***Original Research Article***

**Response of Chickpea [*Cicer arietinum (L.)*] Varieties to Seed Rate and Time of Sowing in 1B Zone of Rajasthan, INDIA**

**Abstract**

A field experiment entitled “Response of Chickpea (*Cicer arietinum* L.) Varieties to Seed Rate and Time of Sowing in 1B Zone of Rajasthan” was conducted during *rabi* season of 2023-24 at Crop Research Farm, Department of Agronomy, Tantia University, Sri Ganganagar, Rajasthan, India. The experiment was laid out in factorial randomized complete block design with three replications. There were 24 treatment combinations consisting of two varieties (GNG-1581 and GNG-2171), three seed rate (62.5, 75.0 and 87.5 kg/ha) and four date of sowing (1st and 3rd week of October and 1st and 3rd week of November). The chickpea variety GNG-1581 recorded significantly higher seed yield (1408 kg/ha), number of pods/plant (60.44), seed weight/plant (11.24 g), total dry matter production at harvest (10.592 g/plant) as compared to GNG-2171. The significantly higher seed yield was obtained with a seed rate of 87.5 kg/ha (1502 kg/ha) over 75.0 kg/ha and 62.5 kg/ha. The chickpea sown during October 1st week recorded significantly higher seed yield (1756 kg/ha), higher number of pods/plant (56.00), seed weight/plant (13.81 g) and leaf area index at 60 days (1.27) as compared to another late sown chickpea. However, the GNG-2171 with a seed rate of 87.5 kg/ha and sowing during October 1st week recorded maximum net returns (Rs. 65,552/ha) and B:C ratio (3.26) over other combinations.

Keywords: Chickpea, 1B Zone, Seed rate, Time of sowing, harvest

**1 Introduction**

Pulse crops play an important role in Indian agriculture. Besides being rich in protein, they sustain the productivity of cropping systems. Their ability to use atmospheric nitrogen through biological nitrogen fixation (BNF) is economically more sound and environmentally acceptable. Pulses constitute an important ingredient in predominantly vegetarian Indian diet. Cereals constitute the staple food and the major source of energy, while the addition of pulses, which are the main source of vegetable proteins provide nutritionally balanced food. On an average, pulses contain 20-25 percent protein on dry seed basis, which is almost 2.5 to 3.0 times of the normally cereals.

Chickpea (*Cicer arietinum* L.) is the most important pulse crop of *rabi* season cultivated mainly in semi-arid and warm temperate regions of the world. It contains 18 percent protein which is almost three times more than that of cereals. Chickpea is the highest protein yielding grain legume except groundnut and soybean. Chickpea is also credited with the ability of atmospheric nitrogen fixation through symbiotic process and it has been estimated that the crop has the capacity to fix 140 kg N/ha in a growing season **(Rupela and Saxena, 1987).** The fixed N2 not only can meet the requirements of the legume for maximum grain formation, but it can also be available for use by subsequent crops, after mineralization of chickpea crop residues. It is mainly grown as a rain-fed crop during the *Rabi* (winter) season on conserved soil moisture from the preceding monsoon **(Singh *et al*. 2011).** Chickpea is an excellent source of protein (18-22%), carbohydrates (52-70%), fat (4-10%), minerals (calcium, phosphorus, iron etc.) and vitamins. It is an excellent animal feed and its straw has good forage value **(Prasad, 2012).**

Chickpea has playing a major role in realization of Pulse Revolution in India making the country self-sufficient in pulses. There has been remarkable increase in chickpea production and productivity in the country during 2014-15 to 2021-22. From a level of 7.33 million tonnes in 2014-15, chickpea production rise to an all-time high of 13.98 million tonnes during 2021-22. This represented an increase of nearly 91% during last eight years. Similarly, there is an increase of more than 34% in chickpea productivity during the period. This increase can be attributed to technological advancements, increased availability of quality seed, better inter-institutional and international collaboration and dedicated policy support. **(GOI, 2021-22).**

Chickpea is gaining popularity evenly in all parts of the country in recent years as it fetches higher price in the market and comes up well even under late sown conditions. Availability of irrigation water is a constraint even during rabi, the performance of early maturing variety (GNG-1581) needs to be evaluated in comparison with variety (GNG-2171) to get higher water use efficiency and net income. There is also need to optimize seed rate in conjunction with sowing time of chickpea varieties for late sown conditions.

