Mysore J. Agric. Sci., 58 (1) : 387-396 (2024)

Influence of Sowing Window and Planting Geometry on Pigeonpea Nutrient Uptake, Quality and Yield

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Received : November 2023
Accepted : December 2023

Abstract

A field experiment entitled 'Influence of sowing window and planting geometry on pigeonpea nutrient uptake quality and yield' was conducted during *kharif* 2021-22 and 2022-23 at K block, Zonal Agricultural Research Station, GKVK, Bengaluru. The experiment was laid out in split-plot design with three replications. The combined effect of sowing window and planting geometry on pigeonpea nutrient uptake, quality parameters and yield was studied. The results revealed that sowing during first fortnight of May month resulted in higher nutrient uptake (94.51 kg ha^{-1}, 14.21 kg ha^{-1} and 85.43 kg ha^{-1}; N, P and K, respectively), protein yield (388 kg ha^{-1}) and pigeonpea grain yield (1945 kg ha^{-1}) and stalk yield (8373 kg ha^{-1}) compared to other treatments. For planting geometry, paired row geometry resulted in higher nutrient uptake (92.44 kg ha^{-1}, 14.36 kg ha^{-1} and 83.24 kg ha^{-1}; N, P and K, respectively), protein yield (235 kg ha^{-1}) and pigeonpea grain yield (1203 kg ha^{-1}) and stalk yield (5187 kg ha^{-1}) compared to normal row geometry. Among varieties Bangalore Red Gram-3 recorded higher nutrient uptake (109.30 kg ha^{-1}, 16.51 kg ha^{-1} and 89.29 kg ha^{-1}; N, P and K, respectively), protein yield (242 kg ha^{-1}) and pigeonpea grain yield (1198 kg ha^{-1}) and stalk yield (5192 kg ha^{-1}) compared to Bangalore Red Gram 4. The interaction effect for all the parameters were found to be non-significant in all the cases.

Keywords : Pigeonpea, Planting geometry, Protein yield, Sowing window

Pigeonpea, also known as arhar, tur and redgram, is a protein-rich pulse crop that is indigenous to the Indian subcontinent and is a member of the Fabaceae family. It ranks sixth among the most prominent grain legumes grown in Asia's semi-arid tropics under large cropping systems and is the second most significant grain legume in India after chickpea. According to reports it has 20 - 22 per cent protein, 1.2 per cent fat and 65 per cent carbohydrates Anonymous (1982). Pulses are the main source of protein in the Indian diet. Pulses are mostly produced, imported and consumed in India. The only practical alternative for expanding pigeonpea production in the nation is to manage a variety of biotic and abiotic elements, as the potential for doing so is limited. Pigeonpea productivity is constrained by a number of factors, including poor drainage/water stagnation, increased phytopthora blight, flower drop during the winter months due to cold temperatures, increased rice cultivation, a lack of cultivars with high yields of disease resistance, smaller land holdings and longer crop maturation, effects of climate change, and unpredictable rainfall. The limitations include water stress (drought and water logging), the lack of acceptable varieties, the varied sowing windows of the available kinds, the late availability of inputs, the use of improper planting geometry and plant populations, and insufficient technology transfer. The key to increasing yields in pigeonpea is to choose the right planting date, cultivars and spacing. Most varieties of pigeonpea are photoperiod-sensitive and therefore, sowing date has an important influence on the vegetative and reproductive processes. Time of sowing, a non-monetary inputs, has a considerable influence on growth and yield of this crop. It ensures complete harmony between vegetative and reproductive phases on the one hand and climatic rhythm on the other. Delayed sowings beyond the optimum period results in low grain yields of pigeonpea (Rao *et al*., 2004 and Kumar *et al*., 2008). The field environment, which affects the yield and yield components, is known to be impacted by agronomic practices for sustaining plant populations. To fully utilize natural resources including nutrients, sunlight, soil moisture and to ensure satisfactory production, optimal plant population should be maintained. (Swathi *et al*., 2017). Recognizing the necessity of enhancing yield of redgram in the changing climatic conditions by selecting best sowing window and planting method the field experiment entitled 'Studies on sowing window and planting geometry on growth and yield of pigeonpea [*Cajanus cajan* (L.) Millsp]' was conducted during the *kharif* season of 2021-22 and 2022-23 at UAS, GKVK, Bengaluru.

