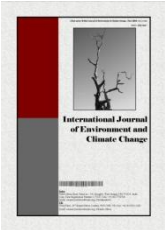

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Impact of Yield Attributes and Yields of Pigeonpea (*Cajanus cajan* (L.)) Varieties under Different Sowing Windows

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

An agro-meteorological investigation was undertaken to determine"the impact of crop yield attributes and yield of pigeonpea (*Cajanus cajan*) varieties under different sowing windows" during *kharif*, 2017-18 and 2018-19 at Department of Agricultural Meteorology, College of Agriculture, Pune. In this context, an experiment was laid out in split plot design with three replications. The treatment comprised of four varieties *viz.,* Vipula, Rajeshwari (Phule T 0012), BDN 711 and ICPH 2740 as main plot and four sowing windows *viz*., 24th, 26th MW, 28th and 30th MW as sub plot treatments. Yield contributing characters *viz.,* number of pods plant^{-1} (149.5 and 143.0), weight of

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pods plant^{-1} (113.8 and 107.6 g) and 100 seed weight (10.79 and 10.75 g) were found significantly higher in var. ICPH 2740 over var. Vipula, Rajeshwari and BDN 711.Grain yield (26.59 and 28.14 q ha^{-1}) and stalk yield (39.61 and 36.7 q ha^{-1}) were significantly higher in var. ICPH 2740 followed by var. Rajeshwari, Vipula and BDN 711.On the other hand, Grain yield (24.31 and 22.86 q ha^{-1}) and stalk yield (63.6 and 61.8 q ha^{-1}) was higher in 24th MW sowing window during the year 2017-18 and 2018-19, respectively.

Keywords: Yield attributes; pigeonpea; sowing window; ICPH 2740; grain yield and stalk yield.

1. INTRODUCTION

Pigeonpea (*Cajanuscajan* (L.) Millspaugh) is one of the major pulses crops of the tropics and subtropics. It is the second most important pulse crop of India, after chickpea [1]. It is commonly known as arhar or red gram. It is an important source of high quality dietary protein and is mostly consumed in the form of split pulse; green seeds are used as a vegetable. On the other hand, crushed dry seeds are used as animal feed, green and dry leaves as fodder, stems as fuel wood and to make huts and baskets in tribal areas. It is an agricultural crop of rainfed-drylands which can be grown on mountain slopes to reduce soil erosion.

The area, productivity and production of pigeonpea in Maharashtra were 12.29 lakh hectares, 937 kg ha^{-1} and 10.59 lakh tons respectively [2]. All of these cultivated types of pigeonpea fall into two group's *viz*., *Cajanus cajan* (L.) var. Bicolour and *C. indicus* (L.) var. flavus.

Pigeonpea is predominantly a crop of tropical areas mainly cultivated in semi-arid regions of India. Pigeonpea can be grown with a temperature ranging from 26 ^{0}C to 30 ^{0}C in the rainy season (June to October) and 17 ^{0}C to 22 ^{0}C in the post rainy (November to March) season. Pigeonpea is very sensitive to low radiation at pod development, therefore flowering during the monsoon and cloudy weather, leads to poor pod formation [3].However, the nature of the response to temperature between the cardinal points is important for calculating the phenology, adaptation and yield of a crop [4].

Sowing dates has a profound impact on the crop performance as it determines the kind of weather conditions to which difficult phenological stages of the crop exposed. Delay in sowing time shortens the growing period, hastens maturity and ultimately reduces the yield [5]. Early sowing may prolong the vegetative growth period while delayed sowing may shrink the vegetative phase period, thereby resulting in poor dry matter accumulation leading to poor portioning to reproductive parts and ultimately poor realization of the potential yield [6]. Therefore, a detailed study on different pigeonpea varieties under different sowing window would provide a base for understanding impact of crop yield attributes and yield under prevailed weather conditions.

2. MATERIALS AND METHODS

2.1 Location of the Experimental Site

The field experiment was conducted for two consecutive years at Department of Agricultural Meteorology farm, College of Agriculture, Pune during *kharif,* 2017 and 2018. The geographical location of the site (Pune) was 18° 32'N, latitude; 73°51E, longitude and 559 m above mean sea level (MSL). The soil is medium black having depth of about 1m. The average annual rainfall of Pune is 675mm.

