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# Effect of sowing date on seed quality of pigeonpea [*Cajanus cajan* (L.) Mill sp.]

**RG Chawhan, RV Chahande and HS Deshmukh**

**Abstract**
The field experiment was conducted at Post Graduate Institute Farm, Mahatma Phule Krishi Vidyapeeth, to study on the effect of sowing date on seed quality of pigeonpea was conducted under field conditions. Further, the laboratory experiment was also conducted in the Seed Technology Research Unit, Mahatma Phule Krishi Vidyapeeth, Rahuri during 2015-16 and 2016-17.

The experiment consisted of two factors *viz*., two dates of sowing ($D_1$-1st fortnight of June and $D_2$-1st fortnight of July) as first factor and four varieties ($V_1$- Vipula, $V_2$- Rajeshwari, $V_3$- BDN-711 and $V_4$- PKV-Tara) as second factor.

The sowing during 1st fortnight of June registered more number of pods per plant (367.70), pod yield per plant (102.11 g), pod yield per hectare (3191.05 kg), seed yield per plant (68.42 g) and seed yield per hectare (2138.01 kg) as spraying during against 1st fortnight of July(343.96, 95.51 g, 2984.57 kg, 63.99 g and 1999.66 kg, respectively). $D_1$ (1st fortnight of June) shows better performance of yield per hectare (6.48%) than $D_2$ (1st fortnight of July) sowing.

Vipula ($V_1$) registered relatively higher values for number of pods per plant (391.19), pod yield per plant (108.63 g), pod yield per hectare (3394.61 g), seed yield per plant (72.78 g) and seed yield per hectare (2274.39 kg) against PKV-Tara ($V_4$) (281.71, 78.18 g, 2442.97 kg, 52.38 g, 1636.79 kg, respectively). The next higher values for seed yield component were recorded in BDN-711 ($V_3$) (383.80, 106.65 g, 3332.89 kg, 71.46 g and 2233.04 kg, respectively). The consistent results were recorded for different dates of sowing with varieties and their interaction effect.

**Keywords:** Pigeonpea, Sowing Date, Cv. (Vipula, Rajeshwari, BDN-711 and PKV-Tara), FRBD, FCRD, Growth and Yield Parameters, Seed Quality Parameters, Biochemical Parameters, Physical Characterization

## Introduction
India is the largest pulses producer and accounts for 27-28 percent of global production. In India area occupied by pigeonpea is about 3.96 million ha with total production of 2.56 million tonnes but average productivity is quite low 646 kg/ha (Anonymous, 2015-16) because of several factors including its cultivation in rainfed and marginal lands, use of old and low quality seeds by the farmers which in turn gives poor germination, delayed emergence and sick seedlings that leads to poor yield.

The agroclimatic location for pigeonpea seed production is one of the most important factors that influence the seed yield and quality since the weather conditions such as temperature, relative humidity, photoperiod, wind velocity, soil type and plant nutrition are known to vary from location to location resulting in differential seed yield and quality. Therefore, selection of ideal provenance or area of seed production for producing higher yield and better quality seeds becomes an integral and essential part of successful seed production programme. Such information of provenance effect on seed yield and quality is very few and scanty in pigeonpea.

The photoperiod sensitive reaction in pigeonpea is positively linked to its maturity duration and biomass production. The recently developed early-maturing varieties are relatively less sensitive to photoperiod and the longer duration types are most sensitive. For efficient seed production of hybrids, a good understanding of this phenomenon is essential for maximizing the seed crop productivity by adjusting plant population in accordance with the planting dates. Date of sowing is one of the important agronomic factors influencing the overall seed productivity of many arable crops owing to fluctuating changes in environmental conditions to which phenological stages of crop growth are exposed. The modified environment resulting from the standardizing the different dates of sowing may largely influence the crop growth and development. Pigeonpea is usually sown between June and July months in many parts of the

Maharashtra state. However, sowings of pigeonpea crop are often delayed due to late onset of monsoons. The delayed sowing in such situation might result in drastic reduction in yield as well as seed quality in pigeonpea.

With this background, a systemic study was conducted on improving seed quality of pigeonpea with the objectives, to study the effect of sowing date on seed quality of pigeonpea.

**Materials and Methods**

The present investigation entitled "Effect of sowing date on seed quality of pigeonpea [*Cajanus Cajan* (L.) Millsp]." was conducted at Post Graduate Institute Farm and Seed Technology Research Unit, Mahatma Phule Krishi Vidyapeeth, Rahuri during the period from 2015-2016 and 2016-2017. The required seed material of the selected varieties were obtained from Pulses Research Unit, Mahatma Phule Krishi Vidyapeeth, Rahuri. Geographically, Rahuri is situated at 190 34' N latitude and 740 64' E longitude with an altitude of 536 meters above Mean Sea Level.