Material and Methods

The field experiment was conducted at K Block, Zonal Agricultural Research Station (ZARS), University of Agricultural Sciences (UAS), Gandhi Krishi Vigyan Kendra (GKVK), Bengaluru during *kharif* 2021 and 2022. The experimental site is located in Eastern Dry Zone (Zone-V) of Karnataka and found between 12º 51' North latitude and 77º 35' East longitude at an altitude of 930 m above mean sea level (MSL). The intital textural class of the soil was red sandy loam consisting of 53.4 per cent coarse sand, 14.8 per cent fine sand, 16.6 per cent silt and 15.2 per cent of clay. The soil was slightly acidic (6.4) in reaction with an electrical conductivity of 0.16 dS m^{-1}. The organic carbon content was 0.43 per cent. The soil was medium in available nitrogen (287.25 kg ha^{-1}), phosphorous (36.5 kg ha^{-1}) and potassium (255.5 kg ha^{-1}).

The experiment was laid out on split-split design with twenty-four (24) treatments and were replicated thrice summing up to 72 plots. Bunds of 30 cm height was erected between each plot and one- meter space was maintained between replications. The experiment consisted of three factors with factor A: Sowing windows (D) (D_1: May first fortnight, D_2: May second fortnight, D_3: June first fortnight, D_4: June second fortnight, D_5: July first fortnight and D_6: July second fortnight), factor B: Planting geometry (P) (P_1: 120 cm × 30 cm and P_2: 60/120 cm × 30 cm) and factor C: Varieties (V) (V_1: Bangalore Red Gram -3 and V_2: Bangalore Red Gram 4).

Other cultural operations were followed as per the recommended package of practices of UAS, Bangalore. Observations on growth as well as yield attributes were recorded and economics was computed. All experimental data was analyzed statistically and presented at five per cent level of significance for making comparison between treatments.

Results and Discussion

Effect of Sowing Window on Nutrient Uptake and Availability

The data on nutrient uptake (kg ha^{-1}) as influenced by sowing windows for both the seasons and pooled data are presented in Table 1. Significantly higher nitrogen uptake was recorded (pooled data) with first fortnight of May (94.51 kg ha^{-1}), which was at par with second fortnight of May (94.15 kg ha^{-1}) and first fort night of June (89.51 kg ha^{-1}). While significantly lower nitrogen uptake was recorded with July second fortnight (80.57 kg ha^{-1}). In phosphorus also, significantly higher phosphorus uptake was recorded (pooled data) with first fortnight of May (14.21 kg ha^{-1}), which was at par with second fortnight of May (14.00 kg ha^{-1}). While significantly lower phosphorus uptake was recorded with July second fortnight (12.31 kg ha^{-1}).Significantly higher potassium uptake was recorded (pooled data) with first fortnight of May (85.43 kg ha^{-1}), which was at par with second fortnight of May (82.83 kg ha^{-1}) and first fort night of June (81.10 kg ha^{-1}). While significantly

TABLE 1

Nutrient uptake by pigeonpea as influenced by sowing windows, planting geometry and varieties

Treatments	Nitrogen (kg ha^{-1})			Phosphorus (kg ha^{-1})			Potassium (kg ha^{-1})		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
Sowing Windows (D)									
D_1: 1st FN May	93.39	95.62	94.51	13.77	14.69	14.21	84.43	86.43	85.43
D_2: 2nd FN May	95.38	92.91	94.15	13.64	13.49	14.00	81.81	83.83	82.83
D_3: 1st FN June	90.41	88.62	89.51	13.01	13.07	13.45	80.10	82.10	81.10
D_4: 2nd FN June	89.56	85.06	87.31	13.73	14.23	13.25	79.38	81.38	80.38
D_5: 1st FN July	86.29	83.92	85.10	13.80	12.42	13.06	77.46	79.46	78.46
D_6: 2nd FN July	81.76	79.37	80.57	12.21	12.32	12.31	76.60	78.60	77.60
SEm±	2.01	2.12	2.05	0.23	0.37	0.27	1.54	1.52	1.50
CD at 5%	6.33	6.69	6.46	0.73	1.16	0.83	4.84	4.77	4.72
Planting geometry(P)									
P_1: Normal rows (120cm × 30cm)	86.09	83.11	84.60	12.67	12.04	12.30	77.68	79.68	78.68
P_2: Paired Rows (60/120cm×30cm)	92.83	92.05	92.44	14.03	14.69	14.36	82.24	84.24	83.24
SEm±	1.21	2.06	1.62	0.41	0.65	0.51	1.26	1.17	1.17
CD at 5%	3.73	6.35	4.99	1.26	1.99	1.58	3.87	3.60	3.59
Varieties(V)									
V_1: Bangalore Red Gram 3	111.48	107.12	109.30	16.56	16.46	16.51	89.72	90.05	89.29
V_2: Bangalore Red Gram 4	67.44	68.03	67.74	10.15	10.26	10.20	70.19	73.87	72.63
SEm±	2.43	2.06	2.54	0.27	0.37	0.30	1.85	1.52	1.52
CD at 5%	7.08	6.35	7.41	0.77	1.09	0.86	5.40	4.44	4.43
Interactions									
D×V SEm±	2.97	5.05	3.97	1.00	1.59	1.26	4.53	2.86	2.86
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
D×V SEm±	5.94	6.59	6.23	0.65	0.92	0.72	4.53	3.73	3.72
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
P×V SEm±	3.43	3.81	3.59	0.38	0.53	0.42	2.62	2.15	2.15
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
D×P×V SEm±	8.41	9.33	8.80	0.92	1.30	1.02	6.41	5.28	5.26
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note : FN - Fortnight