2.2 Weather Conditions during Experimental Period

The weekly maximum temperature experienced during 2017-18 was 33.4 ^{0}C and lowest maximum temperature was 27.1 ^{0}C. The highest minimum temperature experienced was 23.9 ^{0}C and the lowest was 10.3 ^{0}C. The maximum morning relative humidity was 97.0 per cent and the minimum was 81.1 per cent. The maximum evening relative humidity was 82.1 per cent and the minimum was 31.1 per cent. The total rainfall was 909.1 mm and maximum amount of rainfall 135.1 mm in a week.

The weekly maximum temperature experienced during 2018-19 was 33.8^{0}C and lowest maximum temperature was 26.2^{0}C. The highest minimum temperature experienced was 24.6^{0}C and the lowest was 8.7^{0}C. The maximum morning relative humidity was 94.3 per cent and the minimum was 77.9 per cent. The maximum evening relative humidity was 85.4 per cent and

the minimum was 22.6 per cent. The total rainfall was 420.3 mm and maximum amount of rainfall 90.8 mm in a week.

2.3 Experimental Details

The experiment was conducted in a split plot design with three replications and sixteen treatment combinations of different varieties and sowing windows.The treatment comprised of four varieties *viz.,* Vipula, Rajeshwari (Phule T 0012), BDN 711 and ICPH 2740 (*Mannem Konda Kandi*) as main plot and four sowing windows *viz*., 24th, 26th MW, 28th and 30th MW as sub plot treatments. Inter row spacing was 45 cm and plant to plant spacing was 20 cm. Gross plot size was 4.0 × 4.5 square metres and net plot size was 3.6 × 4.0 square metres. Seeds were treated with Thiram @ 4 g per kg of seed followed by Rhizobium and PSB @ 10 g per kg of seed. The seed rate @ 18 kg ha^{-1} for all varieties. Urea and DAP were used as source of N and P, and applied as per recommended dose i.e., 25 kg N and 50 kg per hectare.

2.4 Yield Attributes Studies

The following yield contributing characters were recorded periodically on five observational plants from each net plot.

2.4.1 Number of pods plant^{-1}

The Number of pod plant^{-1} was recorded from the selected five plants in each net plot at harvest.

2.4.2 Length of pod (cm) plant^{-1}

The length of pod plant^{-1} was recorded from the selected five plants in each net plot at harvest.

2.4.3 Weight of pods plant^{-1} (g)

The weights of pods plant^{-1} were recorded from the selected five plants in each net plot at harvest.

2.4.4 Number of grains pod^{-1} (g)

In this study number of grain per healthy pods were collected from the randomly selected five plants.

2.4.5 Test weight (g)

A random sample of 100 grains from each net plot was drawn and their weights were recorded.

2.5 Yield Studies

2.5.1 Grain yield q ha^{-1}

The plants from each net plot (including observational plants) were harvested and threshed seeds were cleaned by winnowing and yield of grain kg plot^{-1} was converted in q ha^{-1}.

2.5.2 Stalk yield q ha^{-1}

The straw yield per net plot was obtained by difference in weight of total produce and seed weight was converted into q ha^{-1}.

3. RESULTS AND DISCUSSION

3.1 Yield Contributing Characters

The mean periodical yield contributing characters of pigeonpea varieties *viz.,* number of pods plant^{-1} (g), pod weight plant^{-1}(g), length of pods (cm), number of seeds pod^{-1} and 100 grain weight as influenced by different treatments were recorded at harvest and reported.

3.1.1 Number of pods per plant and pod weight plant^{-1}(g)

Data with respect to mean number of pods plant^{-1} and pod weight plant^{-1} as influenced by various treatments are presented in Table 1. The mean number of pods plant^{-1} was (138.8 and 131.4) and pod weight plant^{-1} was (105.8 and 98.6 g) during 2017-18 and 2018-19, respectively.

3.1.1.1 Effect of varieties

The pigeonpea varieties differ in their number of pods plant^{-1}. The number of pods plant^{-1} was found significantly higher in var. ICPH 2740 (149.5 and 143.0), followed by Rajeshwari (141.4 and 132.2), Vipula (135.3 and 128.3) and BDN 711 (128.9 and 122.1) during 2017-18 and 2018-19, respectively.

