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Influence of Varieties and Sowing Dates on Growth, Yield Attributes and Yield of Chickpea (*Cicer arietinum* L.) under Delayed Sowing

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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 experiment was carried out at Agricultural Research station, Adilabad during *Rabi-summer* 2023-24 on "Influence of varieties and sowing dates on growth, yield attributes and yield of chickpea (*Cicer arietinum* L.) under delayed sowing". The experimental design was strip plot with three

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replications. The treatments comprise five chickpea varieties (two are kabuli and three are desi) viz., NBeG-119, NBeG-810, NBeG-857, JG-14 and JAKI-9218 as horizontal factors and three sowing dates viz., December 1st week, December 3rd week and January 1st week as vertical factors. The results of the experiment indicated that JG-14 took more days to 50% flowering (43.2) and maturity (102.1), resulted in more pods plant^{-1} (50.8), higher 100 seed weight among desi varieties (25.2 g), greater seed yield (2564 kg ha^{-1}), straw yield (5108 kg ha^{-1}) on par with NBeG-857 (5213 kg ha^{-1}), high harvest index (33.3%). Plant height and dry matter were higher for NBeG-810 (46.1 cm and 4036 kg ha^{-1} respectively) but was on par with JG-14 (42.5 cm) for plant height. Lower yield attributes and yield were recorded with NBeG-119 except test weight. Across sowing dates December 1st week obtained higher plant height (44.9 cm), dry matter (3817 kg ha^{-1}), days to 50% flowering (44 days) and maturity (101.5 days), number of pods plant^{-1} (44.4), seed yield (2234 kg ha^{-1}), straw yield (4463 kg ha^{-1}) and harvest index (33.2%) and was on par with December 3rd week. January 1st week recorded low growth and yield parameters but was on par with December 3rd week. Seeds pod^{-1} was not significant for different varieties and sowing dates. Test weight was non-significant for sowing dates.

Keywords: Chickpea; varieties; sowing dates; yield.

1. INTRODUCTION

Chickpea (*Cicer arietinum* L.) is recognized as 'King of pulses' is an annual cool season legume and leading pulse crop with share of about 49% of total pulses being produced in India [1] and it is commonly referred as Bengal gram or gram. Chickpeas are categorized into Desi (smaller and dark-colored) and Kabuli (larger and white). Kabuli varieties were low performing compared to desi varieties in India [2].

In 2022, chickpea was cultivated in nearly 14.81 million hectares area globally realizing a production of about 18.09 million tones [3]. India's share in global chickpea area and production exceeds two-thirds holding the top spot in chickpea production. It was estimated that chickpea was cultivated in around 10.47 million hectares realizing 12.26 million tons production with a productivity of 1172 kg ha^{-1} during 2022-23 and in Telangana the projected area, production and productivity are 0.148 million hectares, 0.232 million tons, 1568 kg ha^{-1} correspondingly during 2022-23 [4]. Chickpea is predominantly grown in Adilabad, Kamareddy, Jogulamba Gadwal, Nirmal and Nizamabad districts of Telangana.

Bengal gram is multi-benefit crop which can be grown for fodder and human food, being leguminous it can also be cultivated as intercrop, alternative crop. Chickpea seeds are abundant in nutrients and are consumed as entire seeds that have been processed or as dal and dal flour. It serves as a versatile ingredient in the preparation of various sweet treats, snack items and condiments.

As a cool season crop, its growth flourishes in temperatures that are relatively low. Internationally, moisture and heat stress are major obstacles for chickpea productivity responsible for half of yield losses induced by environmental stresses. Chickpea yields are limited by elevated temperatures coinciding reproductive period which attracted notable attention recently stemming from (1) A significant change in chickpea raising has occurred, moving from cooler, long season environments to warmer short season regions. (2) Chickpea production area is increasing under delayed sowing due to augmented agricultural intensity. (3) Anticipated rise in worldwide temperatures caused by climate change [5].