lower nitrogen uptake was recorded with July second fortnight (77.60 kg ha^{-1}).

The data on soil available nutrient (kg ha^{-1}) after harvest as influenced by sowing windows for both the seasons and pooled data are presented graphically illustrated in Fig. 1.

Available nitrogen in soil was found to be significantly affected (pooled data) due to different sowing windows. Significantly higher available nitrogen was recorded with July second fortnight sowing (278.18 kg ha^{-1}) and lower with May first fortnight (241.55 kg ha^{-1}).Similarly, significantly higher available

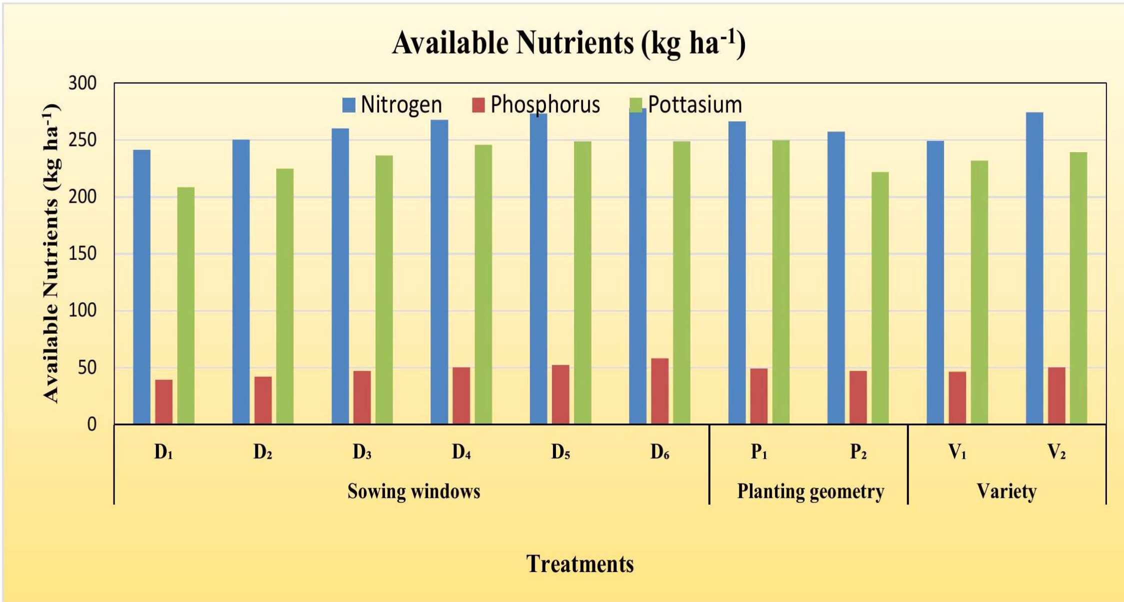

Fig. 1 : Influence of sowing windows, planting geometry and varieties on soil available nutrients after harvest of pigeonpea

Note : D_1: 1st FN May, D_2: 2nd FN May, D_3: 1st FN June, D_4: 2nd FN June, D_5: 1st FN July, D_6: 2nd FN July, P_1: Normal rows (120cm × 30cm), P_2: Paired Rows (60/120cm×30cm), V_1: Bangalore Red Gram 3, V_2: Bangalore Red Gram 4; FN-Fortnight

phosphorus in soil was recorded with July second fortnight sowing (58.34 kg ha^{-1}) and lower with May first fortnight (39.36 kg ha^{-1}). For soil available potassium higher value was recorded with July second fortnight sowing (249.12 kg ha^{-1}) and lower with May first fortnight (208.58 kg ha^{-1}).