**2 MATERIALS AND METHODS**

**2.1 Experimental Site**

 The experiment was conducted in *Rabi* Season of 2023-24 at Crop Research Farm, Department of Agronomy, Tantia University, Sri Ganganagar, Rajasthan, India. This located at 28.4° N latitude, 72.2° E longitude and 178 m above mean sea level.

**2.2 Climate**

The experimental site comes under North Western Plain Zone (I b) of agroclimatic zones in Rajasthan. The Sri Ganganagar is located between Latitude of 28.40˚ to 30.60˚ and Longitude of 72.30˚ to 75.30˚. The total area of Sri Ganganagar is 11,154.66 km2 or 1,115,466 hectares. It is surrounded on the east by [Hanumangarh district](https://en.wikipedia.org/wiki/Hanumangarh_district%22%20%5Co%20%22Hanumangarh%20district), on the south by [Bikaner district](https://en.wikipedia.org/wiki/Bikaner_district), and on the west by [Bahawalnagar district](https://en.wikipedia.org/wiki/Bahawalnagar_District) of [Pakistani Punjab](https://en.wikipedia.org/wiki/Punjab%2C_Pakistan) and on the north by [Fazilika district](https://en.wikipedia.org/wiki/Fazilka_district%22%20%5Co%20%22Fazilka%20district) of [Indian Punjab](https://en.wikipedia.org/wiki/Punjab%2C_India). This zone receives on an average rainfall of 322 mm out of which about 75% received from July to end of September month. The winter months are very cold whereas, summer months are hot and dry. Western hot winds are started from the March and remain continues till onset of monsoon.

**2.3 Experimental Design**

The experiment was conducted in Factorial Randomized Block Design (FRBD) using two factors and each factor having three levels and replicated thrice.

**2.4 Treatment details**

There were 24 treatment combinations consisting of two varieties of chickpea, three seed rates and four dates of sowing.

