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Assessment of Sowing Time and Cultivars on Growth, Development and Yield Parameters of Pigeonpea

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ABSTRACT

Background: Pigeonpea, a nutritious crop grown in wide range of environmental condition both in tropical and sub-tropical regions of the world. Time of sowing, a non- monetary input, ensures the complete harmony between vegetative and reproductive phases on one hand whereas on the other hand it also maintain the rhythm of the climate with crop. Further cultivars under suitable environment conditions perform to its full potential and play a crucial role in its overall yield.

Methods: A field experiment was conducted at Department of Agricultural Meteorology, CCS HAU, Hisar, during *Kharif* season 2017 to evaluate the effect of sowing time and cultivars on growth, development and yield parameters of pigeonpea. The experiment was laid out in split-plot design.

Result: Investigation revealed that leaf area index (LAI) and dry matter significantly decreased with delay in sowing at all growth intervals and found higher in crop sown on first fortnight of May. Among varieties, UPAS-120 produced higher LAI and dry matter at all growth intervals followed by Paras and Manak. Crop sown on first fortnight of May produced highest number of primary branches, secondary branches and pods per plant. Also there was a significant increase in seeds per pod, test weight, seed yield, biological yield and harvest index followed by first fortnight of June and second fortnight of June sown crops.

Key words: Biological yield, Cultivar, Development, Pigeonpea, Sowing time.

INTRODUCTION

Pigeonpea [*Cajanus cajan* (L.) Millisp.] commonly known as red gram, is a low input, rain fed crop with characteristics that provide economic returns from each and every part of the plant (Saxena, 2006). The centre of origin is probably peninsular India, where the closest wild relatives (*Cajanus cajanifolia*) occur in tropical deciduous woodlands. Pigeon pea is grown for grains, green manuring, fodder and forage in all cropping systems *i.e.* as sole crop, intercrop, mixed crop and sequential crop mostly in tropical and sub tropical countries all over the world. Some of the countries with notable pigeonpea production are India, Nepal, Myanmar, Malawi and Uganda along with some other countries in eastern Africa and the Dominican Republic in the Americas (Prasad, 2013). India accounts for 90 per cent of world's pigeonpea growing area and 85 per cent of world's production (Dahariya *et al*., 2018). In world pigeonpea is cultivated on 6.93 m ha with annual production of 6.67 MT. In India pigeonpea is cultivated on 5.38 m ha with a total production of 4.87 MT (Anonymous, 2017). In Haryana, it is cultivated on 15.1 thousand hectares with production and productivity of 16.4 thousand tonnes and 1033 kg/ha, respectively (Anonymous, 2016).

Pigeonpea is rich source of proteins, carbohydrate and amino acids such a methionine, lysine and tryptophan. Pulses are also fairly good sources of thiamin and niacin and provide calcium, phosphorus and iron (Ramcharran and Walker, 1985). Pigeonpea plant is known to provide several benefits to soil such as fixing atmospheric nitrogen, adding organic matter and micro nutrients and breaking hard plough pan with its long tap roots and thereby sometimes referred as "biological plough" (Saxena *et al*., 2010). Pigeonpea crop generally enhances soil fertility through leaf litter and biological nitrogen fixation (Udaya *et al*., 2015). In rainfed areas for sustainable agriculture system pigeon pea has become an ideal crop, because of its so many benefits at low cost. In Western Uttar Pradesh, Haryana, Punjab, Delhi, Northern Madhya Pradesh and command area of Rajasthan some of the short duration pigeonpea varieties used in multiple cropping (Nadarajan and Chaturvedi, 2010). It is well adapted to the tropical and sub-tropical regions of the world having arid and semi-arid climates (Rao *et al.,* 2003). Sowing time and cultivars played a vital role in determining the growth, development and yield of pigeonpea crop. Sowing dates has a profound impact on the crop performance as it determines the kind of environmental conditions to which difficult phenological stages of the crop exposed. Optimum plant population needs to maintained in

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order to exploit maximum natural resources such as nutrient, sunlight, soil moisture and to ensure satisfactory yield Sharifi *et al*. (2009) hence they are known to affect crop environment, which influence the yield and yield components. Pigeonpea suffers more when sowing is delayed (Padhi, 1995). Reddy *et al.* (2012) reported that significant reduction occurs in branches/plant and dry weight/plant at harvest with delayed sowing than normal sowing. Ram *et al.* (2011) revealed that the time to achieve harvest maturity was decreased in case of late sowing as compared to early sowing. Further cultivars have a profound impact on the crop performance. Long duration genotypes produce maximum yield than early maturing genotypes, but they take more time to mature which may delay the sowing of succeeding crop such as wheat in a cropping system (Singh, 2006). Pigeon pea is the most important crops in the world as they play vital roles in global agricultural economy. Therefore, the main objective of this study was to identify the optimum date of sowing and suitable cultivar for better growth, development and yield parameters of pigeon pea.