Higher biomass production and higher nutrient uptake are directly related to each other. Sowing at right time takes advantage of the temperature conditions that are conducive to plant growth. Warmer temperatures might have stimulated root development which might have lead to higher nutrient uptake. Early sown crop results in higher post harvest soil available nutrients which might be due to longer duration of crop that have efficiently utilized the soil applied nutrients. Timely sowing also helped in maintaining congenial environment conditions in soil system throughout the crop-growth period, increased the availability of nutrients and also total dry matter production per hectare, resulting in increased the uptake of nutrients by the crop (Meena *et al.*, 2022). Higher nutrient uptake with the early sown crop was due to the crop's prolonged vegetative lag phase, which could have better utilised growth resources, resulting in higher nutrient content, dry matter production, and hence nutrient uptake.

Delayed sowing had cooler atmosphere which might have reduced transpiration and also have reduced nutrient uptake which might have further affected the yield as seen previously. Similar results were reported by Dass (2010), Neenu *et al.* (2017) and Ray *et al.* (2017). As crop uptake was lower for late sowing windows, therefore it is reported significantly higher available soil nutrients.

Effect of Planting Geometry on Nutrient Uptake and Availability

The data on nutrient uptake (kg ha^{-1}) as influenced by planting geometry for both the seasons and pooled data are presented in Table 1. The outcome showed that significantly higher nitrogen, phosphorus and potassium uptake was recorded (pooled data) with paired row geometry (92.44 kg ha^{-1}, 14.36 kg ha^{-1} and 83.24 kg ha^{-1}, respectively) compared to normal row geometry (84.60 kg ha^{-1}, 12.30 kg ha^{-1}, 78.68 kg ha^{-1}, respectively).

The data on soil available nutrients (kg ha^{-1}) as influenced by planting geometry for both the seasons and pooled data are graphically illustrated in Fig. 1.

Available nitrogen in soil was found to be significantly (pooled data) impacted due to different planting geometry. Significantly higher available nitrogen, phosphorus and potassium was recorded with normal row geometry (266.39 kg ha^{-1}, 49.27 kg ha^{-1} and 249.78 kg ha^{-1}) compared to paired row geometry (257.35 kg ha^{-1}, 47.23 kg ha^{-1} and 221.97 kg ha^{-1}).

Significantly higher nutrient uptake in paired row might because of higher dry-matter production and grain yield per ha. The higher planting density in paired row systems might be due to increased absorption of nutrients from the soil.

Effect of Varieties on Nutrient Uptake and Availability

The data on nutrient uptake (kg ha^{-1}) as influenced by varieties for both the seasons and pooled data are presented in Table 1.

Significantly higher nitrogen, phosphorus and potassium uptake was recorded (pooled data) with Bangalore Red Gram 3 (109.30 kg ha^{-1}, 16.51 kg ha^{-1} and 89.29 kg ha^{-1}, respectively) compared to Bangalore Red Gram 4 (67.74 kg ha^{-1}, 10.20 kg ha^{-1} and 72.63 kg ha^{-1}, respectively).

The data on soil available nutrients as influenced by varieties for both the seasons and pooled data are graphically illustrated in Fig. 1.

Available nitrogen, phosphorus and potassium in soil was found to be significantly (pooled data) affected due to different varieties. Significantly higher available nitrogen, phosphorus and potassium was recorded with Bangalore Red Gram 4 (274.58 kg ha^{-1}, 50.15 kg ha^{-1} and 239.27 kg ha^{-1}, respectively) compared to Bangalore Red Gram 3 (249.16 kg ha^{-1}, 46.35 kg ha^{-1} and 231.88 kg ha^{-1}, respectively).

Higher yield potential of Bangalore Red Gram 3 might be due to higher nutrient absorption from the soil and it also reduced available soil nutrients after harvest, due to which it has produced significantly higher dry matter and subsequently higher pigeonpea grain yield.

Effect of Sowing Windows on Protein Content in Seed and Protein Yield

The data on quality parameters as influenced by sowing windows for both the seasons and pooled data are presented in Table 2 and 3.

Agronomic manipulation by sowing windows did not significantly affect the seed protein content (%). Although numerically differences (pooled data) were observed starting with highest at first fortnight of May (19.90%) and lowest at second fortnight of July (19.12%) .

Significant difference was observed with respect to protein yield (kg ha^{-1}) as per the pooled data, where significantly higher protein yield was found in first fortnight of May (388 kg ha^{-1}) followed by second fortnight of May (275 kg ha^{-1}) and first fort night of June (224 kg ha^{-1}) followed by second fort night of June (189 kg ha^{-1}). Significantly lowest protein content was observed in second fortnight of July (85 kg ha^{-1}).

The protein yield differences were observed due to pigeonpea grain yield. Higher grain yield enhanced protein yield. Proper agronomic practices by choosing early sowing which has promoted healthy plant growth and increased the potential for higher protein yield. Climate variability, including changes in rainfall patterns and temperature fluctuations, also impacted the choice of sowing window and its effect on protein yield. Adaptation to changing climate conditions might be necessary to maintain or increase protein yield. Similar findings were reported by Patil *et al*. (2015) and Gupta *et al*. (2016).