**2.5 Details of treatment combinations**

T1: GNG-1581 sown on first week of October with a seed rate of 62.5 kg/ha

T2: GNG-1581 sown on first week of October with a seed rate of 75.0 kg/ha

T3: GNG-1581 sown on first week of October with a seed rate of 87.5 kg/ha

T4: GNG-2171 sown on first week of October with a seed rate of 62.5 kg/ha

T5: GNG-2171 sown on first week of October with a seed rate of 75.0 kg/ha

T6: GNG-2171 sown on first week of October with a seed rate of 87.5 kg/ha

T7: GNG-1581 sown on third week of October with a seed rate of 62.5 kg/ha

T8: GNG-1581 sown on third week of October with a seed rate of 75.0 kg/ha

T9: GNG-1581 sown on third week of October with a seed rate of 87.5 kg/ha

T10: GNG-2171 sown on third week of October with a seed rate of 62.5 kg/ha

T11: GNG-2171 sown on third week of October with a seed rate of 75.0 kg/ha

T12: GNG-2171 sown on third week of October with a seed rate of 87.5 kg/ha

T13: GNG-1581 sown on first week of November with a seed rate of 62.5 kg/ha

T14: GNG-1581 sown on first week of November with a seed rate of 75.0 kg/ha

T15: GNG-1581 sown on first week of November with a seed rate of 87.5 kg/ha

T16: GNG-2171 sown on first week of November with a seed rate of 62.5 kg/ha

T17 -GNG-2171 sown on first week of November with a seed rate of 75.0 kg/ha

T18: GNG-2171 sown on first week of November with a seed rate of 87.5 kg/ha

T19: GNG-1581 sown on third week of November with a seed rate of 62.5 kg/ha

T20: GNG-1581 sown on third week of November with a seed rate of 75.0 kg/ha

T21: GNG-1581 sown on third week of November with a seed rate of 87.5 kg/ha

T22: GNG-2171 sown on third week of November with a seed rate of 62.5 kg/ha

T23: GNG-2171 sown on third week of November with a seed rate of 75.0 kg/ha

T24: GNG-2171 sown on third week of November with a seed rate of 87.5 kg/ha

**2.6 Varietal characteristics**

Salient features of chickpea varieties used in the present investigation are furnished below Table 1: Salient features of chickpea varieties used in the present investigation

|  |  |
| --- | --- |
| Varieties  | Salient features |
| GNG-1581(Ganguar) | Variety was developed in 2008 at ARS, Sri Ganga Nagar (Rajasthan) with an average yield of 24-25 Q/ha with days to maturity 151-155. It is normally sown variety in irrigated regions. This variety was developed in order to make it resistant to Wilt Ascochyta Blight, Stunt, Root Rot. |
| GNG-2171 | Variety was developed in 2017at ARS, Sri Ganga Nagar (Rajasthan) with an average yield of 20-21 Q/ha with days to maturity 163-165. It is normally sown variety in irrigated regions. This variety was developed in order to make it tolerant to fusarium wilt disease |

Data recorded on different aspects of crop, *viz.,* growth, yield attributes were subjected to statistically analysis by analysis of variance method. (**Gomez and Gomez, 1976)** and economic data analysis mathematical method.

**3 RESULT AND DISCUSSION:**

**3.1 Growth parameters**

**3.1.1 Plant height**

At harvest significantly higher plant height was registered with GNG-2171 (34.70 cm) over GNG-1581 (30.09 cm). The seed rate of 87.5 kg ha**-1** recorded significantly higher plant height(34.30 cm) over 75.0 kg/ha (33.07 cm) and 62.5 kg/ha (29.81 cm) Chickpea varieties sown on October 1st week registered significantly higher plant height (85.62 cm) over October 3rd week (33.89 cm), November 1st week (31.20 cm) and November 3rd week (28.88 cm).The two way interactions of V x S, V x D and S x D were not significant with regard to their effect on plant height. The three-way interactions of V x S x D were also not significant. However, a maximum plant height (40.53 cm) was recorded in V2S2D1followed by V2S2D1.

**3.1.2 Number of primary branches per plan**t

At harvest significantly higher number of primary branches per plant were registered by GNG-2171 (3.20) over GNG-1581 (2.94). The seed rate of 62.5 kg/ha recorded significantly higher number of primary branches per plant (3.35) over 75.0 kg/ha (3.05) and 87.5kg/ha (2.82).Chickpea varieties sown on October 1st week registered significantly higher number of primary branches per plant (3.78) over October 3rd week (3.19), November 1st week (2.81) and November 3rdweek (2.51).The two-way interactions of V x S x V x D and S x D were not significant regarding their effect on number of primary branches per plant. The three-way interactions of V x S x D were also not significant. The maximum number of primary branches per plant of 4.30 was recorded in V2S2D treatment combination.

**3.1.3 Total dry matter production**

At harvest, significantly higher total dry matter production was registered by GNG-1581 (10.592 g/plant) over GNG-2171 (10.313g/plant).A seed rate of 62.5 kg/ha recorded significantly higher total dry matter production (11.253 g/plant over 75.0 kg/ha (10.694 g/plant)and 87.5 kg/ha (9.409 g/plant). Chickpea varieties sown on October1stweek registered significantly higher total dry matter production(12.823 g/plant) over October 3rdweek (11.822 g/plant), November 1stweek (9.757 g/plant) and November 1stweek (7.407 g/plant).The two-way interactions of V x S, V x D and S x D were not significant regarding their effect on total dry matter production. The three-way interaction of V x S x D was also not significant. However, a maximum total dry matter production of 14.420 g/plant was recorded inV2S1D1.