Climate change is expected to lead to increased frequency and severity of extreme weather events, impacting agricultural productivity [6]. Climate change is projected to lead to a 2-5% decline in global crop yields by 2050 [7]. Climate change is anticipated to increase global temperatures by 2°C by the mid-to-late 21st century, leading to more frequent and intense precipitation events, heat waves, and fewer cold snaps [8] which adversely affect chickpea production leading to potential yield losses of up to 19% due to environmental upheavals [8]. A 10-15% reduction in chickpea yields is anticipated for each degree centigrade above optimum temperature. Research indicates that chickpea yields drop by 53 kg ha^{-1} for every 1°C rise in seasonal temperature [8]. Climate change-induced weather extremes require farmers to adopt flexible and adaptive crop production strategies, ensuring food security and environmental stewardship.

The favorable planting period for Bengal gram is between mid-October and early November. In many areas of Telangana's northern region, gram is typically planted immediately after cotton harvest, resulting in yields of 17.5-20.0 q ha^{-1} in the wake of prolonged winter season till late January compared to usual yields of 22.5-25.0 q ha^{-1} from the regular crop, normally sown soon after soybean harvest. Since the final pickings in HDPS cotton (or) traditional methods are typically completed in the last week of November, the sowing of chickpea is subsequently postponed. Bengal gram is subjected to elevated temperatures during sensitive growth phases such as, flowering and pod development leading to a significant decline in yields. Late sowing exposes the crop to extreme heat during the reproductive phase, resulting in diminished yields. In this regard, the research was carried out to determine the most appropriate chickpea cultivars for planting after cotton harvest under delayed sowing conditions.

2. METHODS

The research study was performed at Agricultural Research Station, Adilabad, Professor Jayashankar Telangana State Agricultural University, Telangana during rabi-summer 2023-24. The research field is situated at an elevation of 264 m above mean sea level, 78˚ 32´ E longitude and 19˚ 39´ N latitude and classified under Northern Telangana region.

The soil was clay textured, neutral soil reaction, medium in organic carbon, low in available nitrogen, high in available phosphorous and high in available potassium. The experiment was laid out in strip plot design with three replications comprising fifteen treatment combinations with five varieties viz., two kabuli varieties (V_1: NBeG-119 and V_2: NBeG-810) and three desi varieties (V_3: NBeG-857, V_4: JG-14 and V_5: JAKI-9218) and three sowing windows viz., December 1st week,2023 (D_1), December 3rd week,2023 (D_2) and January 1st week,2024 (D_3). Seed rate of 125 kg ha^{-1} (kabuli) and 75 kg ha^{-1} (desi) with a spacing of 45×10 cm (kabuli) and 30×10 cm (desi) are followed. Farm yard manure is applied @ 5 t ha^{-1} along with recommended dose of fertilizers 20-50-20 kg NPK ha^{-1} as basal doses in the form of urea, single super phosphate and muriate of potash and all other package of practices were followed as per University recommendations.

Gomez and Gomez depicted the method of analysis of variance was used for statistical analysis of compiled data [9].

3. RESULTS AND DISCUSSION

3.1 Effect of Varieties and Sowing Dates on Growth Parameters and Phenology of Chickpea

3.1.1 Plant height (cm)

It was observed that the plant height at harvest was influenced by varietal differences (Table 1). NBeG-810 (46.1 cm) recorded significantly superior plant height between kabuli varieties. JG-14 (42.5 cm) obtained more plant height but it was comparable with other two varieties amongst desi varieties. On the whole, NBeG-810 (46.1 cm) attained higher plant height and was equivalent with JG-14 (42.5 cm) and lower was obtained by NBeG-857 (39.1 cm) comparable with other varieties except NBeG-810. Parallel results of difference in varietal response with regard to plant height was documented by [10,11].

Among the different dates of sowing, D_1 (44.9 cm) recorded more plant height and on par with D_2 (42.0 cm) and less was recorded by D_3 (38.3 cm) and was analogous to D_2. Plant height was decreased with delay in sowing possibly owing to unfavorable environmental conditions.

Interaction effect of varieties and sowing dates was not significant for plant height.