Effect of Planting Geometry on Protein Content in Grain and Protein Yield

The data on quality parameters as influenced by sowing windows for both the seasons and pooled data are presented in Table 2 and 3.

TABLE 2

Seed protein content of pigeonpea as influenced by sowing windows, planting geometry and varieties

Treatments	Seed protein content (%)		
	2021-22	2022-23	Pooled
Sowing Windows (D)			
D_1: 1st FN May	20.20	19.57	19.90
D_2: 2nd FN May	20.03	19.51	18.84
D_3: 1st FN June	20.00	19.39	19.72
D_4: 2nd FN June	19.70	19.11	19.72
D_5: 1st FN July	19.41	18.83	19.40
D_6: 2nd FN July	19.13	18.21	19.12
S.Em±	0.35	0.34	0.35
CD at 5%	NS	NS	NS
Planting geometry (P)			
P_1: Normal rows (120cm × 30cm)	19.84	19.25	19.54
P_2: Paired Rows (60/120cm×30cm)	19.71	19.06	19.36
S.Em±	0.11	0.11	0.11
CD at 5%	NS	NS	NS
Varieties (V)			
V_1: Bangalore Red Gram 3	20.46	19.84	20.15
V_2: Bangalore Red Gram - 4	19.94	19.33	19.75
S.Em±	0.23	0.22	0.22
CD at 5%	NS	NS	NS
Interaction			
D×V S.Em±	0.27	0.26	0.27
CD at 5%	NS	NS	NS
D×V S.Em±	0.56	0.54	0.55
CD at 5%	NS	NS	NS
P×V S.Em±	0.32	0.31	0.32
CD at 5%	NS	NS	NS
D×P×V S.Em±	0.79	0.76	0.77
CD at 5%	NS	NS	NS

Note : FN-Fortnight

TABLE 3

Protein yield of pigeonpea as influenced by sowing windows, planting geometry and varieties

Treatments	Protein Yield (kg ha^{-1})		
	2021-22	2022-23	Pooled
Sowing Windows (D)			
D_1: 1st FN May	459	317	388.12
D_2: 2nd FN May	299	251	275.16
D_3: 1st FN June	233	214	223.51
D_4: 2nd FN June	203	170	186.51
D_5: 1st FN July	159	153	156.30
D_6: 2nd FN July	84	87	85.43
SEm±	7.36	10.78	6.10
CD at 5%	23.18	33.98	19.22
Planting geometry (P)			
P_1: Normal rows (120cm × 30cm)	223	184	203
P_2: Paired Rows (60/120cm×30cm)	256	214	235
SEm±	5.83	3.03	3.29
CD at 5%	17.96	9.34	10.12
Varieties (V)			
V_1: Bangalore Red Gram 3	265	220	242
V_2: Bangalore Red Gram 4	214	178	196
SEm±	4.82	5.33	4.43
CD at 5%	14.05	15.56	12.93
Interaction			
D×V SEm±	14.28	7.43	8.05
CD at 5%	NS	NS	NS
D×V SEm±	11.80	13.06	10.85
CD at 5%	NS	NS	NS
P×V SEm±	6.81	7.54	6.27
CD at 5%	NS	NS	NS
D×P×V SEm±	16.68	18.47	15.35
CD at 5%	NS	NS	NS

Note: FN-Fortnight

Agronomic manipulation of spacing did not bring significant variations (pooled data) in seed protein content (%), but numerical variations were observed where normal planting geometry recorded numerically higher protein content of 19.54 per cent compared to paired row geometry with 19.36 percentage.

Significant variations were recorded in case of protein yield (kg ha^{-1}) where paired row geometry recorded significantly higher protein yield (235 kg ha^{-1}) compared to normal planting geometry (203 kg ha^{-1}). This was due to increased grain yield in case of paired row system which was due to increased number of plants per unit area in paired row system. Antaravalli *et al.* (2002) also reported similar findings.

Effect of Varieties on Protein Content in Seed and Protein Yield

The data on quality parameters as influenced by varieties for both the seasons and pooled data are presented in Table 2 and 3.

Varieties showed non significant variations (pooled data) in protein content (%) of the seed. But Bangalore Red Gram 3 had numerically higher protein content of 20.15 percentage as compared to Bangalore Red Gram 4 (19.75 %).

The protein yield (kg ha^{-1}) followed the same trend of the protein content and grain yield with significantly higher protein yield (pooled data) in Bangalore Red Gram 3 (242 kg ha^{-1}) compared to Bangalore Red Gram 4 (196 kg ha^{-1}).