The pigeonpea varieties were also differ in their weight of pods plant^{-1}(g). The weight of pods plant^{-1} was found significantly higher in var. ICPH 2740 (113.8 and 107.6 g), followed by Rajeshwari (108.6 and 102.4 g), Vipula (106.4 and 100.2 g) and BDN 711 (94.5 and 79.5 g) during 2017-18 and 2018-19, respectively.

The varietal effect on pods plant^{-1} was significant. A var. ICPH 2740 was found significantly superior over other varieties. This can be

attributed due to high leaf area index, better assimilation of photosynthates and efficiency to tolerate temperatures. These results are in confirmation with the findings of Mishra et al. [7].

3.1.1.2 Effect of sowing windows

The number of pods plant^{-1} was recorded the highest at 24th MW (157.9 and 150.7) which was significantly superior over rest of the sowing windows, followed by 26th MW (146.8 and 136.8), 28th MW (134.5 and 126.0) and 30th MW sowing window (115.7 and 112.1) during 2017-18 and 2018-19, respectively.

The weight of pods plant^{-1} was recorded the highest at 24th MW (117.7and 112.7 g) which was significantly superior over rest of the sowing window followed by 26th MW (109.5 and 103.5 g), 28th MW (100.4 and 93.7 g) and 30th MW sowing window (95.7 and 79.8 g) during 2017-18 and 2018-19, respectively.

Phenological development from sowing to physiological maturity is dependent on the accumulation of thermal units above threshold or base temperature. A slow process of developmental events provides longer growing period and gives opportunity for the plant parts to survive with more number of pods and grains pod^{-1}. These results are concurrence with the findings of Hakim et al. [8] and Kumar et al. [9].

Table 1. Number of pods plant^{-1}and pod weight plant^{-1} (g) of pigeonpea as affected by different treatments during 2017-18 and 2018-19

Treatment	No. of pods per plant			Pod weight per plant (g)		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
A) Main plot treatments: Varieties						
V_1: Vipula	135.3^{b}	128.3^{b}	131.8^{b}	106.4^{b}	100.2^{a}	103.3^{b}
V_2: Rajeshwari	141.4^{b}	132.2^{a}	136.8^{b}	108.6^{a}	102.4^{a}	105.5^{b}
V_3: BDN 711	128.9^{c}	122.1^{b}	125.5^{c}	94.5^{c}	79.5^{b}	87.0^{c}
V_4: ICPH 2740	149.5^{a}	143.0^{a}	146.3^{a}	113.8^{a}	107.6^{a}	110.7^{a}
S. Em±	1.88	3.55	2.03	1.85	2.45	1.89
C. D. at 5%	6.51	12.29	6.26	6.40	8.48	5.83
B) Sub plot treatments: Sowing windows						
D_1: 24 MW	157.9^{a}	150.7^{a}	154.3^{a}	117.7^{a}	112.7^{a}	115.2^{a}
D_2: 26 MW	146.8^{b}	136.8^{b}	141.8^{b}	109.5^{b}	103.5^{b}	106.5^{b}
D_3: 28 MW	134.5^{c}	126.0^{c}	130.3^{c}	100.4^{c}	93.7^{c}	97.1^{c}
D_4: 30 MW	115.7^{d}	112.1^{d}	113.9^{d}	95.7^{d}	79.8^{d}	87.8^{d}
S. Em±	1.39	2.08	1.20	1.08	2.98	1.34
C. D. at 5%	4.06	6.08	3.40	3.14	8.69	3.81
C) Interaction (A×B)						
D_1V_1	156.7^{b}	138.0^{bc}	147.4^{d}	115.6^{b}	109.5^{ab}	112.5^{b}
D_2V_1	136.6^{d}	132.2^{c}	134.4^{ef}	109.1^{c}	102.0^{b}	105.6^{c}
D_3V_1	132.3^{d}	126.7^{cd}	129.5^{f}	101.3^{d}	95.5^{bc}	98.4^{cd}
D_4V_1	115.5^{e}	116.2^{d}	115.9^{g}	99.7^{d}	93.8^{bc}	96.8^{d}
D_1V_2	161.5^{ab}	161.0^{ab}	161.3^{b}	120.0^{b}	111.3^{ab}	115.7^{b}
D_2V_2	154.6^{bc}	136.7^{c}	145.6^{d}	115.3^{bc}	106.9^{b}	111.1^{bc}
D_3V_2	134.7^{d}	125.6^{cd}	130.1^{f}	101.6^{d}	97.5^{bc}	99.5^{cd}
D_4V_2	114.7^{e}	105.5^{de}	110.1^{g}	97.6^{d}	93.8^{bc}	95.7^{d}
D_1V_3	145.9^{c}	139.8^{bc}	142.8^{de}	103.8^{cd}	103.5^{b}	103.6^{cd}
D_2V_3	137.0^{cd}	128.2^{cd}	132.6^{ef}	99.5^{d}	94.3^{bc}	96.9^{d}
D_3V_3	129.1^{d}	119.5^{d}	124.3^{f}	89.9^{e}	83.3^{c}	86.6^{e}
D_4V_3	103.4^{f}	100.9^{e}	102.2^{h}	84.9^{e}	37.0^{d}	61.0^{f}
D_1V_4	167.6^{a}	164.1^{a}	165.9^{a}	131.4^{a}	126.5^{a}	129.0^{a}
D_2V_4	159.2^{ab}	150.0^{b}	154.6^{c}	114.1^{bc}	110.8^{ab}	112.4^{bc}
D_3V_4	142^{cd}	132.3^{c}	137.1^{e}	108.8^{c}	98.7^{bc}	103.8^{cd}
D_4V_4	129.4^{d}	125.5^{cd}	127.5^{f}	100.7^{d}	94.4^{bc}	97.6^{d}
S. Em±	2.78	4.17	2.39	2.15	5.96	2.68
C. D. at 5%	8.11	12.16	6.80	6.28	17.38	7.63
General Mean	138.8	131.4	135.1	105.8	98.6	101.6

