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Himanshu
Department of Agronomy, MS Swaminathan School of Agriculture, Shoolini University of Biotechnology and Management Sciences, Solan, Himachal Pradesh, India

Ranjeet Singh Bochalya
Department of Agronomy, MS Swaminathan School of Agriculture, Shoolini University of Biotechnology and Management Sciences, Solan, Himachal Pradesh, India

Kartikeya Choudhary
Department of Agronomy, MS Swaminathan School of Agriculture, Shoolini University of Biotechnology and Management Sciences, Solan, Himachal Pradesh, India

Mukul Thakur
Department of Agronomy, MS Swaminathan School of Agriculture, Shoolini University of Biotechnology and Management Sciences, Solan, Himachal Pradesh, India

Jyoti Bala
Department of Agronomy, MS Swaminathan School of Agriculture, Shoolini University of Biotechnology and Management Sciences, Solan, Himachal Pradesh, India

Corresponding Author:
Himanshu
Department of Agronomy, MS Swaminathan School of Agriculture, Shoolini University of Biotechnology and Management Sciences, Solan, Himachal Pradesh, India

Effect of sowing dates on growth characters of chickpea cultivars in mid hills of Himachal Pradesh

Himanshu, Ranjeet Singh Bochalya, Kartikeya Choudhary, Mukul Thakur and Jyoti Bala

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Abstract
The current research investigation was conducted during *rabi* season of 2023-24 at Chamelti Agriculture Farm of Shoolini University of Biotechnology and Management Sciences, Solan, Himachal Pradesh to study the effect of sowing dates on growth of chickpea cultivars in Mid Hills of Himachal Pradesh. The soil of the experimental field was sandy loam texture, medium in organic carbon, available nitrogen and potassium, high available phosphorus, neutral in reaction, EC within a safer range. The experiment was laid out in a split plot design with three main plot treatments, four sub plot treatments, and three replications. The main plot treatments having three cultivars: (V_1) Himachal Channa 1, (V_2) Himachal Channa 2 and (V_3) GPF 2, whereas the sub-plot treatments comprising four sowing dates: (D_1) October 1st, (D_2) October 15th, (D_3) October 30th and (D_4) November 15th. The recommended dose of nitrogen, phosphorus and potassium (30:60:30 kg ha^{-1}) were applied through urea, SSP and MOP, respectively at the time of sowing as basal dose. The findings of the experiment showed that among the cultivars, GPF 2 recorded significantly higher growth characters *viz.* plant height, number of branches plant^{-1}, dry matter accumulation, crop growth rate, number of nodules plant^{-1} and dry weight of nodules plant^{-1}. In case of sowing dates, sowing on 1st October resulted in significantly higher growth at all stages under mid hills of Himachal Pradesh.

Keywords: Chickpea, sowing dates, cultivars, nodules and accumulation

Introduction
Pulses are a fundamental component of people's meals in India due to their nutritional value and ability to maintain agricultural production systems. Pulses will continue to be in high demand as the population grows and consumers become more aware of their nutritional advantages (Gaur, 2021) [3]. Pulses, often known as “poor man’s meat” and “rich man’s vegetable,” are key sources of proteins, vitamins and minerals. They contribute greatly to the country's nutritional security (Singh *et al.*, 2015) [4].

Among the pulses, chickpea (*Cicer arietinum* L.) is an essential annual pulse crop that belongs to the genus Cicer (Family: Fabaceae) and is also recognized as “Garbanzo bean” and “Bengal gram”. It is the third-largest food legume produced worldwide, after *Pisum sativum* L. and *Phaseolus vulgaris* L. *Cicer arietinum* is considered the wild progenitor of chickpea (Koul *et al.*, 2022) [5] and are a great source of important nutrients, proteins, minerals, fibres, unsaturated fatty acids, and β-carotene. It is considered one of the most nutritious pulses intended for human consumption health benefits (Kakaei *et al.*, 2024) [2]. India ranks first in production of chickpea followed by Australia, Ethiopia, Turkey, Myanmar, Russia, Pakistan, Mexico, Iran, USA, and Sudan (FAOSTAT, 2022) [1].

Regardless of its great nutritional and economic value, chickpea yields are extremely low in India. There are many variables responsible for the low yield of chickpea but sowing date and use of suitable cultivars are most important. Thus, there is need to identify proper sowing time and use of high yielding cultivars. Crop plants can withstand abiotic stresses by using various kinds of avoidance or tolerance techniques (Shunmugam *et al.*, 2018) [6]. A common crop strategy to avoid late-season stresses and help with adaptation to short-season environments is early phenology.