The variety GNG-2171 recorded significantly higher protein content (22.51%) as compared to 20.58 per cent in GNG-1581. Similar higher seed protein content GNG-2171 over GNG-1581 was also reported by Singh *et al.* (1990).

**3.2 Yield components of chickpea**

**3.2.1 Number of pods per plant**

The data on number of pods per plant of chickpea varieties as influenced by seed rate and dates of sowing are presented in Table 5.Number of pods per plant differed significantly due to chickpea varieties. The significantly higher number of pods were registered byGNG-1581 (50.44 per plant) over GNG-2171 (40.03 per plant). The seed rate of 62.5 kg/ha recorded significantly higher number of pods (52.62 per plant) over 75.0 kg/ha (45.67 per plant) and 87.5 kg ha-1(40.42 per plant). Chickpea varieties sown on October1st week registered significantly higher number of pods (56.00 per plant) over October 3rdweek (47.56 per plant), November 1stweek (44.11 per plant) and November 3rdweek (37.28 per plant).The two-way interactions V x S, V x D and S x D were not significant regarding their effect on number of pods per plant The three-way interaction of V x S x D was also not significant. The maximum number of pods (66.33 per plant) were recorded in V2S3D1treatment combination.

**3.2.2 Number of seeds per pod**

The data on number of seeds per pod of chickpea varieties as influenced by seed rate and dates of sowing are furnished in Table 5. There was no significant difference between the chickpea varieties. However, GNG-1581 recorded maximum number of seeds pod-1 (1.03 seeds per pod) overGNG-2171 (1.02 seeds per pod).There was no significant difference between the seed rate. However, a seed rate of 87.5 kg ha-1recorded maximum number of seeds per pod(1.04). Chickpea varieties sown on October1stweek, October 3rdweek, November 1st week and November 3rd week were not significant. However, October 1st week sowing recorded maximum number of seeds per pod(1.06).The two-way interactions of V x S, V x D and S x D were not significant regarding their effect on number of seeds per pod. The three-way interaction of V x S x D was also not significant. However, a maximum number of seeds per pod (1.17) was recorded inV2S3D1 treatment combination.

**3.2.3 Seed weight per plant**

The data on seed weight plant-1 of chickpea as influenced by varieties, seed rate and dates of sowing are presented in Table 5.The seed weight plant differed significantly due to chickpea varieties. Significantly higher seed weight was registered by GNG-1581(11.24 g plant-1) over GNG-2171 (10.46 g plant-1). The seed rate of 62.5 kg/ha recorded significantly higher seed weight(11.85 g plant-1) over 75.0 kg/ha(11.12g plant-1) and 87.5 kg ha-1 (9.59g plant-1).Chickpea varieties sown on October 1st week registered significantly higher seed weight (13.81 g plant-1) over October 3rdweek(12.66 g plant-1), November 1stweek (9.94 g plant-1) and November 3rd week (6.99 g plant-1).The two-way interactions of V x S, V x D and S x D were not significant regarding their effect on seed weight plant-1.The three-way interaction of Vx S x D was also not significant. A maximum seed weight of 15.94 g plant-1 was recorded in V2S3D1treatment combination.

**3.2.4 Thousand seed weight**

The data on thousand seed weight (g) of chickpea varieties as influenced by seed rate and dates of sowing are presented in Table 6.The thousand seed weight differed significantly due to chickpea varieties. Significantly higher thousand seed weight was registered GNG-2171(242.83 g) over GNG-1581 (206.17 g).A seed rate of 62.5 kg ha-1recorded significantly higher thousand seed weight (235.71 g) over 75.0 kg/ha (225.33 g) and 87.5 kg/ha(212.46 g).Chickpea varieties sown on October1stweek registered significantly higher thousand seed weight (249.28 g) over October 3rdweek (238.28 g), November 1stweek (211.89 g) and November 3rdweek(198.57 g).The two-way interactions of V x S, V x D and S x D were not significant regarding their effect on thousand seed weight. The three-way interaction of V x S x D was also not significant. However, a maximum thousand seed weight of 270.33 g was recorded inV2S1D1treatment combination.