The field experiment consisted of 8 treatment combinations involving two factors *viz*., two dates of sowing as first factor *viz*., D1 -1st fortnight of June and D2 -1st fortnight of July and four varieties as second factor *viz*., V1- Vipula, V2- Rajeshwari, V3- BDN-711 and V4- PKV-Tara etc.

The data obtained from all the parameters in (field and laboratory) by using Factorial Randomized Block Design (FRBD) and Factorial Completely Randomized Design (FCRD) as per Panse and Sukhatme (1985).

Plant based observations like Growth and yield parameters *viz*., Plant height at maturity (cm), Number of primary branches per plant, Number of secondary branches per plant, Days to flower initiation, Days to 50% flowering, Duration of flowering, Pod retention per plant, Days to pod initiation, Percent of flower drop per plant, Days to pod maturity, Number of pods per plant, Pod yield per plant (g), Pod yield per hectare (Kg), Seed yield per plant (g) and Seed yield per hectare (kg) were recorded of five randomly selected and tagged plants.

Afterwards, Seed Quality Parameters such as *viz*., Germination percentage (%), Seed mycoflora, Root length (cm), Shoot length (cm), Hundred seed weight (g), Seedling dry weight (mg-10 seedlings), Vigour index- I, Vigour index-II and Electrical conductivity (dSm-1) were recorded at laboratory condition.

Biochemical Parameter *viz*., Protein and Carbohydrate content estimated by NIR spectrometer (ZEUTEC) again various seedling response test like GA3 and 2,4-D Test also estimated at laboratory.

The seeds visualized under the computerized vision system (Image Analyzer) for Physical Characterization of seeds *viz*., Seed surface area (mm), Seed length (mm), Seed width (mm), Seed roundness (mm) and Seed volume (mm3).

Plant growth and quality of seed production of field crop like pigeonpea is influenced mainly by the interplay between genotypic and environmental factors as supported by judicious application of seed crop management practices. Among the several cultural practices, optimum date of sowing will play important role for realizing the maximum possible yield of quality seeds of pigeonpea.

**Results and Discussion**

Plant growth and quality of seed production of field crop like pigeonpea is influenced mainly by the interplay between genotypic and environmental factors as supported by judicious application of seed crop management practices. Among the several cultural practices, optimum date of sowing will play important role for realizing the maximum possible yield of quality seeds of pigeonpea.

According to Table. 1, 2 and 3, data from the results of this evaluation indicated that, Irrespective of varieties, date of sowing showed significant differences for crop growth parameters *viz*., plant height at maturity (220.13, 217.68 and 218.91 cm), number of primary branches per plant (22.18, 22.40 and 22.29), number of secondary branches per plant (29.03, 28.26 and 28.64) were significantly more in D1 (1st fortnight of June) in 2015-16, 2016-17 and pooled respectively. It also depleted in Graph 1 and 2. Among the dates of sowing, the plants sown in 1st fortnight of June have showed significant delay in onset of flowering and reproductive characters. This delay in flowering and reproductive parameters noticed in June sowing may be attributed to the extended expression of growth parameters like plant height at maturity, number of primary branches per plant and number of secondary branches per plant due to longer rainy days, higher rainfall and congenial weather conditions which have delayed the onset of flowering and reproductive parameters. On the other hand 1st fortnight of July sowing has shown significantly earliness in flowering and reproductive parameters but longer flowering duration irrespective of varieties and it may be attributed to the prevalence of shorter rainy days, less rainfall, moderate rise in day temperature and moisture stress condition which might have accelerated the crop growth period and resulted in earliness in flowering and reproductive parameters in all the varieties. These results were in conformity with the finding of Mishra *et al*. (2008) [10] in pigeonpea, Kaya *et al*. (2010) [8] in chickpea, Moosavi *et al*. (2010) [11] in soybean and Ram Hari *et al*. (2011) [16] in pigeonpea.

Among the different dates of sowings, D2 (1st fortnight of July) sowing has significantly recorded less number of days for days to flower initiation (95.69, 93.39 and 94.54), days to 50% flowering (106.51, 104.40 and 105.45), days to pod initiation (104.15, 101.73 and 102.94), days to pod maturity (136.71, 134.75 and 135.73) than the D1 (1st fortnight of June) in 2015-16, 2016-17 and pooled respectively. D1 (1st fortnight of June) sowing significantly recorded shorter duration of flowering (34.20, 34.23 and 34.22) against D2 (1st fortnight of July) (35.72, 35.14 and 35.43) in 2015-16, 2016-17 and pooled respectively.