Note: Observations with same superscript are on par and with different superscript are significantly different

3.1.1.3 Interaction effects

The interaction effect between pigeonpea varieties with different sowing windows were found significant for number of pods plant^{-1}. The sowing of var. ICPH 2740 during 24th MW *i.e.* D_1V_4 recorded higher number of pods plant^{-1} (167.6 and 164.1). This was followed by var. Rajeshwari (161.5 and 161.0), Vipula (156.7 and 138.0) and BDN 711 (145.9 and 139.8) during 2017-18 and 2018-19, respectively.

The interaction effect between pigeonpea varieties with different sowing windows were also found significant for weight of pods plant^{-1}. The sowing of var. ICPH 2740 during 24th MW *i.e.* D_1V_4 recorded higher number of pods plant^{-1} (131.4 and 126.5). This was followed by var. Rajeshwari (120.0 and 111.3), Vipula (115.6 and 109.5) and BDN 711 (103.8 and 103.5) during 2017-18 and 2018-19, respectively. It might have improved the rate of photosynthesis, dry matter accumulation and its translocation to pods, as referred in terms of higher values of growth and yield components that resulted in higher pod yield plant^{-1} of red. The better availability growth resources like water, nutrients, air, mulching, better cultural practices and effective weed control in early sowing dates to exhibit their full potential and produced higher yield. These results were confirmed with the results of [10] and [11].

3.1.2 Length of pod (cm), number of grains pod^{-1} and 100 grain weight

Data on mean length of pod (cm), number of grains per pod and 100 grain weight of pigeonpea as influenced significantly by the different treatment are presented TableS 2 & 3. The mean length of pod was (4.926 and 4.909), number of grains per pod (4.220 and 4.160) and 100 grain weight (10.27 and 10.23) during 2017-18 and 2018-19.

3.1.2.1 Effect of varieties

The length of pod (cm) of pigeonpea was significantly higher (5.223 and 5.176 cm) in Rajeshwari which was superior over rest of all the genotypes, followed by ICPH 2740 (4.982 and 4.973), Vipula (4.966 and 4.958) and BDN 711 (4.533 and 4.528) during 2017-18 and 2018-19, respectively.

The number of grains per pod of pigeonpea was significantly higher (4.486 and 4.378) in Rajeshwari which was superior over rest of all genotypes, followed by Vipula (4.147 and 4.146), BDN 711 (4.136 and 4.115) and ICPH 2740 (4.131 and 4.104) during 2017-18 and 2018-19, respectively.

