79)	0.06 (2.89)	1.34 (64.45)	21.22
S_2 (40 x 12.5)	12.15	57.38	69.52	18.39	3.45 (36.87)	0.42 (4.56)	0.72 (7.80)	0.93 (42.74)	0.06 (2.77)	1.37 (62.96)	21.28
S_3 (50 x 12.5)	12.23	53.21	65.44	19.59	3.49 (37.53)	0.44 (4.74)	0.73 (7.95)	0.94 (39.84)	0.07 (2.98)	1.43 (60.87	21.34
S_4 (30 x 25)	11.06	49.91	60.98	18.68	3.54 (34.95)	0.46 (4.54)	0.75 (7.48)	0.96 (39.07)	0.07 (2.86)	1.49 (60.64)	21.42
S_5 (40 x 25)	11.59	48.31	59.90	19.67	3.57 (36.45)	0.47 (4.78)	0.77 (7.93)	0.97 (36.55)	0.07 (2.65)	1.52 (57.29)	21.52
S_6 (50 x 25)	12.28	45.73	58.00	21.12	3.66 (38.61)	0.48 (5.03)	0.78 (8.26)	0.98 (34.71)	0.07 (2.50)	1.55 (55.03)	21.64
SEm ±	0.40	1.86	1.98	0.84	0.04	0.02	0.03	0.03	0.00	0.05	0.14
CD (p=0.05)	1.19	5.47	5.80	NS	NS	NS	NS	NS	NS	NS	NS
Variety											
V_1 (Pusa Arhar 16)	11.72	39.98	51.69	22.53	3.52 (36.28)	0.46 (4.65)	0.76 (7.80)	0.95 (30.01)	0.07 (2.08)	1.45 (45.46)	21.58
V_2 (AL 882)	12.41	65.08	77.48	16.15	3.51 (38.40)	0.43 (4.79)	0.74 (8.09)	0.93 (48.88)	0.07 (3.45)	1.44 (74.94)	21.55
SEm ±	0.23	1.07	1.14	0.48	0.01	0.01	0.01	0.01	0.00	0.03	0.08
CD (p=0.05)	0.69	3.16	3.35	1.42	NS	NS	NS	NS	NS	NS	NS

Uptake of nutrients by seed and stover are presented in bracket

Table 4: Interaction effect of different spacing and varieties on seed yield(q/ha) of pigeon pea.

Spacing (cm) → Varieties ↓	S_1 (30 x 12.5)	S_2 (40 x 12.5)	S_3 (50 x 12.5)	S_4 (30 x 25)	S_5 (40 x 25)	S_6 (50 x 25)
V_1 (Pusa Arhar 16)	16.42	13.58	12.59	9.90	9.19	8.26
V_2 (AL 882)	9.74	10.71	11.85	12.21	13.98	15.93
SEm ±	0.57					
CD (p=0.05)	1.68					

Table 5: Interaction effect of different spacing and varieties on harvest index (%)of pigeon pea.

Spacing (cm) → Varieties ↓	S_1 (30 x 12.5)	S_2 (40 x 12.5)	S_3 (50 x 12.5)	S_4 (30 x 25)	S_5 (40 x 25)	S_6 (50 x 25)
V_1 (Pusa Arhar 16)	25.38	23.54	24.01	21.13	21.61	20.50
V_2 (AL 882)	11.83	13.23	15.17	16.24	18.73	21.75
SEm ±	1.19					
CD (p=0.05)	3.49					

Table 6: Economics of pigeonpea crop under different spacing and varieties.

Treatment	Gross return of grains (Rs. ha^{-1})	Gross return of stover (Rs. ha^{-1})	Total gross return (Rs. ha^{-1})	Total cost (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B: C
Spacing (cm)						
S_1 (30 x 12.5)	75883	4243.5	80127	27900	52227	2.87
S_2 (40 x 12.5)	70460	4016.5	74477	27550	46927	2.70
S_3 (50 x 12.5)	70905	3724.5	74630	27340	47290	2.73
S_4 (30 x 25)	64148	3494.5	67642	27200	40442	2.49
S_5 (40 x 25)	67222	3382	70604	27025	43579	2.61
S_6 (50 x 25)	71204	3201	74406	26920	47486	2.76
Variety						
V_1 (Pusa Arhar 16)	67976	2798.33	70774	27323	43452	2.58
V_2 (AL 882)	71965	4555.66	76521	27323	49198	2.81

Table 7: Economics of different treatment incurred under different spacing (Rs. ha^{-1}).