MATERIALS AND METHODS

An experiment was conducted in *Kharif* season 2017 at Research Farm, Department of Agricultural Meteorology, CCS HAU Hisar, Haryana. The field area was adjacent to Agrometeorological observatory at 290 10′ N latitude, 750 46′ E longitude and altitude of 215.2 m. The experiment was laid out in split-plot design, the main-plots treatments consisted of three dates of sowing *i.e.* D_1 (First fortnight of May), D_2 (First fortnight of June) and D_3 (Second fortnight of June). The sub-plots treatment consisted of three cultivars Manak, Paras and UPAS-120. The five randomly selected plants from destructive sampling were used to record the dry matter production at 30 days interval after sowing. The sampled plants were sun dried. Further, the samples were oven dried at 65°C to 70°C to a constant weight. The plant leaves separated from samples taken for dry matter were used for determining leaf area from each plot at 30 days interval after sowing. The green leaf area (cm^2) was recorded using leaf area meter (LI-3000 Area meter, LI-COR Biosciences, Nebraska, USA).

The leaf area measured with the help of leaf area meter was used to compute the leaf area index by the following formula:

$$LAI = \frac{\text{Leaf area } (cm^2)}{\text{Land area covered by plant } (cm^2)}$$

Observations on three random plants from each plot were recorded for primary and secondary branches per plant, pods per plant, seeds per plant and seeds per pod. From the total produce of the plot, 100 seeds were taken randomly and counted and weighed for 100-seed weight. The crop harvested from net plot was threshed after sun drying, cleaned and weighed. The seed yield obtained was converted to quintal per hectare. Biological yield from net plot was calculated and expressed as q per hectare. It was taken as the seed yield and stover yield together .The harvest index for each plot was calculated by dividing the total grain yield by the total biological yield (seed + stover yield) of the same net plot and multiplied by 100 as given below:

$$HI = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

Photosynthetically Active Radiation (PAR) was taken after 30 days of sowing at 30 days interval. PAR was measured during noon hours at top, middle and bottom of canopy with the help of Line Quantum sensor. The reflected radiation was obtained by keeping the sensor inverted above the crop canopy and the transmitted radiation at the ground was obtained by keeping the sensor on ground across the rows diagonally at random sites.

Transmitted radiation (%)

It is the ratio of transmitted PAR to the total incidence PAR over crop surface and multiplied by 100.

Reflected radiation (%)

It is the ratio of reflected radiation by crop with the total incidence PAR over crop surface and multiplied by 100.

Absorbed PAR

It is calculated by the formula as below:

APAR = 100 - Transmitted radiation - Reflected radiation

The data used in the study are the mean values of replicated observations, which was tabulated and subjected to statistical analysis using analysis of variance (ANOVA) as applicable to split plot design (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Growth studies

Leaf Area Index (LAI) of pigeonpea varieties under different dates of sowing was computed at various growth intervals and is presented in Table 1. LAI was found maximum at 120 days after sowing in all the varieties.

The LAI significantly decreased with delay in sowing, irrespective of the varieties at all growth intervals and it was maximum (2.61) in crop sown in first fortnight of May which was significantly superior to first fortnight of June (2.41) and second fortnight of June (2.26) sown crops. Among varieties of pigeonpea, UPAS-120 produced maximum LAI (2.60) which was significantly superior to Paras (2.42) and Manak (2.26). The maximum LAI produced by first sown crop (D_1) and variety UPAS-120 was because of highest photosynthetically active radiation (PAR) intercepted by them. Dry matter produced by pigeonpea varieties under different dates of sowing at various growth intervals is presented in Table 2. Dry matter per plant showed increasing trend with the advancement of crop growth and attained maximium at maturity *i.e.* 180 DAS in first fortnight of May and first fortnight of June sown crops where at 150 DAS in second fortnight of June sown crop. Among different sowing

dates, crop sown in first fortnight of May accumulated maximum dry matter (208.60 g/plant) which was significantly superior than first fortnight of June (200.69 g/plant) and second fortnight of June (169.63 g/plant) sown crops. Among varieties, maximum dry matter per plant (206.98 g/plant) was accumulated by UPAS-120 which was significantly superior to Paras (204.56 g/plant) and Manak (202.39 g/plant). The crop sown in first fortnight of May (D_1) and variety UPAS-120 produced highest dry matter because of highest LAI and PAR interception by them.

Yield and yield attributes

From the data, it was revealed that the yield components (primary branches/plant, Secondary branches/plant, pods/plant, seeds/pod and test weight) and yield were significantly influenced by time of sowing (Table 3). Primary branches

Table 1: Leaf area index of pigeonpea varieties at various growth intervals under different growing environments.