The 100 grains weight (g) of pigeonpea was significantly higher (10.79 and 10.75) in ICPH 2740 which was superior over rest of all the varieties, followed by Rajeshwari (10.34 and 10.32) and Vipula (10.13 and 10.11). The var. BDN 711 recorded significantly lower 100 grain weight (g) (9.81 and 9.74). Similar results were reported by Bedis et al*.* [12].The difference in 100 grain weight (g) of pigeonpea variety might be due to inherent genetical potential varieties. Saxena et al., [13] reported that seed size varies from 10.9 to 11.3 g/100 seeds with brown seed coat and 18.4% protein in ICPH 2740.

3.1.2.2 Effect of sowing windows

The length of pod plant^{-1} of pigeonpea was recorded the non significantly highest at 24thMW (4.953 and 4.993) which was superior over rest of the sowing windows, followed by 26th MW (4.931 and 4.917), 28th MW (4.916 and 4.900) and 30th MW sowing window (4.904 and 4.885) during 2017-18 and 2018-19, respectively. The length of pod was not change with different sowing windows because genetic character of length of pod does not change with sowing windows.

Table 2. Length of pod and number of grains per pod of pigeonpea as affected by different treatments during 2017-18 and 2018-19

Treatment	Length of pod (cm)			No. of grains per pod		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
A) Main plot treatments: Varieties						
V_1: Vipula	4.966^{b}	4.958^{b}	4.962^{b}	4.147^{b}	4.046^{b}	4.096^{b}
V_2: Rajeshwari	5.223^{a}	5.176^{a}	5.199^{a}	4.486^{a}	4.378^{a}	4.432^{a}
V_3: BDN 711	4.533^{c}	4.528^{c}	4.531^{c}	4.136^{b}	4.105^{c}	4.120^{b}
V_4: ICPH 2740	4.982^{b}	4.973^{b}	4.977^{b}	4.131^{b}	4.111^{b}	4.121^{b}
S. Em±	0.024	0.015	0.015	0.007	0.009	0.013
C. D. at 5%	0.082	0.053	0.046	0.026	0.033	0.040

Treatment	Length of pod (cm)			No. of grains per pod		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
B) Sub plot treatments: Sowing windows						
D_1: 24 MW	4.953	4.933	4.943[a]	4.244	4.185	4.215[a]
D_2: 26 MW	4.931	4.917	4.924[a]	4.228	4.171	4.200[a]
D_3: 28 MW	4.916	4.900	4.908[b]	4.227	4.147	4.187[b]
D_4: 30 MW	4.904	4.885	4.895[b]	4.200	4.138	4.169[c]
S. Em±	0.016	0.014	0.010	0.011	0.013	0.006
C. D. at 5%	NS	NS	0.030	NS	NS	0.017
C) Interaction (A×B)						
S. Em±	0.032	0.029	0.021	0.022	0.026	0.012
C. D. at 5%	NS	NS	0.060	NS	NS	0.035
General Mean	4.926	4.909	4.917	4.220	4.160	4.190

Note: Observations with same superscript are on par and with different superscript are significantly different

Table 3. 100 seeds weight (g) per 100 seeds of pigeonpea as affected by different treatments during 2017-18 and 2018-19

Treatment	100 seeds weight (g)		
	2017-18	2018-19	Pooled
A) Main plot treatments: Varieties			
V_1: Vipula	10.13[c]	10.11[c]	10.12[c]
V_2: Rajeshwari	10.34[b]	10.32[b]	10.33[b]
V_3: BDN 711	9.81[d]	9.74[d]	9.77[d]
V_4: ICPH 2740	10.79[a]	10.75[a]	10.77[a]
S. Em±	0.03	0.03	0.02
C. D. at 5%	0.11	0.099	0.07
B) Sub plot treatments: Sowing windows			
D_1: 24 MW	10.41[a]	10.37[a]	10.39[a]
D_2: 26 MW	10.31[b]	10.30[b]	10.31[b]
D_3: 28 MW	10.20[c]	10.18[c]	10.19[c]
D_4: 30 MW	10.15[d]	10.06[d]	10.10[d]
S. Em±	0.028	0.026	0.018
C. D. at 5%	0.080	0.076	0.052
C) Interaction (A×B)			
S. Em±	0.06	0.05	0.04
C. D. at 5%	NS	NS	0.10
General Mean	10.27	10.23	10.25

Note: Observations with same superscript are on par and with different superscript are significantly different

The number of grains pod^{-1} was non significantly maximum at 24th MW sowing window (4.244 and 4.185) which followed by 26th MW sowing window (4.228 and 4.171). This was followed by 28th MW sowing window (4.227 and 4.147). The least number of grains pod^{-1} of pigeonpea was observed in 30th MW sowing window (4.200 and 4.138). Similar results were observed by Chauhan et al.[14], Salih [15] and Kumar et al. [9]. They reported that the number of seeds, seed weight and yield plant^{-1} at harvest and 100 seed weight of all cultivars were greatly reduced by late sowing. It might be due to fruit-bearing length of pigeonpea decreased with later planting probably due to influence of day-length as observed for plant height and number of branches per plant. These results confirmed with Egbe et al. [22].