Irrespective of dates of sowing, V1 (Vipula) significantly recorded maximum number of pods per plant (396.23, 386.16 and 391.19), pod yield per plant (110.04, 107.22 and 108.63), pod yield per hectare (3438.75, 3350.47 and 3394.61), seed yield per plant (73.73, 71.83 and 72.78) and seed yield per hectare (2303.96, 2244.81 and 2274.39) in 2015-16, 2016-17 and pooled respectively. The maximum seed yield per plant and hectare noticed in 1st fortnight of June sowing may be ascribed to the better growth of morphological and phonological characters of plants and it might have resulted in more number of productive branches and pods per plant as evident in this study. Similarly, increase in seed yield per hectare might be also related to the efficient photosynthetic activity, translocation and assimilation of photosynthesis from sourse to sink (developing seeds) in the plants of early sowings over those of late sowings (Shkoluik and Abdurashitov, 1958). These findings are in agreement with those of Mishra *et al*. (2008) [10] in pigeonpea, Kaya *et al*. (2010) [8] in chickpea, Moosavi *et al*. (2010) [11] in soybean

and Ram Hari *et al*. (2011) [16] in pigeonpea.

Seed mycoflora was observed significantly less in D1 (1st fortnight of June) sowing (20.28, 21.89 and 21.09) in 2015-16, 2016-17 and pooled respectively than D2 (1st fortnight of July) sowing. The superior seed quality parameters noticed in 1st fortnight of June sowing may be attributed to better vegetative growth and reproductive parameters of the plants which resulted in higher 100 seed weight and other seed quality parameters. Similar variable effects of different sowing dates on seed quality parameters were also reported by Mishra *et al*. (2008) [10] in pigeonpea, Kaya *et al*. (2010) [8] in chickpea, Moosavi *et al*. (2010) [11] in soybean and Ram Hari *et al*. (2011) [16] in pigeonpea.

The pooled value of biochemical parameters shown in Table 4, Irrespective of dates of sowing, V2 (Rajeshwari) significantly recorded more protein content (21.25, 21.17 and 21.21) and carbohydrate content (64.94, 64.64 and 64.79) in 2015-16, 2016-17 and pooled respectively. Muhammad (2009) [12] reported that when sowing was delayed, significant reduction in protein content was observed. It might be due to the decrease in seed size and yield that might be the possible cause of reduction in protein content. Similar findings were reported by Sambasivarao *et al*. (2002) [17] in groundnut and Biradarpatil *et al*. (2006) [4] while working on safflower.

The interaction effect due to sowing dates and varieties were significant for number of pod per plant, pod yield per plant (g), pod yield per hectare (kg), seed yield per plant (g), seed yield per hectare (kg), protein content (%) and carbohydrate content (%). These results were in conformity with the finding of Paulsen *et al*. (1989) in maize and Geetha *et al*. (2011) [6].

**Influence of Sowing Dates**

Irrespective of varieties, D1 (1st fortnight of June) sowing has significantly recorded maximum number of pods per plant, pod yield per plant, pod yield per hectare, seed yield per plant and seed yield per hectare than D2 (1st fortnight of July) sowing. The optimum date of sowing of pigeonpea varieties was D1 (1st fortnight of June) as compared to D2 (1st fortnight of July). D1 (1st fortnight of June) recorded higher seed yield per hectare (4.6%) than D2 (1st fortnight of July) sowing. D1 (1st fortnight of June) sowing significantly recorded shorter duration of flowering against D2 (1st fortnight of July). Irrespective of varieties, date of sowing showed significant differences for crop growth parameters such as plant height at maturity, number of primary branches per plant and number of secondary branches per plant were significantly more in D1 (1st fortnight of June) than D2 (1st fortnight of July).

**Influence of Varieties**

Irrespective of sowing dates, V1 (Vipula) recorded maximum number of pods per plant, pod yield per plant, pod yield per hectare, seed yield per plant and seed yield per hectare followed by V3 (BDN-711) whereas minimum values seen in V4 (PKV-Tara). Irrespective of dates of sowing, V2 (Rajeshwari) significantly recorded more values for protein content and carbohydrate content. Seed mycoflora was significantly lesser in D1 (1st fortnight of June) sowing than D2 (1st fortnight of July) sowing. V3 (BDN-711) took lesser days for days to flower initiation, days to pod initiation, dasy to 50% flowering and duration of flowering. Similar varietal differences on crop growth parameters were also reported by the workers like Poma *et al*. (1990) [15]. Such differential genotypic responses on flowering and reproductive characters are also in conformity with those reports of Sangakkara (1993) in mungbean, Patra *et al*. (2000) [14] in greengram and Greven *et al*. (2004) [7] in French bean.