3.1.2 Dry matter production (kg ha^{-1})

There was deviation amongst varieties in accumulating dry matter (Table 1). NBeG-810 (4036 kg ha^{-1}) produced maximum dry matter and was comparable with NBeG-119 (3869 kg ha^{-1}) among kabuli varieties. JG-14 (3521 kg ha^{-1}) accumulated higher amount of dry matter and was analogous to NBeG-857 (3392 kg ha^{-1}) while JAKI-9218 (3247 kg ha^{-1}) obtained lower dry matter and was equivalent with NBeG-857 amongst desi varieties. On the whole, more biomass was obtained by NBeG-810 (4036 kg ha^{-1}) being at par with NBeG-119 and JAKI-9218 (3247 kg ha^{-1}) recorded less biomass and was analogous to NBeG-857. Kabuli varieties had recorded higher biomass in comparison with desi varieties which might be attributed to their longer duration character.

Out of three dates, D_1 (3818 kg ha^{-1}) obtained more biomass and was equivalent with D_2 (3654 kg ha^{-1}) and less was produced by D_3 (3368 kg ha^{-1}). Dry matter accumulation had diminished with delay in sowing which might be due to inclement weather conditions. The results were in line with findings of [12].

There was no interaction effect between varieties and sowing dates for dry matter production.

3.1.3 Days to 50% flowering

From the data present in Table 1 it was observes that longer duration was taken by NBeG-810 (40.5 days) to attain 50% flowering stage and was equivalent with NBeG-119 (39.7 days) pertaining to kabuli varieties. JG-14 (43.2 days) took more time to reach 50% flowering stage and was comparable with JAKI-9218 (41.7 days) while NBeG-857 (39.1 days) shorter period regarding desi varieties. In view of all varieties, JG-14 (43.2 days) took longer period and NBeG-857 (39.1 days) took shorter period to attain 50% flowering stage. Divergence among varieties in days required to attain 50% flowering stage possibly due to disparities in cultivars duration.

D_1 (44.0 days) and D_3 (36.7 days) took more and less duration, respectively to attain 50% flowering stage among three sowing dates. The outcomes were in parallel with findings of [10]. Reduction in duration to reach 50% flowering stage with delay in sowing might be a consequence of soaring temperatures that cut short the vegetative growth.

The interaction effect of varieties and sowing dates was statistically non-significant.

3.1.4 Days to maturity

According to data in Table 1, significantly longer periods were taken by NBeG-810 (98.6 days) in comparison with NBeG-119 (91.7 days) to reach the maturity stage with reference to kabuli varieties. JG-14 (102.1 days) took more days and less number of days were taken by NBeG-857 (93.3 days) being on par with JAKI-9218 (95.5 days) among desi varieties. On the whole, JG-14 (102.1 days) had taken a longer span and a shorter period was taken by NBeG-119 (91.7 days) to reach maturity.

Longer periods were taken by D_1 (101.5 days) and D_3 (91.4 days) took shorter periods to attain maturity stage. It was observed that there was decrease in time period required to attain maturity with delay in sowing which may be connected to surging temperatures that accelerated the growth process. Similar results were also noted by [13].

There was no appreciable interaction in between varieties and sowing dates.

3.2 Effect of Varieties and Sowing Dates on Yield Attributes and Yield of Chickpea

3.2.1 Number of pods $plant^{-1}$

Notably more number of pods $plant^{-1}$ were produced by NBeG-810 (37.0) in comparison with NBeG-119 (30.2) regarding kabuli varieties. Amongst desi varieties, significantly more pods were obtained with JG-14 (50.8) and less with JAKI-9218 (37.6) which was equivalent with NBeG-857 (41.5). Overally, significantly higher number of pods were formed by JG-14 (50.8) and least with NBeG-119 (30.2). Variation in varietal response to number of pods $plant^{-1}$ was also reported by [14] (Table 2).

Substantially higher number of pods $plant^{-1}$ were formed by D_1 (44.4) and least with D_3 (34.7). Reduction in number of pods $plant^{-1}$ with delay in sowing possibly linked to adverse weather conditions under delayed sowing. Parallel results were documented by [15,10]. Effect of interaction between varieties and sowing dates was non-significant for number of pods $plant^{-1}$.