Treatments	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS	180 DAS
D1 (First fortnight of May)	0.55	0.76	1.61	2.61	1.67	0.93
D2 (First fortnight of June)	0.19	0.69	1.47	2.41	1.49	0.84
D3 (Second fortnight of June)	0.22	0.66	1.33	2.26	1.36	-**
SE(m)±	0.16	0.01	0.02	0.03	0.01	0.02
CD at 5%	NS	0.04	0.07	0.02	0.03	0.03
V1 (Manak)	0.19	0.67	1.11	2.26	1.41	0.79
V2 (Paras)	0.25	0.71	1.37	2.42	1.50	0.89
V3 (UPAS-120)	0.53	0.75	1.56	2.60	1.67	0.98
SE(m)±	0.19	0.01	0.02	0.02	0.01	0.01
CD at 5%	NS	0.03	0.05	0.05	0.03	0.03

*DAS- Days after sowing; **Crop mature in 150 days.

Table 2: Dry matter (g/plant) of pigeonpea varieties at various growth intervals under different growing environments.

Treatments	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS	180 DAS
D1 (First fortnight of May)	18.54	72.83	96.21	125.81	184.43	208.60
D2 (First fortnight of June)	17.22	63.90	87.01	119.52	177.16	200.69
D3 (Second fortnight of June)	14.86	54.44	78.57	113.08	169.63	-**
SE(m)±	0.12	0.25	0.14	0.16	0.11	0.10
CD at 5%	0.49	1.03	0.57	0.66	0.45	0.65
V1 (Manak)	15.78	61.14	84.32	117.68	174.77	202.39
V2 (Paras)	17.12	63.58	87.64	119.63	177.24	204.56
V3 (UPAS-120)	17.72	66.44	89.84	121.10	179.21	206.98
SE(m)±	0.13	0.21	0.21	0.19	0.17	0.24
CD at 5%	0.39	0.66	0.65	0.59	0.54	0.79

*DAS- Days after sowing; **Crop mature in 150 days.

Table 3: Yield and yield attributes of pigeonpea varieties at various growth intervals under different growing environments.

Treatments	No. of primary branches per plant	No. of secondary branches per plant	No. of pods per plant	No. of seeds per plant	Test weight (100 seeds)	No. of seeds per pod	Seed yield q/ha	Biological yield q/ha	Harvest Index
D1 (First fortnight of May)	15.11	13.78	267.22	685.33	7.39	2.84	17.97	70.21	25.96
D2 (First fortnight of June)	14.11	10.44	256.11	677.67	6.90	2.46	15.13	64.04	23.57
D3 (Second fortnight of June)	12.56	8.00	237.22	602.89	6.79	2.36	13.83	59.17	23.40
SE(m)±	0.46	0.37	4.51	9.76	0.03	0.04	0.34	1.70	0.37
CD at 5%	1.84	1.47	18.17	39.34	0.13	0.17	1.36	6.84	1.49
V1 (Manak)	12.22	8.89	235.56	604.33	6.71	2.34	14.32	63.22	22.51
V2 (Paras)	13.44	9.22	239.78	640.00	7.18	2.45	15.42	63.00	24.90
V3 (UPAS-120)	16.11	14.11	285.22	721.56	7.19	2.86	17.18	67.20	25.51
SE(m)±	0.60	0.55	6.64	6.79	0.05	0.08	0.35	0.79	0.57
CD at 5%	1.86	1.72	20.68	21.15	0.17	0.26	1.08	2.46	1.77