The duration of crop growth must fit to enhance farming operation or production environment. The plant growth duration must suit or complement a production environment and/or farming enterprise. The genes governing chickpea phenology and growth durations are well-known and are extensively characterized at the genetic level (Mallikarjuna *et al.*, 2017 and Gaur *et al.*, 2019) [7, 8]. Apart from genetic knowledge, one can minimize the exposure to environmental stress factors during critical growth periods by implementing management practices like maximizing sowing dates for particular varieties (Lake and Sadras, 2014) [9]. In order to test for adaptability in new regions, it is practical to use a range of sowing dates across diverse sites and years, matching cultivar performance to the long-term average climatic conditions.

Materials and Methods

The experiment was conducted in the *rabi* season of 2023-24 at the Chamelti Agriculture Research Farm of Shoolini University of Biotechnology and Management Sciences, Solan (latitude 30º 85'67.30 N and longitude 77° 13 20.38). The soil of the experimental field was sandy loam in texture, medium in organic carbon, available nitrogen, potassium, with high available phosphorus, neutral in reaction with EC in safer range. The experiment was laid out in a split plot design with three main plot treatments, four sub plot treatments, and three replications. The main plot treatments having three varieties: (V_1) Himachal Channa 1, (V_2) Himachal Channa 2 and (V_3) GPF 2, whereas the sub-plot treatments comprising four sowing dates: (D_1) October 1st, (D_2) October 15th, (D_3) October 30th and (D_4) November 15th. Total 241.6 mm rainfall received during crop growing season. An equal dose of RDF @ 30-60-30 kg N, P and K were applied through urea, SSP and MOP, respectively at the time of sowing as basal application. Sowing was done as per treatments. All other operations were done as per recommendations of the area.

Statistical Analysis and Interpretation of Data

The observations on various parameters were compiled and statistically analysed using the analysis of variance approach developed by Gomez and Gomez (1984). The 'F' test was used to determine whether there was a significant treatment difference at the 5% significance level.

Results

Effect on plant height (cm)

Plant height of chickpea cultivars were significantly affected by sowing date. At 30 DAS, cultivar GPF 2 recorded significantly higher plant height (9.76 cm) followed by Himachal Channa 2 and Himachal Channa 1. Similar trend was followed at 60, 90, 120, 150 DAS and at harvest. Cultivar GPF 2 was statistically on par with Himachal Channa 2 at 30, 60 and 90 DAS. Among the sowing dates, average plant hight of chickpea was significantly affected by sowing dates at all growth stages of crop. At 30 DAS, significantly higher plant hight (10.56 cm) was recorded sowing on 1st October followed by 15th October, 30th October and 14th November. Similar results were discovered at all growth stages of crop.

Interaction between cultivars and sowing dates was found to be non-significant.

Effect on number of branches plant^{-1}

Result revelled that number of branches plant^{-1} of chickpea cultivars were significantly affected by sowing dates. Cultivar GPF 2 recorded significantly higher number of branches (8.58 plant^{-1}) followed by Himachal Channa 2 (8.00 plant^{-1}) and Himachal Channa 1 (6.80 plant^{-1}) at 60 DAS. Similar findings were seen at 90 and 120 DAS. In case of sowing dates, at 60 DAS, crop sown on October 1st recorded significantly higher number of branches (9.04 plant^{-1}), followed by October 15th, October 30th and November 14th sown crop, respectively. Similar trend was also followed at 90 and 120 DAS.

Interaction between cultivars and sowing dates was found to be non-significant.

Effect on dry matter accumulation (g plant^{-1})

Dry matter accumulation plant^{-1} was significantly affected by different sowing date and cultivars. Among the cultivars, GPF 2 recorded significantly higher dry matter accumulation (0.794 g plant^{-1}) followed by Himachal Channa 2 and Himachal Channa 1 at 30 DAS. Similar trend was seen at all crop growth stages. Cultivar GPF 2 was statically at par with Himachal Channa 2 at all growth stages except at harvest. In case of sowing dates, results revealed that crop sown on October 1st accumulated significantly higher dry matter (0.827 g plant^{-1}) and crop sown on 14th November (0.649 g plant^{-1}) accumulated lowest dry matter at 30 DAS. Similar trend was followed at 60, 90, 120, 150 DAS and at harvest.

Interaction between cultivars and sowing dates was found to be non-significant.

Effect on crop growth rate (g plant^{-1} day^{-1})

Results indicated that crop growth rate of chickpea cultivars was significantly affected by sowing dates. In between 0-30 DAS, cultivar GPF 2 had a significantly higher crop growth rate (0.026 g plant^{-1} day^{-1}), which was statistically at par with Himachal Channa 2. Similar results were also found at 30-60, 60-90, 90-120, 120-150 DAS and 150 DAS - at harvest stage of crop. In case of sowing dates, crops sown on October 1st recorded significantly higher crop growth rates (0.028 g plant^{-1} day^{-1}) followed by crops sown on October 15th, October 30th and November 14th, respectively at 0-30 DAS. Similar results were seen at all crop growth stages.