The 100 grains weight (g) of pigeonpea was recorded non significantly highest at 24th MW sowing window (10.41 and 10.37) which was followed by 26th MW sowing window (10.31 and 10.30). This was followed by 28th MW sowing window (10.20 and 10.18). The least 100 grains weight (g) of pigeonpea was observed in 30th MW sowing window (10.15 and 10.06 g). Similar results were reported by Rani and Raji Reddy [10] and revealed that delay in pigeonpea sowing from first fortnight of June to second fortnight of August during 2001-02 and 2002-03 resulted in significant reduction in the yield attributing characters.

3.1.2.3 Effects of interaction

The interaction effect between pigeonpea varieties with different sowing windows were found no significant for length of pod plant^{-1}, number of grains pod^{-1} and 100 grains weight (g).

3.2 Yield Studies

Data in respect of mean grain yield and stalk yield of pigeonpea as influenced by different treatments are presented in Table 4.

3.2.1 Grain yield (q ha^{-1})

The mean grain yield of pigeonpea was 19.80 and 18.58 q ha^{-1} was recorded during the year 2017-18 and 2018-19, respectively.

3.2.1.1 Effect of varieties

The grain yield of pigeonpea was influenced significantly due to different pigeonpea varieties. The grain yield was significantly higher in ICPH 2740 (22.10 and 20.64 q ha^{-1}) which was significantly superior rest of the pigeonpea varieties. This was followed by Rajeshwari (20.49 and 19.45 q ha^{-1}), Vipula (18.80 and 17.26 q ha^{-1}). The var. BDN 711 recorded significantly lower grain yield (17.80 and 16.97 q ha^{-1}) during the year 2017-18 and 2018-19, respectively. Saxena et al. [13] reported that multi-locations evaluation of ICPH 2740 over five years produced on average 2792 kg ha^{-1} yield with a range of 2207 - 3652 kg ha^{-1} and mean standard heterosis of 40.7%. Rajeshwari variety has semi-spreading, semi-determinate growth habit; bold seed size with better response to inputs and perform well under rainfed condition [12].

3.2.1.2 Effect of sowing windows

The grain yield of pigeonpea was influenced significantly due to extended sowing windows. The grain yield was the maximum at 24th MW sowing window (24.31 and 22.86 q ha^{-1}) followed by 26th MW (22.04 and 20.18 q ha^{-1}), 28th MW sowing window (18.42 and 17.46 q ha^{-1}) and 30th MW sowing window (14.43 and 13.82 q ha^{-1}) during the year 2017-18 and 2018-19, respectively. The reduction in grain yield caused due to sowing windows because of difference in temperature. A sowing window of 24th MW was favorable to maximum grain production, it might be due to among the sowing windows, 2nd FN of June and 1st FN of July sowings received highest amount of rainfall, mean maximum and mean minimum temperature, GDD, HUE and lower sunshine hours and humidity compared to latter sowings [17].These results are in confirmation by Patel and Mehta [18] reported that higher seed yield was on early sowing 30th June than late sowing 9th August.

3.2.1.3 Effects of interaction

The grain yield (q ha^{-1}) was significantly influenced by interaction between varieties and sowing windows during the year 2017-18 and 2018-19. Sowing at 24th MW sowing window recorded maximum grain yield (26.39 and 25.14 q ha^{-1}) in var. ICPH 2740. This was followed by var. Rajeshwari (24.80 and 22.93), Vipula (23.78 and 22.39 q ha^{-1}), and BDN 711 (22.27 and 20.97 q ha^{-1}) during the year 2017-18 and 2018-19, respectively. The significant interaction of planting dates and variety observed for number of pods per plant, pod weight, grain yield and straw weight implied that the various varieties responded differently to the various planting dates. This is to be expected because the genetic make-up of the varieties differed. Similar results were found by Reddy et al. [19], [16] and reported that a reduction of 23% means seed yield was observed with late sowing by 15-30 days, such as normal (June) sowing seed yield was high as compared to late sowing.