Studies have shown that there is a significant variation in seed protein content among different pigeonpea varieties. Some varieties have naturally high protein content, while others have a lower protein content. Varieties with higher seed protein content are likely to contribute to higher protein yield per unit area, assuming other factors like plant density and environmental conditions are similar. Therefore, Bangalore Red Gram 3 recorded higher protein content and also higher grain yield which lead to higher protein yield. Gupta *et al*., 2016 also confirm the above findings.

Effect of Sowing Windows on Pigeonpea Grain Yield, Stalk Yield and Harvest Index

The grain yield, stalk yield and harvest index of pigeonpea were significantly influenced by sowing window . The two season data and pooled data is given in Table 4 and Fig. 2.

As per the pooled data the crop sown during first fortnight of May recorded significantly higher pigeonpea grain yield of 1945 kg ha^{-1}. It was followed by second fortnight of May with the grain yield of 1392 kg ha^{-1}, followed by 1130 kg ha^{-1} in the first fortnight of June. Significantly lower grain yield was recorded in second fortnight of July (443 kg ha^{-1}).

In case of stalk yield, as per the pooled data higher stalk yield was recorded with first fortnight of May (8373 kg ha^{-1}), followed by second fortnight of May (6024 kg ha^{-1}) and first fortnight of June (4996 kg ha^{-1}). Significantly lower stalk yield was recorded with second fort night of July (2005 kg ha^{-1}).

Due to higher grain yield, higher harvest index (pooled data) was recorded with crop sown during first fortnight of May (0.21) followed by second fortnight of May (0.19). While crop sown during first and second fortnight of June and first and second fortnight of July recorded similar harvest index of 0.18. These results were obtained as, early sowing enabled the crop to have significant access to longer bright sunshine hours and favourable temperature which had positive impact on growth and development of the crop and finally on the yield of the crop. Similar findings were reported by Kumar *et al*. (2008), Rani and Raji Reddy (2010) and Somashekar and Kalyanamurthy (2015).

Effect of Planting Geometry on Yield

The grain yield, stalk yield and harvest index of pigeonpea were significantly influenced by planting geometry. The two season data and pooled data is given in Table 4 and Fig. 2.

Paired row system of planting recorded significantly higher pigeonpea grain yield (pooled data) of 1203 kg ha^{-1} compared to normal row planting 1029 kg ha^{-1}. Similarly significantly higher stalk yield was

TABLE 4

Pigeonpea grain yield and stalk yield as influenced by sowing windows, planting geometry and varieties

Treatments	Pigeonpea grain yield (kg ha^{-1})			Stalk yield (kg ha^{-1})		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
Sowing Windows (D)						
D_1: 1st FN May	2273	1617	1945	9284	6461	7873
D_2: 2nd FN May	1488	1295	1392	6357	5739	6048
D_3: 1st FN June	1161	1098	1130	4933	5107	5020
D_4: 2nd FN June	1031	889	960	4153	4358	4256
D_5: 1st FN July	827	824	826	3233	4187	3710
D_6: 2nd FN July	429	457	443	1638	2213	1925
SEm±	26.43	56.99	28.24	342.31	229.52	230.60
CD at 5%	83.28	179.57	88.97	1078.64	723.24	726.63
Planting geometry (P)						
P_1: Normal rows (120cm × 30cm)	1112	946	1029	4642	4211	4424
P_2: Paired Rows (60/120cm×30cm)	1291	1115	1203	5479	5143	5187
SEm± 30.68	14.83	16.22	177.81	86.81	85.76	
CD at 5%	94.53	45.68	49.97	547.88	267.48	264.24
Varieties (V)						
V_1: Bangalore Red Gram – 3	1290	1107	1198	5457	5075	5192
V_2: Bangalore Red Gram - 4	1114	953	1034	4664	4280	4418
SEm± 19.36	23.41	16.39	82.10	97.02	66.86	
CD at 5%	56.52	68.34	47.82	239.62	283.18	195.15
Interaction						
D×V SEm±	75.15	36.32	39.73	435.54	212.64	210.06
CD at 5%	NS	NS	NS	NS	NS	NS
D×V SEm±	47.43	57.35	40.14	201.10	237.65	163.77
CD at 5%	NS	NS	NS	NS	NS	NS
P×V SEm±	27.39	33.11	23.17	116.10	137.21	94.56
CD at 5%	NS	NS	NS	NS	NS	NS
D×P×V SEm±	67.68	81.11	56.77	284.39	336.09	231.61
CD at 5%	NS	NS	NS	NS	NS	NS

Note : FN - Fort Night

recorded in case of paired row system with 5187 kg ha^{-1}, which was followed by normal row system with 4424 kg ha^{-1} of stalk yield. The harvest index for both the planting geometries was similar with the harvest index value of 0.19. Higher yield per hectare was recorded in paired row system. Higher planting density enabled better resource utilisation leading to higher grain and stalk yield per hectare. This is supported by Bhanu Kumar Meena (2010), Pavan *et al*. (2011) and Sharanappa *et al*. (2018).