3.2.2 Number of seeds pod^{-1}

Influence of varieties, sowing dates and their interaction effect was not significant for number of seeds pod^{-1}.

3.2.3 Test weight

Maximum test weight was registered by NBeG-810 (38.8 g) and minimum by NBeG-119 (36.8 g) between kabuli varieties. Across desi varieties JG-14 (25.2 g) obtained more test weight and was analogous with NBeG-857 (24.4 g) and less test weight by JAKI-9218 (23.6 g) but it was at par with NBeG-857. Amongst all varieties, notably higher test weight was obtained by NBeG-810 (38.8 g) and least by JAKI-9218 (23.6 g) being equivalent to NBeG-857. It was seen that varietal difference exists for test weight as it was a genetic character. The results were in line with [16].

The impact of sowing dates was insignificant for test weight as it was a hereditary trait. Similar outcomes were documented by [13,16].

There was no notable interaction between varieties and sowing dates for test weight.

3.2.4 Seed yield (kg ha^{-1})

Seed yield of desi and kabuli Bengal gram is presented in Table 2, where NBeG-810 (1629 kg ha^{-1}) yielded more against NBeG-119 (1495 kg ha^{-1}) among kabuli varieties. JG-14 (2564 kg ha^{-1}) realized higher yield and less was obtained by JAKI-9218 (2006 kg ha^{-1}) amongst desi varieties. Basically, significant superior yield was produced by JG-14 (2564 kg ha^{-1}) and least was recorded by NBeG-119 (1495 kg ha^{-1}). Varieties exhibited deviation in seed yield and similar results were reported by Sekhar et al. (2015). It was also noticed that desi varieties realized higher yields in comparison with kabuli varieties which might be due to higher plant stand as closer spacing (30×10 cm) was adopted. JG-14 yielded superiorly possibly stemming from its heat tolerant trait. Results were in line with findings of [13,17,14].

Higher yields were realized from D_1 (2234 kg ha^{-1}) which was comparable with D_2 (2002 kg ha^{-1}) and lower was reported from D_3 (1788 kg ha^{-1}) equivalent with D_2. Yield dropped by 10.3 percent and 19.9 percent in D_2 and D_3, respectively. Delayed sowing led to high temperature induced decline in seed yield as long days and elevated temperatures hastened maturity and negatively impacted seed yield. Reduced yields under late sown conditions was also reported by [18,10,19,20].

The relationship between varieties and sowing dates was not statistically significant.

3.2.5 Straw yield (kg ha^{-1})

In between kabuli varieties NBeG-810 (3642 kg ha^{-1}) recorded maximum straw yield and was equivalent with NBeG-119 (3503 kg ha^{-1}). NBeG-857 (5213 kg ha^{-1}) obtained higher straw yield and was analogous with JG-14 (5108 kg ha-1) and JAKI-9218 (4140 kg ha^{-1}) produced lower straw yield amongst desi varieties. On the whole, NBeG-857 (5213 kg ha^{-1}) realized more straw yield. However it was at par with JG-14 (5108 kg ha^{-1}) and less was registered by NBeG-119 (3503 kg ha^{-1}) which was parallel with NBeG-810 (3642 kg ha^{-1}).

Table 1. Growth parameters and phenology of chickpea as influenced by varieties and sowing dates

Treatments	Plant height (cm)	Dry matter production (kg ha^{-1})	Days to 50% flowering	Days to maturity
Varieties				
V_1: NBeG-119	41.6	3869	39.7	91.7
V_2: NBeG-810	46.1	4036	40.5	98.6
V_3: NBeG-857	39.1	3391	39.1	93.3
V_4: JG-14	42.5	3520	43.2	102.1
V_5: JAKI- 9218	39.3	3247	41.7	95.5
SEm±	1.16	83.06	0.66	1.00
CD (*P*=0.05)	3.81	270.86	2.15	3.26
Dates of sowing				
D_1: 1st week of December	44.9	3817	44.0	101.5
D_2: 3rd week of December	42.0	3653	41.8	95.9
D_3: 1st week of January	38.3	3367	36.7	91.4
SEm±	1.25	42.28	0.27	0.69
CD (*P*=0.05)	4.94	166.0	1.09	2.73
Interaction				
Varietal means at the same level of sowing dates				
SEm±	2.18	141.95	0.87	1.57
CD (*P*=0.05)	NS	NS	NS	NS
Dates of sowing means at the same level of variety				
SEm±	2.38	132.99	0.68	1.50
CD (*P*=0.05)	NS	NS	NS	NS