3.2.2 Stalk yield

Data with respect to mean stalk yield of pigeonpea as influenced by different treatments are presented in Table 4. The mean stalk yield of pigeonpea was 56.0 and 53.3 q ha^{-1} during the year 2017-18 and 2018-19, respectively.

3.2.2.1 Effect of varieties

The stalk yield of pigeonpea was influenced significantly due to pigeonpea varieties. The stalk yield was significantly higher in ICPH 2740 (59.1 and 55.6 q ha^{-1}) and significantly superior rest of the pigeonpea varieties. This was followed by Rajeshwari (57.2 and 54.2 q ha^{-1}), Vipula (54.5 and 52.5 q ha^{-1}). The var. BDN 711 recorded significantly lower stalk yield (53.4 and 50.9 q ha^{-1}) during the year 2017-18 and 2018-19, respectively. The differences in stalk yield of pigeonpea varieties might be due

Table 4. Grain yield (q ha^{-1}) and stalk yield (q ha^{-1}) of pigeonpea as affected by different treatments during 2017-18 and 2018-19

Treatment	Grain yield (q ha^{-1})			Stalk yield (q ha^{-1})		
	2017-18	2018-19	Pooled	2017-18	2018-19	Pooled
A) Main plot treatments: Varieties						
V_1: Vipula	18.80^{c}	17.26^{c}	18.03^{c}	54.5^{b}	52.5^{b}	53.5^{c}
V_2: Rajeshwari	20.49^{b}	19.45^{b}	19.97^{b}	57.2^{a}	54.2^{a}	55.7^{a}
V_3: BDN 711	17.80^{d}	16.97^{c}	17.38^{d}	53.4^{b}	50.9^{b}	52.1^{c}
V_4: ICPH 2740	22.10^{a}	20.64^{a}	21.37^{a}	59.1^{a}	55.6^{a}	57.3^{a}
S. Em±	0.17	0.12	0.13	0.55	0.68	0.47
C. D. at 5%	0.59	0.41	0.42	1.90	2.36	1.44
B) Sub plot treatments: Sowing windows						
D_1: 24 MW	24.31^{a}	22.86^{a}	23.58^{a}	63.6^{a}	61.8^{a}	62.7^{a}
D_2: 26 MW	22.04^{b}	20.18^{b}	21.11^{b}	58.1^{b}	55.7^{b}	56.9^{b}
D_3: 28 MW	18.42^{c}	17.46^{c}	17.94^{c}	54.0^{c}	51.2^{c}	52.6^{c}
D_4: 30 MW	14.43^{d}	13.82^{d}	14.13^{d}	48.4^{d}	44.6^{d}	46.5^{d}
S. Em±	0.14	0.20	0.09	0.66	0.71	0.47
C. D. at 5%	0.42	0.59	0.27	1.93	2.06	1.32
C) Interaction (A×B)						
D_1V_1	23.78^{c}	22.39bc	23.08^{d}	63.5^{ab}	62.3^{a}	62.9^{b}
D_2V_1	21.23^{e}	18.12ef	19.67^{g}	56.9^{c}	54.8^{bc}	55.9^{d}
D_3V_1	17.03^{g}	15.76fg	16.40^{i}	53.0^{cd}	50.9^{cd}	52.0^{ef}
D_4V_1	13.17^{l}	12.78i	12.97^{l}	44.5^{e}	42.1^{e}	43.3^{g}
D_1V_2	24.80^{b}	22.93b	23.86^{b}	64.1^{ab}	61.8^{ab}	62.9^{b}
D_2V_2	22.75^{d}	21.34c	22.05^{e}	60.6^{bc}	58.1^{b}	59.3^{c}
D_3V_2	18.80^{f}	18.75ef	18.78^{h}	53.2^{cd}	53.5^{c}	53.4^{de}
D_4V_2	15.62^{h}	14.77h	15.20^{k}	50.8^{d}	43.5^{e}	47.2^{f}
D_1V_3	22.27^{d}	20.97d	21.62^{e}	59.4^{bc}	57.2^{bc}	58.3^{cd}
D_2V_3	19.74^{f}	18.34ef	19.04^{h}	53.6^{cd}	52.4^{c}	53.0^{e}
D_3V_3	16.46^{gh}	16.15f	16.31^{ij}	51.6^{d}	47.8^{d}	49.7^{f}
D_4V_3	12.71^{i}	12.41ij	12.56^{m}	48.9^{d}	46.4^{de}	47.6^{f}
D_1V_4	26.39^{a}	25.14a	25.77^{a}	67.4^{a}	65.9^{a}	66.6^{a}
D_2V_4	24.45^{bc}	22.91bc	23.68^{c}	61.3^{b}	57.4^{bc}	59.3^{c}
D_3V_4	21.36^{e}	19.17e	20.27^{f}	58.2^{bc}	52.8^{c}	55.5^{de}
D_4V_4	16.22^{gh}	15.33g	15.77^{j}	49.4^{d}	46.3^{de}	47.9^{f}
S. Em±	0.29	0.40	0.19	1.32	1.42	0.93
C. D. at 5%	0.84	1.18	0.54	3.86	4.14	2.65
General Mean	19.80	18.58	19.19	56.0	53.3	54.7