Effect of Pigeonpea Varieties on Yield

The grain yield, stalk yield and harvest index of pigeonpea were significantly influenced by different

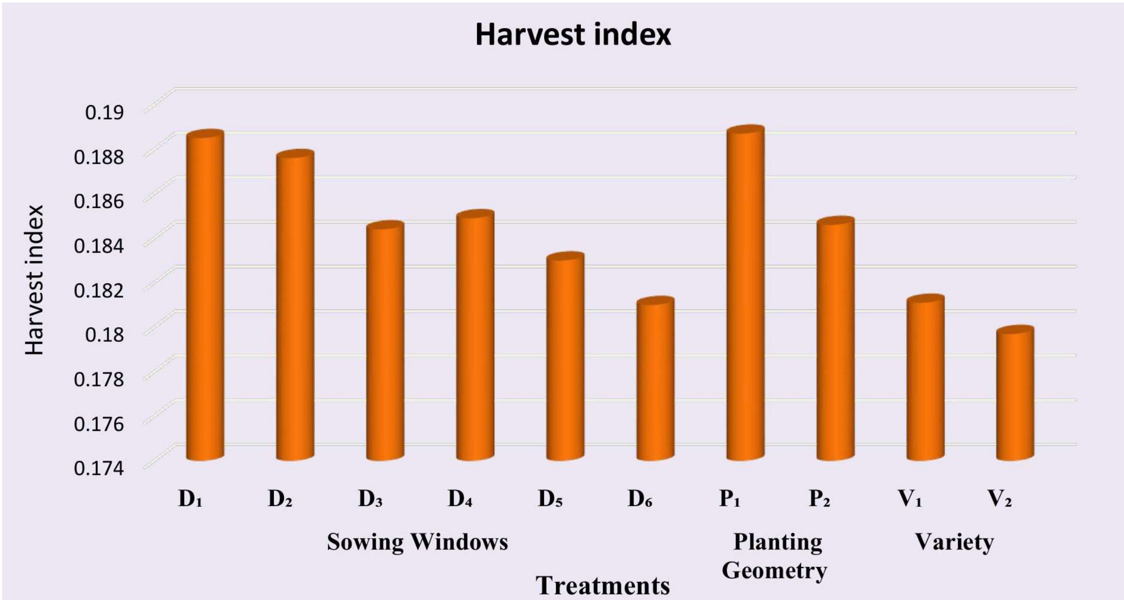

Fig. 2 : Influence of sowing windows, planting geometry and varieties on harvest index of pigeonpea

Note: D_1: 1st FN May, D_2: 2nd FN May, D_3: 1st FN June, D_4: 2nd FN June, D_5: 1st FN July, D_6: 2nd FN July, P_1: Normal rows (120cm × 30cm), P_2: Paired Rows (60/120cm×30cm), V_1: Bangalore Red Gram 3, V_2: Bangalore Red Gram 4; FN - Fortnight

varieties. Both the season and pooled data is given in Table 4 and Fig. 2.

Among the varieties, Bangalore Red Gram 3 recorded significantly higher grain yield (pooled data) compared to Bangalore Red Gram 4. Bangalore Red Gram 3 recorded 1198 kg ha^{-1} grain yield while Bangalore Red Gram 4 produced 1034 kg ha^{-1} grain yield.

In case of stalk yield BRG 3 recorded significantly higher stalk yield (pooled data) of 5192 kg ha^{-1} compared to Bangalore Red Gram 4 (4418 kg ha^{-1}). Similarly higher harvest index was recorded in Bangalore Red Gram 3 (0.19) contrast to lower harvest index of 0.17 in Bangalore Red Gram 4. Bangalore Red Gram 3 has a higher yield potential due to its genetic make up which enhanced its grain yield compared Bangalore Red Gram 4. These findings are in same line with that of Prashant *et al.* (2015) Patil *et al.* (2015) and Gupta *et al.* (2016).

References

Anonymous, 1982, Legumes in human nutrition, Food and Agriculture Organization of United Nations. *Food and Nutrition Sci.,* No. 20, Rome.