Treatment	Gross return of grains	Gross return of stover	Total gross return	Total cost of cultivation	Net return	B: C
V_1S_1	95255	3397	98652	27900	70752	3.54
V_1S_2	78764	3103	81867	27550	54317	2.97
V_1S_3	73041	2807	75849	27340	48509	2.77
V_1S_4	57459	2576	60034	27200	32834	2.21
V_1S_5	53341	2515	55855	27025	28830	2.07
V_1S_6	49996	2392	52388	26920	25468	1.95
V_2S_1	56511	5090	61602	27900	33702	2.21
V_2S_2	62157	4930	67087	27550	39537	2.44
V_2S_3	68769	4642	73411	27340	46071	2.69
V_2S_4	70837	4413	75250	27200	48050	2.77
V_2S_5	81103	4249	85352	27025	58327	3.16
V_2S_6	92413	4010	96423	26920	69503	3.58

*Price of grain of pigeon pea =5800 Rs. q^{-1}; * Price of stover of pigeon pea = 70 Rs. q^{-1}

CONCLUSIONS

With regard to the quantitative measure of seed yield, the recently introduced cultivar Pusa Arhar 16 exhibited superior performance when cultivated under a narrower spacing regime of 30 cm × 12.5 cm, in comparison to the cultivar AL 882 which performed better when cultivated under a wider spacing regime of 50 × 25 cm. Nonetheless, when assessing the economic profitability of the two cultivars in the specific agro-climatic conditions prevalent in Amritsar, it was observed that the cultivar AL 882 proved to be economically more viable than Pusa Arhar 16, taking into account the total net returns generated from both seed and stover.

FUTURE SCOPE

Variety recommendations for a specific location cannot be made on the basis of a one-year trial; instead, more study is required.

REFERENCES

Anonymous (2017). www.fao.org/faostat

Bansal, K. K., Sandhu, K.S., Bharti, V., Saha, A., Srivastava, H., Nesar, N. A. and Attri, M. (2022). Influence of varieties and spacings on growth, yield attributes and productivity of pigeonpea. *Indian Journal of Agricultural Research*, *1*, 6.

Chandrakar, K., Chandrakar, D. K., Das, G. K. and Birendra, T. (2015). Climate resilient agro technological intervention to boost up pigeonpea production in Chhattisgarh. *Journal of Environment Science, Toxicology and Food Technology*, *1*, 48-52.

Cochran, W. G. and Cox, G. M. (1967). *Experiment Designs.* Asia publishing House, New Delhi, India.

Das, S. N., Mukherjee, A. K. and Nanda, M. K. (1996). Effect of dates of sowing and row spacing on yield attributing factors of different varieties of French bean (*Phaseolus vulgaris* L.). *Agricultural Science Digest (Karnal)*, *16*(2), 130-132.

Kashyap, T. L., Shrivastava, G. K., Lakpale, R. and Choubey, N. K. (2003). Productive potential of pigeonpea (*Cajanus cajan L. Millsp*) genotypes in response to growth regulator under vertisols of Chattisgarh plains. *Ann. Agric. Res. New Series*, *24*(2), 449-452.

Kaur, K. and Saini, K. S. (2020). Productivity of Pigeonpea (*Cajanus cajan* L.) Under Different Row Spacing and Genotypes. *Int. J. Curr. Microbiol. App. Sci.*, *7*(5), 942-946.

Kumar, V., Reena,Bansal, K.K. , Srivastava, H , Attri M., Lalrammawii C. (2023). Seed Priming on Crop Establishment of Late Sown Wheat Crop, *Environment and Ecology*, *41*(1B), 507-512.

Mallikarjun, C., Hulihalli, U. K., Somanagouda, G., Kubsad, V. S. and Kambrekar, D. N. (2014) Performance of hybrid pigeonpea (cv. ICPH-2671) under varied planting methods and planting geometries in Northern dry zone of Karnataka. *Karnataka Journal of Agricultural Sciences*, *27*(3), 296-299.

Mallikarjun, C., Hulihalli, U. K. (2015) Yield, yield parameters and economics of hybrid pigeonpea (cv. ICPH-2671) as influenced by planting methods and geometry. *International Journal of Agricultural Sciences*, *11*(1), 19-23.

Saritha, K. S., Pujari, B. T., Basavarajappa, R., Naik, M. K., Ramesh, B. and Desai, B. K. (2012). Growth of pigeonpea [*Cajanus cajan* (L.) Millsp.] and nutrient status of soil after the harvest of crop as influenced by plant densities, different irrigation and nutrient levels. *Karnataka Journal of Agricultural Sciences*, *25*(1), 134-136.

Singh, H., Sadhu S.K. and Bansal K.K. (2022). Effect of first irrigation scheduling and herbicides on productivity of direct-seeded rice (*Oryza sativa*), *Indian Journal of Agronomy*, *67*(1), 93-96

Suresh, K. (2012). *Response of pigeonpea to plant densities and supplemental irrigation through drip*, Ph.D. Thesis. Acharya N.G. Ranga Agricultural University.

Tuppad, G. B., Koppalkar, B. G., Halepyati, A. S. and Desai, B. K. (2012). Yield and economics of pigeonpea genotypes as influenced by planting geometry under rainfed condition. *Karnataka Journal of Agricultural Sciences*, *25*(2), 179-182.

Umesh, M. R., Shankar, M. A. and Ananda, N. (2013). Yield, nutrient uptake and economics of pigeonpea (*Cajanus cajan* L.) genotypes under nutrient supply levels in dryland Alfisols of Karnataka. *Indian Journal of Agronomy*, *58*(4), 554-559.

Walelign, W. and Demisie, W. (2012). Growth, light interception and radiation use efficiency response of pigeonpea (*Cajanus cajan*) to planting density in southern Ethiopia. *Journal of Agronomy*, *11*(4), 85-93.

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