The differences in seedling growth reduction among the varieties might be due to differences in ethylene production because of application of 2-4 D (Sundaru *et al*. 1983) [18]. The most obvious response was extreme malformation of plants within a few days after treatment, it was not possible to measure varietal differences in foliage reaction accurately, and reason for differential was greater ability of some strains to recover by production of new floral primordial (Fribourg and Johnson, 1995) [5]. These results are in conformity with the findings of Sainis *et al*. (2009) in wheat and Geetha *et al*. (2011) [6] in mustard.

**Interaction effect (T×S)**

The interaction effect due to sowing dates and varieties was significant for number of pod per plant, pod yield per plant (g), pod yield per hectare (kg), seed yield per plant (g), seed yield per hectare (kg), protein content (%) and carbohydrate content (%).

The marked variations noticed in the growth parameters may be related to differential response of varieties to the dynamic changes in the environment under different dates of sowing starting from June to July. This result are in conformity with those of Sangakkara (1993) in mungbean, Patra *et al*. (2000) [14] in greengram, Greven *et al*. (2004) [7] in frenchbean, Thalji *et al*. (2006) [19] in fababean and Mishra *et al*. (2008) [10] in pigeonpea.

The differential response in flowering and reproductive behavior may be attributed to the varietal differences in relation to weather conditions under different dates of sowing. These results are in agreement with those of Thalji *et al*. (2006) [19] in fababean, Mishra *et al*. (2008) [10] in pigeonpea and Mansur *et al*. (2010) [9] in chickpea.

The marked increase in seed yield noticed in these varieties under June sowing may be due to prevalence of congenial environmental conditions like cool day temperature, moderate humid climate and bright sunshine favoring luxuriant growth in the early sown crop compared to late sown crop. The similar varietal differences in different sowing dates on seed yield components are also reported in chickpea by Mishra *et al*. (2008) [10], Kaya *et al*. (2010) [8], Moosavi *et al*. (2010) [11] and Ram Hari *et al*. (2011) [16]. Similar findings were reported by Sambasivarao *et al*. (2002) [17] in groundnut and Biradarpatil *et al*. (2006) [4] while working on safflower. Similar findings were reported by Arefi *et al*. (2011) [2] and Yano *et al*. (2012) [20].

**Table 1:** Influence of date of sowing (D) on growth and yield parameters of pigeonpea varieties (V) and their interactions (D×V)