**3.2.5 Seed yield (kg ha-1)**

Seed yield differed significantly due to chickpea varieties. Significantly higher seed yield was registered by GNG-1581 (1408 kg ha-1) over GNG-2171 (1332 kg/ha).The seed rate of 87.5 kg/ha recorded significantly higher seed yield (1502 kg/ha) over 75.0 kg/ha(1386 kg/ha) and 62.5 kg/ha(1222 kg/ha).Chickpea varieties sown on October 1stweek registered significantly higher seed yield (1756kg ha-1)over October 3rdweek(1603 kg ha-1), November 1stweek (1258 kg ha-1) and November 3rdweek(869 kg/ha). The two-way interactions of Vx S, Vx D and S x D were not significant regarding their effect on seed yield. The three-way interaction of V x S x D was also not significant. However, a maximum seed yield of 1990 kg/ha was recorded in V2S3D1treatment combination.

The increase in seed yield of GNG-1581 over GNG-2171 was to an extent of 5.45 per cent. Similar better performance of GNG-1581 over GNG-2171 was also obtained by Singh *et al.* (1991), Singh and Bhattacharya (1992) and Brar *et al.* (1993).

**3.2.6 Haulm yield**

The data recorded on haulm yield of chickpea varieties as influenced by seed rate and dates of sowing are furnished in Table 6 Haulm yield differed significantly due to chickpea varieties. The significantly higher haulm yield registered by GNG-1581 (1693 kg/ha)over GNG-2171 (1610 kg/ha). The seed rate of 87.5 kg/ha recorded significantly higher haulm yield(1876 kg/ha) over 75.0 kg/ha (1668 kg/ha) and 62.5 kg/ha (1411 kg/ha), Chickpea varieties sown on October 1stweek registered significantly higher haulm yield (1997 kg/ha) over October 3rdweek(1908 kg/ha), November 1stweek (1538 kg/ha) and November 3rdweek(1164 kg/ha). The haulm yield recorded with October 1st week and October 3rd week were on par with each other. The two-way interactions of V×S, V×D and S×D were not significant regarding their effect on haulm yield. The three-way interaction of V×S×D was also not significant. However, a maximum haulm yield of 2289 kg/ha was recorded in V2S3D1 treatment combination.

**3.3 Economics**

The data on economics of chickpea varieties as influenced by seed rates and dates of sowing are presented in Table 7 Chickpea variety GNG-2171 registered significantly higher gross turns (Rs.85,660 ha-1) with a seed rate of 87.5 kg/ha by early sowing on October1stweek over GNG-1581 with varying seed rates and dates of sowing. Significantly higher net returns were realized (Rs.65,552 ha-1) in chickpea variety GNG-2171 with a seed rate of 87.5 kg/ha by early sowing on October 1st week over all other treatment combinations. It was on par with GNG-2171 sown on October 1stweek with a seed rate of75 kg ha-1. Significantly higher B:C ratio (3.26) was recorded in chickpea variety GNG-2171 with a seed rate of 87.5 kg/ha by early sowing on October 1stweek over all other treatment combinations. It was on par with GNG-2171 sown on October 1stweek with a seed rate of 75 kg ha-1.

Higher net returns and benefit cost ratio realized in V2S3D1 is-attributed higher gross returns (Rs.42,802 ha-1) because of higher market price though the seed yield was marginally lower than that of GNG-1581. The results agree with the findings of Singh *et al*. (1990) and Prasad et al. (2012).