**NS- Nonsignificant*

Table 2. Yield attributes and yield of chickpea as influenced by varieties and sowing dates

Treatments	No. of pods plant^{-1}	Number of seeds pod^{-1}	100 seed wt. (g)	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	HI (%)
Varieties						
V_1: NBeG-119	30.2	1.1	36.8	1495	3503	29.8
V_2: NBeG-810	37.0	1.1	38.8	1629	3642	30.8
V_3: NBeG-857	41.5	1.2	24.4	2345	5213	30.9
V_4: JG-14	50.8	1.2	25.2	2564	5108	33.3
V_5: JAKI- 9218	37.6	1.4	23.6	2006	4140	32.6
SEm±	1.48	0.11	0.43	33.89	84.14	0.52
CD (*P*=0.05)	4.83	NS	1.42	110.52	274.37	1.71
Dates of sowing						
D_1: 1st week of December	44.4	1.2	29.8	2234	4463	33.2
D_2: 3rd week of December	39.2	1.2	30.1	2002	4300	31.6
D_3: 1st week of January	34.7	1.2	29.5	1788	4200	29.6
SEm±	1.09	0.13	0.46	62.29	44.38	0.81
CD (*P*=0.05)	4.30	NS	NS	244.57	174.25	3.1
Interaction						
Varietal means at the same level of sowing dates						
SEm±	2.82	0.25	0.88	86.95	174.87	1.09
CD (*P*=0.05)	NS	NS	NS	NS	NS	NS
Dates of sowing means at the same level of variety						
SEm±	2.84	0.29	0.96	107.59	173.68	1.32
CD (*P*=0.05)	NS	NS	NS	NS	NS	NS

**NS- Nonsignificant*

Among the different dates, D_1 (4463 kg ha^{-1}) obtained more straw yield which was comparable with D2 (4300 kg ha^{-1}) and less was recorded by D_3 (4200 kg ha^{-1}) on par with D_2. The results were comparable with [20].

The combination effect of varieties and sowing dates was not comparable.

3.2.6 Harvest index (%)

Table 2 shows the data compiled on harvest index which indicates NBeG-810 (30.8%) recorded more harvest index and was equivalent with NBeG-119 (29.8%) within kabuli varieties. Higher harvest index was attained by JG-14 (33.3%) and was on par with JAKI-9218 (32.6%) while lower was obtained with NBeG-857 (30.9%) which was equivalent with JAKI-9218 among desi varieties. On the whole, higher harvest index was observed with JG-14 (33.3%) on par with JAKI-9218 (32.6%) and lower with NBeG-119 (29.8%) comparable with all other varieties except JG-14. Varietal variation with respect to harvest index was also reported by [10].

Greater harvest index was recorded by D_1 (33.2%) commensurate with D_2 (31.6%) and D_3 (29.6%) obtained lesser but was comparable with D_2. The decrease in harvest index with delay in sowing might be possibly linked to diminished yields due to heat stress. Outcomes were consistent with [13,10]. The combined impact of varieties and sowing dates was negligible.

4. CONCLUSION

From this research analysis, it can be inferred that JG-14 is suitable for growing after cotton under delayed sowings in overall and among kabuli varieties NBeG-810 is suitable for late sowing. December 1st week sowing realized good yields, but chickpea sowing can be taken up to January 1st week with yield decline at about 10 percent and 20 percent during December 3rd week and January 1st week correspondingly over December 1st week.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc have been used during writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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