per plant were significantly more in the early sown crop in first fortnight of May (15.11) than the late sown crop (12.56). Among varieties, highest number of primary branches per plant (16.11) was recorded in UPAS-120 followed by Paras (13.44) and Manak (12.22). Earlier sown crop (First fortnight of May) produced higher number of secondary branches (13.78) as compared to late sown crop (8.00). Among varieties, highest number of secondary branches per plant (14.11) was recorded in UPAS-120 followed by Paras (9.22) and Manak (8.89). This may be attributed due to favorable environmental conditions for early sown crop particularly during the vegetative growth phase. Ram *et al.* (2011) also reported higher number of primary and secondary branches from early sown pigeonpea. The number of pods per plant is an important character which directly influences seed yield of the crop. First fortnight of May sown crop produced significantly higher number of pods (267.22) than second fortnight of June (237.22) sown crop. Among varieties, highest number of pods per plant (285.22) was also recorded in UPAS-120. The increase in number of pods was attributed due to increase in number of branches per plant and better balance between the vegetative and reproductive phases. These results are in accordance with the earlier findings of Rani and Reddy (2010) and Singh *et al.* (2016). Same trends were followed for number of seeds per plant and number of seeds per pod. This was highest in crop sown in first fortnight of May *i.e.* (685.33) and (2.84), respectively. Among varieties, highest number of seeds per plant and seeds per pod were recorded in UPAS-120 that is (721.56) and (2.86). The highest test weight (7.39 g) was recorded in crop sown in first fortnight of May followed by first fortnight of June (6.90 g). Among varieties, highest test weight (7.19 g) was recorded in UPAS-120. First fortnight of May sowing gave significantly higher seed yield (17.97 q ha^{-1}) than second fortnight of June sown crop (13.83 q ha^{-1}). Among varieties, highest seed yield (17.18 q ha^{-1}) was recorded in UPAS-120 followed by Paras (15.42 q ha^{-1}) and Manak (14.32 q ha^{-1}). The higher seed yield from first fortnight of May was cumulative favorable effect of various growths and yield attributes. As early sowing get favorable environmental condition for proper growth and development which resulted in higher leaf area development and high biomass accumulation which ultimately lead to significant improvement in seed yield. The crop sown on first fortnight of May produced more number of primary and secondary branches which ultimately resulted in production of more number of pods per plant that too contributed towards higher seed yield. With delay in sowing, flowering was induced earlier resulting in less vegetative growth and earliness in maturity resulting in low seed yield. These results are in close conformity with those of (Reddy *et al.,* 2015) and Nene and Sheila, 1990. Highest biological yield (70.21 q ha^{-1}) was recorded in crop sown in first fortnight of May followed by first fortnight of June (64.04 q ha^{-1}) and second fortnight of June (59.17 q ha^{-1}) sown crops. Among varieties, highest biological yield (67.20 q ha^{-1}) was recorded in UPAS-120 followed by Manak (63.22 q ha^{-1}) and Paras (63.00 q ha^{-1}).

Table 4: Optical characteristics of pigeonpea cultivars at maturity under different growing environments.

Treatments	Reflection (%)	Transmission (%)	Absorption (%)
First fortnight of May	6.6	10.9	82.5
First fortnight of June	7.3	11.4	81.3
Second fortnight of June	7.6	14.6	77.8
Varieties			
Manak	6.7	14.5	78.8
Paras	6.4	9.7	83.9
UPAS-120	6	6.4	87.6

The higher seed yield may be attributed to high leaf area index as well as higher PAR interception and absorption, leading to higher dry matter accumulation before the attainment of reproductive stage by pigeonpea crop (Patel *et al.,* 2000). Harvest index is a measure of physiological productivity potential of crop cultivars. Harvest index is the ability of a plant to convert the dry matter into economic yield. Harvest index was significantly influenced by sowing dates. First fortnight of May sown crop produced higher harvest index (25.96%) than second fortnight of June sown crop (23.40%). Similar, results was reported by Islam *et al.* (2008). Among varieties, highest HI (25.51%) was recorded in UPAS-120 followed by Paras (24.90%) and Manak (22.51%).

Optical characteristics

The optical characteristics (Transmission, Reflection and Absorption) of pigeonpea varieties in different sowing time are presented in Table 4. Among different date of sowings, maximum reflection (7.6%) and maximum transmission (14.6%) was recorded in crop sown in second fortnight of June followed by first fortnight of June and first fortnight of May sown crops where as maximum absorption (82.5%) was recorded in crop sown in first fortnight of May (D_1) followed by first fortnight of June (D_2) and second fortnight of June (D_3) sown crops. Among varieties, maximum reflection (6.7%) and maximum transmission (14.5%) was recorded in Manak followed by Paras and UPAS-120 where as maximum absorption (87.6%) was recorded in UPAS-120 followed by Paras and Manak. The minimum transmission and maximum absorption of PAR in first sown crop and variety UPAS-120 were because of maximum LAI recorded in these treatments. These results are in accordance with the results of (Monga 2009) in tomato crop under different sowing environments.

CONCLUSION

This study was conducted to evaluate the effect of sowing time and cultivars on growth, development and yield parameters of pigeonpea. According to the results obtained, leaf area index (LAI) and dry matter significantly decreased with delay in sowing at all growth intervals and found higher in crop sown on first fortnight of May followed by first fortnight

of June and second fortnight of June sown crops. Among varieties, UPAS-120 produced higher LAI and dry matter at all growth intervals followed by Paras and Manak. This is because of highest photosynthetically active radiation (PAR) intercepted by them.

Delay in sowing also significantly reduced the number of primary and secondary branches per plant, pods per plant, seeds per pod, test weight and seed yield as compared to early sown crop and found highest in crop sown on first fortnight of May followed by first fortnight of June and second fortnight of June sown crops. Among varieties, UPAS-120 produced highest primary and secondary branches per plant, pods per plant, seeds per pod, test weight and seed yield followed by Paras and Manak.

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