**CONCLUSION**

GNG-1581 recorded significantly higher seed yield (1408 kg ha-1) over GNG-2171 (1332 kg ha-1). The seed rate of 87.5 kg/ha resulted in significantly higher seed yield of chickpea over a seed rate of 75.0 kg/ha and 62.5 kg/ha. Chickpea sown during October 1st week recorded 9.00, 28.36 and 52.52 per cent higher seed yield over crop sown during October 3rdweek, November1st week and November 3rd week respectively.

|  |  |
| --- | --- |
| Treatments | Plant height at Harvest |
| Variety (V) | Seed rate (S) | Dates of sowing (D) |
| D1 | D2 | D3 | D4 | **Mean** |
| V1 | S1S2S3 | 31.1733.7735.00 | 29.2731.3732.5 | 27.2729.931.47 | 24.226.532867 | **27.97****30.39****31.91** |
|  | **Mean** | **33.31** | **31.04** | **29.54** | **26.47** | **30.09** |
|  V2 | S1S2S3 | 34.338.9340.53 | 34.237.5738.43 | 29.9733.9334.67 | 28.1332.633.13 | **31.65****35.76****36.69** |
|  | **Mean** | **37.92** | **36.73** | **32.86** | **31.29** | **34.7** |
| Mean of S1Mean of S2Mean of S3 | 32.7336.3537.77 | 31.7334.4735.47 | 28.6231.9233.07 | 26.1729.5730.90 | **29.81****33.07****34.3** |
|  | **Mean** | **35.62** | **33.89** | **31.2** | **28.88** |  |
| Sources | SEm (±) | CD (0.05) |
| Variety (V)Seed rate (S)Dates of sowing (D)VxSVxDSxDVxSxD | 0.340.420.480.590.680.841.19 | 0.971.191.38NSNSNSNS |
| CV (%) | 6.34 |

|  |  |
| --- | --- |
| Treatments | Number of primary branches per plant At harvest |
| Variety (V) | Seed rate (S) | Dates of sowing (D) |
| D1 | D2 | D3 | D4 | **Mean** |
| V1 | S1S2S3 | 4.03 | 3.37 | 2.93 | 2.77 | **3.27** |
|  | 3.37 | 3.03 | 2.70 | 2.20 | **2.82** |
|  | 3.33 | 2.97 | 2.50 | 2.10 | **2.72** |
|  | **Mean** | **3.58** | **3.12** | **2.71** | **2.36** | **2.94** |
| V2 | S1 | 4.30 | 3.33 | 3.20 | 2.83 | **3.42** |
|  | S2 | 4.27 | 3.30 | 2.80 | 277 | **3.28** |
|  | S3 | 3.37 | 3.17 | 2.70 | 2.40 | **2.91** |
|  | **Mean** | **3.98** | **3.27** | **2.90** | **2.67** | **3.20** |
| Mean of S1 | 4.17 | 3.35 | 3.07 | 2.80 | **3.34** |
| Mean of S2 | 3.82 | 3.17 | 2.75 | 2.48 | **3.05** |
| Mean of S3 | 3.35 | 3.07 | 2.60 | 2.25 | **2.82** |
|  | **Mean** | **3.78** | **3.19** | **2.81** | **2.51** |  |
| Sources | SEm± | CD (0.05) |
| Variety (V)Seed rate (S)Dates of sowing (D)VxSVxDSxDVxSxD | 0.060.070.080.100.110.140.20 | 0.160.200.23NSNSNSNS |
| CV (%) | 11.03 |

**Table 2 Effect of varieties, seed rate and dates of sowing on Plant height at Harvest of chickpea**

**Table 3 Effect of varieties, seed rate and dates of sowing on Number of primary branches per plant At harvest of chickpea**