| | Plant height at maturity (cm) | Number of primary branches per plant | Number of secondary branches per plant | Days to flower initiation | Days to 50% flowering | Duration of flowering | Pod retention per plant | Days to pod initiation |
|---|---|---|---|---|---|---|---|---|
| **Dates of sowing (D)** | | | | | | | | |
| $D_1$ | 218.91 | 22.29 | 28.64 | 102.36 | 113.11 | 34.22 | 373.6 | 110.99 |
| $D_2$ | 216.12 | 21.52 | 25.58 | 94.54 | 105.45 | 35.43 | 349.95 | 102.94 |
| Mean | 217.52 | 21.91 | 27.11 | 98.45 | 109.28 | 34.82 | 361.78 | 106.96 |
| S.Em(±) | 1.08 | 0.26 | 0.29 | 0.98 | 0.65 | 0.15 | 4.43 | 1.79 |
| CD 5% | NS | 0.75 | 0.83 | 2.86 | 1.9 | 0.45 | 12.93 | 5.22 |
| **Variety (V)** | | | | | | | | |
| $V_1$ | 221.18 | 20.51 | 26.42 | 98.09 | 108.1 | 34.44 | 396.19 | 105.62 |
| $V_2$ | 231.57 | 23.68 | 27.6 | 100.63 | 112.01 | 35.49 | 373.51 | 109.6 |
| $V_3$ | 203.42 | 18.46 | 24.73 | 90.41 | 101.23 | 33.72 | 388.75 | 99.5 |
| $V_4$ | 213.89 | 24.98 | 29.69 | 104.67 | 115.78 | 35.65 | 288.66 | 113.14 |
| Mean | 217.52 | 21.91 | 27.11 | 98.45 | 109.28 | 34.82 | 361.78 | 106.96 |
| S.Em(±) | 0.76 | 0.18 | 0.2 | 0.69 | 0.46 | 0.11 | 3.13 | 1.27 |
| CD 5% | 2.23 | 0.53 | 0.59 | 2.02 | 1.35 | 0.32 | 9.14 | 3.69 |
| **Interaction (DxV)** | | | | | | | | |
| $D_1V_1$ | 223.1 | 21.12 | 27.91 | 101.65 | 111.15 | 33.85 | 411.58 | 109.55 |
| $D_1V_2$ | 233.78 | 24.13 | 29 | 104.5 | 115.9 | 34.86 | 389.29 | 113.8 |
| $D_1V_3$ | 204.14 | 18.15 | 26.1 | 95.21 | 103.73 | 33.15 | 396.53 | 104.19 |
| $D_1V_4$ | 214.61 | 25.75 | 31.55 | 108.09 | 121.65 | 35 | 297.02 | 116.43 |
| $D_2V_1$ | 219.26 | 19.91 | 24.93 | 94.53 | 105.05 | 35.03 | 380.79 | 101.69 |
| $D_2V_2$ | 229.37 | 23.23 | 26.2 | 96.77 | 108.12 | 36.11 | 357.73 | 105.39 |
| $D_2V_3$ | 202.71 | 18.77 | 23.35 | 85.61 | 98.74 | 34.29 | 380.98 | 94.8 |
| $D_2V_4$ | 213.17 | 24.2 | 27.83 | 101.25 | 109.9 | 36.3 | 280.3 | 109.86 |
| S.Em(±) | 2.16 | 0.52 | 0.57 | 1.96 | 1.3 | 0.31 | 8.86 | 3.58 |
| CD 5% | NS | NS | NS | NS | NS | NS | NS | NS |

**Table 2:** Influence of date of sowing (D) on growth and yield parameters of pigeonpea varieties (V) and their interactions (D×V)

| | Percent of flower drop per plant | Days to pod maturity | Number of pods per plant | Pod yield per plant (g) | Pod yield per hectare (Kg) | Seed yield per plant (g) | Seed yield per hectare (kg) |
|---|---|---|---|---|---|---|---|
| **Dates of sowing (D)** | | | | | | | |
| $D_1$ | 62.48 | 143.38 | 367.7 | 102.11 | 3191.05 | 68.42 | 2138.01 |
| $D_2$ | 63.16 | 135.73 | 343.96 | 95.51 | 2984.57 | 63.99 | 1999.66 |
| Mean | 62.82 | 139.55 | 355.83 | 98.81 | 3087.81 | 66.2 | 2068.83 |
| S.Em(±) | 0.21 | 1.29 | 0.44 | 0.03 | 4.34 | 0.25 | 0.48 |
| CD 5% | 0.61 | 3.78 | 1.29 | 0.1 | 12.68 | 0.74 | 1.4 |
| **Variety (V)** | | | | | | | |
| $V_1$ | 61.64 | 139.82 | 391.19 | 108.63 | 3394.61 | 72.78 | 2274.39 |
| $V_2$ | 63.16 | 141.51 | 366.62 | 101.79 | 3180.78 | 68.2 | 2131.12 |
| $V_3$ | 63.01 | 131.91 | 383.8 | 106.65 | 3332.89 | 71.46 | 2233.04 |
| $V_4$ | 63.48 | 144.98 | 281.71 | 78.18 | 2442.97 | 52.38 | 1636.79 |
| Mean | 62.82 | 139.55 | 355.83 | 98.81 | 3087.81 | 66.2 | 2068.83 |
| S.Em(±) | 0.15 | 0.92 | 0.31 | 0.02 | 3.07 | 0.18 | 0.34 |
| CD 5% | 0.43 | 2.67 | 0.91 | 0.07 | 8.96 | 0.52 | 0.99 |
| **Interaction (DxV)** | | | | | | | |
| $D_1V_1$ | 60.47 | 144.19 | 406.23 | 112.77 | 3524.06 | 75.56 | 2361.12 |
| $D_1V_2$ | 63.1 | 146.12 | 382.96 | 106.36 | 3323.59 | 71.26 | 2226.81 |
| $D_1V_3$ | 62.89 | 135.66 | 391.16 | 108.78 | 3399.38 | 72.88 | 2277.58 |
| $D_1V_4$ | 63.46 | 147.55 | 290.45 | 80.55 | 2517.19 | 53.97 | 1686.52 |
| $D_2V_1$ | 62.8 | 135.45 | 376.16 | 104.49 | 3265.16 | 70 | 2187.65 |
| $D_2V_2$ | 63.21 | 136.9 | 350.28 | 97.22 | 3037.97 | 65.13 | 2035.44 |
| $D_2V_3$ | 63.13 | 128.15 | 376.45 | 104.53 | 3266.41 | 70.03 | 2188.49 |
| $D_2V_4$ | 63.5 | 142.41 | 272.96 | 75.8 | 2368.75 | 50.79 | 1587.06 |
| S.Em(±) | 0.41 | 2.59 | 0.88 | 0.07 | 8.69 | 0.51 | 0.96 |
| CD 5% | NS | NS | 2.58 | 0.2 | 25.35 | 1.47 | 2.81 |