Interaction between cultivars and sowing dates was found to be non-significant.

Effect on number of nodules and dry weight of nodules plant^{-1}

Number and dry weight of nodules plant^{-1} of chickpea cultivars was significantly affected by different date of sowing. In case of cultivars, number and dry weight of nodules plant^{-1} were significantly higher in Cultivar GPF 2 which was at par to Himachal Channa 2, while the lowest dry weight and nodules per plant were discovered in Himachal Channa 1. The earlier sowing resulted in significantly higher number of nodules and nodule dry weight per plant.

Among sowing dates, crops sown on October 1st recorded significantly higher number of nodules (14.12 plant^{-1}), followed by crops sown on October 15th, October 30th and November 14th, respectively. Dry weight of nodules was also significantly higher in the crop sown on October 1st (18.07 mg plant^{-1}), which was statistically at par with the crop sown on October 15th, followed by October 30th and November 14th sown crop.

Interaction between cultivars and sowing dates was found to be non-significant.

Discussion

Among the cultivars, plant height, number of branches, dry matter accumulation and crop growth rate were significantly

affected by different cultivars. Cultivar GPF 2 had significantly higher values of growth characters which was superior than Himachal Channa 2 and Himachal Channa 1. This might be due to inherent variation caused by the superior genetic makeup of the cultivar GPF 2. The variation in plant height, number of branches plant^{-1}, dry matter accumulation and crop growth rate among different cultivars had also been reported by Thombre *et al*. (2019) [12], they found that cultivar PDKV Kanchan had significantly higher plant height and cultivar RVG 203 had significantly higher number of branches plant^{-1} and dry matter among seven cultivars. Kripanidhi *et al*. (2017) and Khangarot *et al*. (2022) [11] were found similar kind of findings.

In case of sowing dates, significantly higher plant height, number of branches, dry matter accumulation and crop growth rate were found under crop sown on 1st October, further delay in sowing caused rapid decline the growth characters. This might be accounted to better growth of plants due better growing conditions in 1st October sown crop and low temperature during grand growth period in delayed sowing resulted in less plant growth. Results are in line with the findings of Sujathamma and Nedunchezhiyan (2023) [16], Khangarot *et al*. (2022) [11] and Getachew and Thomas (2021) [14].

Number of nodules and dry weight of nodules plant^{-1} were also significantly affected by cultivars where GPF 2 had significantly higher values of these characters than Himachal Channa 2 and Himachal Channa 1. Plett *et al*. (2021) [17] found that large genotype by soil nitrogen interaction effects on nodulation and further identified agronomic traits of genotypes (such as shoot weight) associated with high nodulation and they also identified genetic factors affecting chickpea nodule development and nitrogen fixation. Results were also in line with the result of Sethi *et al*. (2016) [15] where they found that significantly higher number of nodules and dry weight nodule plant^{-1} was recorded in cultivar H09-23 followed by H08-18, HC-1 and C235 and they reasoned it to be poor nodule initiation and formation.

Among the sowing dates, early sown on October 1st recorded significantly higher number of nodules and dry weight of nodules which might be due to favourable environmental conditions that stimulated better root nodulation. Similar results were found by Sethi *et al*. (2016) [15], chickpea sown on 2nd Fortnight of November had significantly higher number of noduled and dry weight of nodules as compared to crop sown on 2nd Fortnight of December.

Conclusion

Based on a one-year experiment, it is concluded that GPF 2 cultivar sown on 1st October exerted significant improvement in growth characters of chickpea under mid hills of Himachal Pradesh.

Table 1: Effect of sowing dates on periodic plant height of chickpea cultivars

Treatments	Plant height (cm)					
	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS	At harvest
Main plot (Cultivars)						
V_1: Himachal Channa 1	6.98	24.51	30.87	33.50	35.26	33.23
V_2: Himachal Channa 2	9.10	27.23	33.38	35.42	36.38	34.58
V_3: GPF 2	9.76	29.65	36.02	37.91	39.81	37.12
SEm±	0.18	0.60	0.85	0.68	0.76	0.68
LSD (*p*= 0.05)	0.72	2.34	3.32	2.67	2.99	2.67
Sub plot (Sowing Date)						
D_1: 1st October	10.56	34.86	44.30	46.84	48.31	44.97
D_2: 15th October	9.35	30.29	38.73	40.42	41.61	39.00
D_3: 30th October	8.43	24.93	29.07	30.81	32.61	31.30
D_4: 14th November	6.12	18.44	21.59	24.37	26.07	24.62
SEm±	0.18	0.65	0.93	0.74	0.84	0.74
LSD (*p*= 0.05)	0.54	1.92	2.77	2.20	2.49	2.20
Interaction (V * S)	NS	NS	NS	NS	NS	NS