Antaravalli, M. B., Halikatti, S. I., Kajjidoni, S. T. and Hiremath, S. M., 2002, Effect of plant geometry on the yield, yield components and economics of pigeonpea genotypes in vertisols of Dharwad. *Karnataka J. Agric. Sci.*, **15** (3) : 466 - 471.

Bhanu Kumar Meena, 2010, Response of hybrid pigeonpea [*Cajanus cajan* (L.) Millsp.] to planting geometry and fertility levels. *M.Sc. (Agri.) Thesis*, Uni. Agri. Sci., Dharwad.

Dass, A., 2010, Effect of agronomic factors on nutrient content and uptake, dry matter accumulation and yield of chickpea (*Cicer arietinum*) on farm conditions. *Int. J. Agric. Sci.* **4** (1) : 8 - 12.

Gupta, S., Yadav, R. K., Yadav, V. K. and Singh, A., 2016, Effect of sowing time and varieties on yield, quality and economics of pigeonpea [*Cajanus cajan* (L.) Millsp.] in eastern Rajasthan. *Legum Res.,* **39** (1) : 105 - 110.

Kumar, N., Gopinath, K. A., Anil K. Srivastva and Vinay Mahajan, 2008, Performance of pigeonpea (*Cajanus cajan* (L.) Millsp.) at different sowing dates in the mid-hills of Indian Himalaya. *Arch. Agron. Soil Sci.,* **54** (5) : 507 - 514.

Meena, B. S., Narolia, R. S., Gajendra, N., Meena, S. N. and Meena, D. S., 2022, Effect of sowing window, planting geometry and nutrient-management on yield, nutrient uptake and economics of Indian mustard in *Vertisols* of south-eastern Rajasthan. *Indian J. Agron.,* **67** (1) : 50 - 57.

Neenu, S., Ramesh, K., Ramana, S. and Somasundaram, V., 2017, Effect of cultivars and sowing dates on nutrient uptake and yield of chickpea under aberrant climatic conditions in black soils of central India. *Adv. Res*., **12** (4) : 1 - 11.

Patil, P. L., Reddy, K. R., Patil, V. M. and Konda, C. R., 2015, Effect of sowing time and varieties on quality parameters of pigeonpea (*Cajanus cajan* (L.) Millsp.) genotypes. *Legum Res.*, **38** (5) : 565 - 570.

Pavan, A. S., Nagalikar, V. P., Pujari, B. T. and Halepyati, A. S., 2011, Influence of planting geometry on the growth characters, seed yield and economics of transplanted pigeonpea. *Karnataka J. Agric. Sci.,* **24** (3) : 390 - 392.

Prashant, S. M., Channakeshava, B. C., Narayanaswamy, S., Balakrishna, P., Puttaraju, T. B. and Niranjana, M., 2015, Genotypic response to sowing dates on yield and yield attributing traits in rice bean [*Vigna umbellata* (Thunb.) Ohwi and Ohashi]. *Mysore J. Agric. Sci.*, **49** (1) : 32 - 37.

Rani, B. P. and Raji Reddy, D., 2010, Performance of pigeonpea in sole and intercropping system in *vertisols* of Krishna - Godavari zone in Andhra Pradesh. *Indian J. Agric. Res.,* **44** (3) : 225 - 228.

Rao, P. R. S., Rao, K. N., Sridhara, S., Byregowda, M., Shankarlingappa, B. C., Meinke, H., Devoil, P. and Gadgil, S., 2004, Exploring cropping options with crop models - A case study of pigeonpea versus peanut in rainfed tracts of semi-arid southern India, Proceedings of the 4th International Science Congress, September 26 - October 1, Brisbane, Australia.

Ray, K., Singh, D. and Jat, B., 2017, Effect of sowing time and seed rate on growth and yield of chickpea cultivars. *Adv. Res. J. Crop Improv*., **8** (1) : 1 - 16.

Somashekar, K. S. and Kalyanamurthy, K. N., 2015, Response of gum guar (*Cyamopsis tetragonaloba* L.) varieties to different dates of sowing and spacings under rainfed condition. *Mysore J. Agric. Sci.,* **49** (2) : 211 - 213.

Sharanappa, K., Shivaramu, H. S., Thimmegowda, M. N., Yogananda, S. B., Prakash, S. S. and Murukannappa, 2018, Effect of row spacing, varieties and sowing dates on growth and yield of Pigeonpea. *Int. J. Curr. Microbio. App. Sci*., **7** (8) : 1123 - 1128.

Swathi, Y. M., Srinivasa Reddy, M., Prabhakara Reddy, G. and Kavitha, 2017, Influence of density, planting patterns and mulching on yield of drip irrigated pigeon pea [*Cajanus cajan* (L.) Millsp]. *Indian J. Agr. Res*., **51** (6) : 611 - 614.