**Table 3:** Influence of date of sowing (D) on seed quality parameters of pigeonpea varieties (V) and their interactions (D×V)

| | Germination percentage (%) | Seed mycoflora (%) | Root length (cm) | Shoot length (cm) | Hundred seed weight (g) | Seedling dry weight (mg-10 seedlings) | Vigour index- I | Vigour index- II | Electrical conductivity (dSm-1) |
|---|---|---|---|---|---|---|---|---|---|
| **Dates of sowing (D)** | | | | | | | | | |
| $D_1$ | 68.19 | 27.27 | 13.93 | 12.91 | 11.01 | 78.57 | 2320.01 | 67.63 | 0.83 |
| $D_2$ | 67.09 | 27.91 | 13.69 | 12.34 | 10.7 | 77.05 | 2210.62 | 65.29 | 0.76 |
| Mean | 67.64 | 27.59 | 13.81 | 12.63 | 10.86 | 77.81 | 2265.31 | 66.46 | 0.8 |
| S.Em(±) | 0.38 | 0.1 | 0.08 | 0.13 | 0.08 | 0.24 | 11.47 | 0.19 | 0.01 |
| CD 5% | NS | 0.28 | 0.23 | 0.37 | 0.24 | 0.7 | 33.48 | 0.55 | 0.03 |
| **Variety (V)** | | | | | | | | | |
| $V_1$ | 72.78 | 24.52 | 14.52 | 13.41 | 10.44 | 81.18 | 2551.58 | 74.07 | 0.52 |
| $V_2$ | 67.78 | 27.98 | 14.1 | 12.89 | 11.4 | 78.69 | 2316.6 | 67.42 | 0.72 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| $V_3$ | 64.4 | 27.87 | 13.2 | 11.79 | 11.55 | 74.01 | 2045.78 | 60.19 | 1.03 |
| $V_4$ | 65.59 | 29.99 | 13.41 | 12.43 | 10.04 | 77.35 | 2147.29 | 64.15 | 0.92 |
| Mean | 67.64 | 27.59 | 13.81 | 12.63 | 10.86 | 77.81 | 2265.31 | 66.46 | 0.8 |
| S.Em(±) | 0.27 | 0.07 | 0.06 | 0.09 | 0.06 | 0.17 | 8.11 | 0.13 | 0.01 |
| CD 5% | 0.78 | 0.2 | 0.17 | 0.26 | 0.17 | 0.49 | 23.67 | 0.39 | 0.02 |
| **Interaction (DxV)** | | | | | | | | | |
| $D_1V_1$ | 73.1 | 23.95 | 14.71 | 13.64 | 10.6 | 82.12 | 2594.8 | 75.15 | 0.55 |
| $D_1V_2$ | 68.26 | 27.81 | 14.1 | 13.15 | 11.59 | 79.08 | 2359.82 | 68.2 | 0.75 |
| $D_1V_3$ | 65.08 | 27.1 | 13.5 | 12.15 | 11.69 | 74.93 | 2131.17 | 61.56 | 1.08 |
| $D_1V_4$ | 66.31 | 30.2 | 13.42 | 12.71 | 10.15 | 78.14 | 2194.23 | 65.6 | 0.94 |
| $D_2V_1$ | 72.47 | 25.09 | 14.34 | 13.18 | 10.29 | 80.24 | 2508.36 | 73 | 0.5 |
| $D_2V_2$ | 67.3 | 28.14 | 14.1 | 12.62 | 11.2 | 78.31 | 2273.38 | 66.63 | 0.69 |
| $D_2V_3$ | 63.71 | 28.64 | 12.9 | 11.42 | 11.41 | 73.09 | 1960.39 | 58.83 | 0.97 |
| $D_2V_4$ | 64.87 | 29.77 | 13.4 | 12.15 | 9.92 | 76.57 | 2100.35 | 62.71 | 0.9 |
| S.Em(±) | 0.76 | 0.19 | 0.16 | 0.25 | 0.16 | 0.48 | 22.94 | 0.38 | 0.02 |
| CD 5% | NS | 0.56 | NS | NS | NS | NS | NS | NS | NS |