Note: Observations with same superscript are on par and with different superscript are significantly different

to inherent genetical potential of pigeonpea variety. Plants of ICPH 2740 are non-determinate, photo-sensitive, and respond positively to wider spacing. It takes about 115-122 days to flower and its maturity is achieved in 180-190 days. Seed size varies from 10.9 to 11.3 g/100 seeds. Multi-locations evaluation of ICPH 2740 over five years produced on average 2792 kg ha^{-1} yield with a range of 2207 - 3652 kg ha^{-1}[13].

3.2.2.2 Effect of sowing windows

The stalk yield of pigeonpea was influenced significantly due to extended sowing windows. The stalk yield was the maximum at 24th MW sowing window (63.6 and 61.8 q ha^{-1}), this was followed by 26th MW (58.1 and 55.7 q ha^{-1}), 28th MW sowing window (54.0 and 51.2) and 30th MW sowing window (48.4 and 44.6 q ha^{-1}) during the year 2017-18 and 2018-19, respectively. A sowing window of 24th MW was favorable to high stalk production because of photosynthetic capacity of plant depends upon the accumulation of photosynthates in leaves, leaf number and leaf area. Dry matter accumulation is directly proportional to leaf area index (LAI). To obtain higher dry matter, photosynthetic efficiency of leaf area is very much essential. Since early sowing windows were received higher sunshine hours up to vegetative growth in combination of rainfall, temperature and optimum soil moisture

favored the higher photosynthetic rate and accumulation of higher stalk yield [20]. The results are similar as reported by Bedis et al*.* [12] and Sharanappa et al*.* [11]. Prasad et al*.* [22] observed that biological yield significantly affected by different sowing dates, the maximum biological yield (556.4 g plant^{-1}) on early sowing and with lowest biological yield (41.3 g plant-1) recorded for late sowing.

3.2.2.3 Effects of interaction

The stalk yield (q ha^{-1}) was significantly influenced by interaction between varieties and sowing windows during the year 2017-18 and 2018-19. Sowing at 24th MW sowing window recorded maximum stalk yield (67.4 and 65.4 q ha^{-1}) in var. ICPH 2740. This was followed by var. Rajeshwari (64.1 and 61.8 q ha^{-1}), Vipula (63.5 and 62.3 q ha^{-1}) and BDN 711 (59.4 and 57.2 q ha^{-1}) during the year 2017-18 and 2018-19, respectively. These results showed that delay in sowing of pigeonpea varieties could not able to assimilate the more biomass resulted in reduced haulm yield of pigeonpea [22], [12] and [15].

4. CONCLUSIONS

Amongst all the pigeon pea cultivars, var. ICPH 2740 found significantly superior under extended sowing windows followed by var. Rajeshwari (Phule T 0012), Vipula and BDN 711. Sowing during 24th MW sowing window was observed to be the most suitable and optimum for pigeonpea considering the yield attributes and yield of the crop it might be due to among the sowing windows, 2nd FN of June and 1st FN of July sowings received highest amount of rainfall, mean maximum and mean minimum temperature, GDD, HUE and lower sunshine hours and humidity compared to latter sowings.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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