Table 2: Effect of sowing dates on periodic number of branches plant^{-1} of chickpea cultivars

Treatments	Number branches plant^{-1}		
	60 DAS	90 DAS	120 DAS
Main plot (Varieties)			
V_1: Himachal Channa 1	6.80	9.73	10.50
V_2: Himachal Channa 2	8.00	11.09	11.97
V_3: GPF 2	8.58	11.70	12.87
SEm±	0.18	0.27	0.27
LSD (*p*= 0.05)	0.72	1.04	1.04
Sub plot (Sowing Date)			
D_1: 1st October	9.04	13.39	14.17
D_2: 15th October	8.19	11.84	12.52
D_3: 30th October	7.41	9.87	10.97
D_4: 14th November	6.53	8.26	9.46
SEm±	0.18	0.27	0.27
LSD (*p*= 0.05)	0.54	0.80	0.80
Interaction (V * S)	NS	NS	NS

Table 3: Effect of sowing dates on periodic dry matter accumulation (g plant^{-1}) of chickpea cultivars

Treatments	Dry matter accumulation (g plant^{-1})					
	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS	At harvest
Main plot (Cultivars)						
V_1: Himachal Channa 1	0.674	1.698	3.201	4.451	5.730	7.273
V_2: Himachal Channa 2	0.742	1.927	3.478	4.827	6.204	7.491
V_3: GPF 2	0.794	2.135	3.738	5.157	6.680	8.067
SEm±	0.017	0.050	0.084	0.085	0.107	0.121
LSD (p= 0.05)	0.067	0.198	0.330	0.335	0.418	0.477
Sub plot (Sowing Date)						
D_1: 1st October	0.827	2.352	4.754	6.643	8.512	11.063
D_2: 15th October	0.766	2.048	3.732	5.155	6.619	8.280
D_3: 30th October	0.703	1.783	3.024	4.176	5.403	6.288
D_4: 14th November	0.649	1.498	2.378	3.274	4.286	4.809
SEm±	0.019	0.058	0.093	0.093	0.107	0.133
LSD (p= 0.05)	0.057	0.171	0.276	0.276	0.317	0.396
Interaction (V * S)	NS	NS	NS	NS	NS	NS

Table 4: Effect of sowing dates on periodic crop growth rate (g plant^{-1} day^{-1}) of chickpea cultivars

Treatments	Crop growth rate (g plant^{-1} day^{-1})					
	0-30 DAS	30-60 DAS	60-90 DAS	90-120 DAS	120-150 DAS	150 DAS-Harvest
Main plot (Cultivars)						
V_1: Himachal Channa 1	0.022	0.034	0.050	0.042	0.043	0.029
V_2: Himachal Channa 2	0.025	0.040	0.052	0.045	0.046	0.032
V_3: GPF 2	0.026	0.045	0.053	0.048	0.051	0.034
SEm±	0.001	0.001	0.001	0.001	0.001	0.001
LSD (p= 0.05)	0.002	0.004	0.002	0.003	0.004	0.003
Sub plot (Sowing Date)						
D_1: 1st October	0.028	0.051	0.080	0.063	0.062	0.050
D_2: 15th October	0.026	0.043	0.056	0.047	0.049	0.038
D_3: 30th October	0.023	0.036	0.041	0.039	0.041	0.023
D_4: 14th November	0.022	0.028	0.029	0.030	0.034	0.016
SEm±	0.001	0.001	0.001	0.001	0.001	0.001
LSD (p= 0.05)	0.002	0.003	0.004	0.003	0.003	0.003
Interaction (V * S)	NS	NS	NS	NS	NS	NS

Table 5: Effect of sowing dates on number of nodules (plant^{-1}) and dry weight of nodules (mg plant^{-1}) of chickpea cultivars

Treatments	No. of nodules (plant^{-1})	Dry weight of nodules (mg plant^{-1})
Main plot (Varieties)		
V_1: Himachal Channa 1	11.38	14.85
V_2: Himachal Channa 2	12.44	16.62
V_3: GPF 2	12.63	16.80
SEm±	0.18	0.36
LSD (p= 0.05)	0.72	1.43
Sub plot (Sowing Date)		
D_1: 1st October	14.12	18.07
D_2: 15th October	13.40	17.03
D_3: 30th October	11.23	15.57
D_4: 14th November	9.86	13.70
SEm±	0.20	0.39
LSD (p= 0.05)	0.60	1.15
Interaction (V * S)	NS	NS

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