**Table 4:** Influence of date of sowing (D) on biochemical parameters and physical characterization of pigeonpea varieties (V) and their interactions (D×V)

| | Protein content (%) | Carbohydrates content (%) | Response to GA3 test | Response to 2, 4-D test | Seed surface area (mm) | Seed length (mm) | Seed width (mm) | Seed roundness (mm) | Seed volume (mm3) |
|---|---|---|---|---|---|---|---|---|---|
| **Dates of sowing (D)** | | | | | | | | | |
| $D_1$ | 26.77 | 52.69 | 17.74 | 34.99 | 87.71 | 6.07 | 4.9 | 91.54 | 83.45 |
| $D_2$ | 26.75 | 52.56 | 17.28 | 36.25 | 86.3 | 6.04 | 4.87 | 91.46 | 82.67 |
| Mean | 26.76 | 52.62 | 17.51 | 35.62 | 87 | 6.05 | 4.89 | 91.5 | 83.06 |
| S.Em(±) | 0 | 0 | 0.13 | 0.21 | 0.23 | 0.01 | 0.01 | 0.03 | 0.03 |
| CD 5% | 0.01 | 0.01 | 0.38 | 0.61 | 0.68 | 0.03 | 0.03 | 0.08 | 0.08 |
| **Variety (V)** | | | | | | | | | |
| $V_1$ | 26.81 | 53.03 | 19.47 | 33.44 | 87.46 | 6.21 | 4.92 | 91.93 | 83.7 |
| $V_2$ | 27.42 | 53.6 | 17.4 | 36.1 | 90.27 | 6.27 | 5.02 | 92.23 | 87.09 |
| $V_3$ | 26.14 | 52.3 | 17.59 | 35.12 | 85.66 | 5.94 | 4.83 | 91.2 | 81.53 |
| $V_4$ | 26.66 | 51.55 | 15.56 | 37.81 | 84.62 | 5.8 | 4.78 | 90.65 | 79.92 |
| Mean | 26.76 | 52.62 | 17.51 | 35.62 | 87 | 6.05 | 4.89 | 91.5 | 83.06 |
| S.Em(±) | 0 | 0 | 0.09 | 0.15 | 0.17 | 0.01 | 0.01 | 0.02 | 0.02 |
| CD 5% | 0.01 | 0.01 | 0.27 | 0.43 | 0.48 | 0.02 | 0.02 | 0.05 | 0.06 |
| **Interaction (DxV)** | | | | | | | | | |
| $D_1V_1$ | 26.83 | 53.09 | 19.91 | 32.42 | 88.09 | 6.23 | 4.94 | 91.96 | 84.25 |
| $D_1V_2$ | 27.44 | 53.68 | 17.66 | 35.46 | 91.4 | 6.29 | 5.04 | 92.27 | 87.58 |
| $D_1V_3$ | 26.15 | 52.38 | 17.72 | 34.63 | 86.2 | 5.95 | 4.85 | 91.26 | 81.93 |
| $D_1V_4$ | 26.65 | 51.59 | 15.65 | 37.47 | 85.14 | 5.82 | 4.8 | 90.69 | 80.04 |
| $D_2V_1$ | 26.8 | 52.97 | 19.03 | 34.47 | 86.82 | 6.19 | 4.9 | 91.91 | 83.15 |
| $D_2V_2$ | 27.4 | 53.52 | 17.14 | 36.74 | 89.14 | 6.25 | 5.01 | 92.19 | 86.6 |
| $D_2V_3$ | 26.12 | 52.22 | 17.46 | 35.62 | 85.12 | 5.92 | 4.81 | 91.14 | 81.14 |
| $D_2V_4$ | 26.67 | 51.52 | 15.47 | 38.16 | 84.1 | 5.79 | 4.77 | 90.6 | 79.81 |
| S.Em(±) | 0.01 | 0.01 | 0.26 | 0.42 | 0.47 | 0.02 | 0.02 | 0.05 | 0.06 |
| CD 5% | 0.02 | 0.03 | NS | NS | NS | NS | NS | NS | 0.17 |

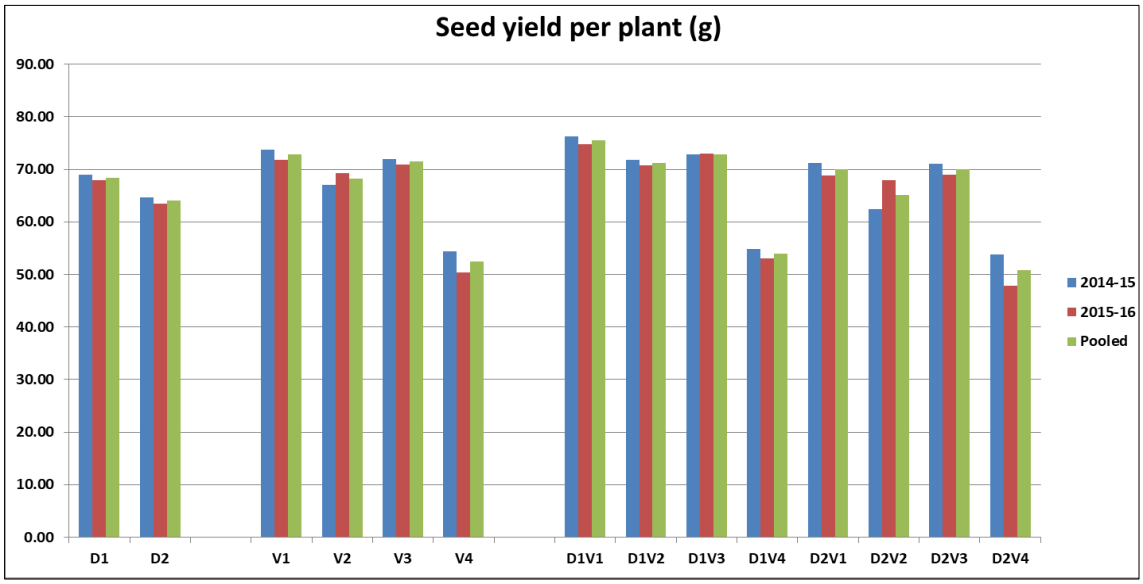


**Fig 1:** Influence of date of sowing (D) on seed yield per plant (g) of pigeonpea varieties (V) and their interactions (D×V)

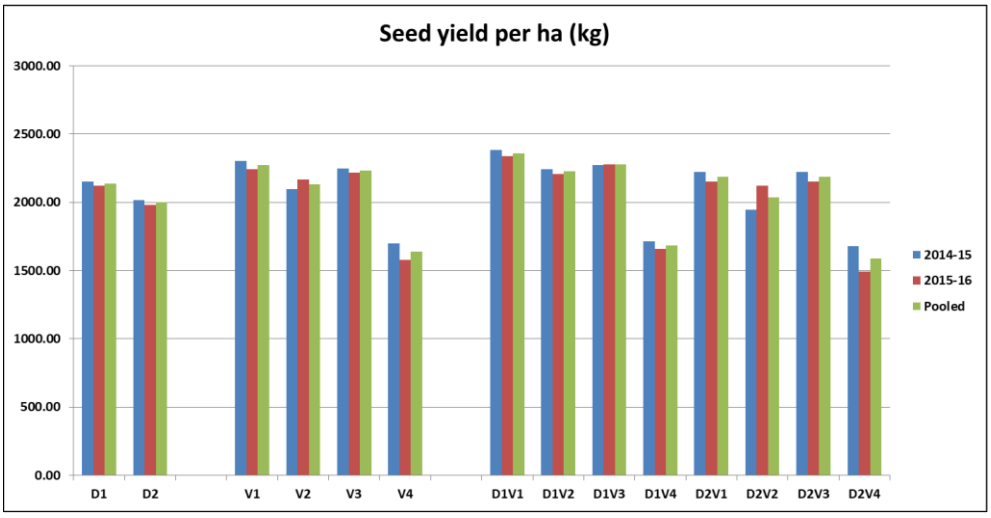


**Fig 2:** Influence of date of sowing (D) on seed yield per hectare (kg) of pigeonpea varieties (V) and their interactions (D×V)

## Conclusion

On the basis of all above result, it was concluded that, There is a need to study the influence of other growth regulators at various concentrations, methods of application at different crop stages on flower drop, seed yield and quality. There is a need to investigate and identify suitable sowing dates and varieties under different agro-climatic zones for getting higher seed yield and seed quality. The characterization based on distinct and stable seed, seedling and plant morphological markers are need to be standardized for different varieties of pigeonpea.

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