**Table 4 Effect of varieties, seed rate and dates of sowing on Total dry matter production weight of chickpea**

|  |  |
| --- | --- |
| Treatments | At harvest |
| Variety (V) | Seed rate (S) | Dates of sowing (D) |
| D1 | D2 | D3 | D4 | **Mean** |
| V1 | S1S2S3 | 14.420 | 12.780 | 10.617 | 8.093 | **11.478** |
|  | 13.183 | 12.197 | 10.077 | 7.850 | **10.827** |
|  | 11.907 | 10.510 | 8.9970 | 6.470 | **9.471** |
|  | **Mean** | **13.170** | **11.829** | **9.8970** | **7.471** | **10.592** |
| V2 | S1 | 13.337 | 12.633 | 10.307 | 7.840 | **11,029** |
|  | S2 | 13.003 | 12.150 | 9,513 | 7.580 | **10,562** |
|  | S3 | 11.090 | 10.660 | 9.030 | 6.610 | **9.348** |
|  | **Mean** | **12.477** | **11.814** | **9.617** | **7.343** | **10.313** |
| Mean of S1 | 13.878 | 12.707 | 10.462 | 7,967 | **11.253** |
| Mean of S2 | 13.093 | 12.173 | 9.795 | 7.715 | **10.694.** |
| Mean of S3 | 11.498 | 10.585 | 9.013 | 6.540 | **9.409** |
|  | **Mean** | **12.883** | **11.822** | **9.757** | **7.407** |  |
| Sources | SEm± | CD (0.05) |
| Variety (V)Seed rate (S)Dates of sowing (D)VxSVxDSxDVxSxD | 0.0980.1200.1380.1690.1950.2391.338 | 0.2780.3400.393NSNSNSNS |
| CV (%) | 5.61 |

**Table 5 Effect of varieties, seed rate and dates of sowing on number of pods per plant, seeds per pod and seed weight of chickpea**

|  |  |  |  |
| --- | --- | --- | --- |
| Treatments | **Pods per plant** | **Seeds per pod** | **Seed weight (g per plant)** |
| Variety (V) | Seed rate (S) | Dates of sowing (D) | Dates of sowing (D) | Dates of sowing (D) |
| D1 | D2 | D3 | D4 | **Mean** | D1 | D2 | D3 | D4 | **Mean** | D1 | D2 | D3 | D4 | **Mean** |
| V1 | S1S2S3 | 66.33 | 57.00 | 56.33 | 46.00 | **56.42** | 2.05 | 2.03 | 2.01 | 2.01 | **2.02** | 15.94 | 14.07 | 11.26 | 8.08 | **12.34** |
|  | 60.33 | 49.67 | 48.67 | 41.33 | **50.00** | 2.06 | 2.02 | 2.02 | 2.02 | **2.03** | 14.65 | 13.40 | 10.37 | 7.60 | **11.50** |
|  | 56.33 | 45.67 | 41.00 | 36.67 | **44.92** | 2.17 | 2.02 | 2.02 | 2.00 | **2.05** | 12.97 | 11.20 | 9.31 | 6.05 | **9.88** |
|  | **Mean** | **61.00** | **50.78** | **48.67** | **41.33** | **50.44** | **2.09** | **2.02** | **2.01** | **2.01** | **2.03** | **14.52** | **12.89** | **10.31** | **7.24** | **11.24** |
| V2 | S1 | 56.67 | 53.00 | 46.33 | 39.33 | **48.83** | 2.05 | 2.00 | 2.01 | 2.00 | **2.01** | 14.09 | 13.57 | 10.39 | 7.37 | **11.36** |
|  | S2 | 51.00 | 43.00 | 39.33 | 32.00 | **41.33** | 2.07 | 2.01 | 2,01 | 2.00 | **2.02** | 13.75 | 12.75 | 9.44 | 7.01 | **10.74** |
|  | S3 | 45.33 | 37.00 | 33.00 | 28.33 | **35.92** | 2.00 | 2.07 | 2.02 | 2.03 | **2.02** | 11.46 | 10.98 | 8.91 | 5.82 | **9,29** |
|  | **Mean** | **51.00** | **44.33** | **39.56** | **33.22** | **42.03** | **2.03** | **2.02** | **2.01** | **2.01** | **2.02** | **13.1** | **12.43** | **9.58** | **6.73** | **10.46** |
| Mean of S1 | 61.50 | 55 | 51.33 | 42.67 | **52.62** | 2.05 | 2.01 | 2.01 | 2.00 | **2.02** | 15.02 | 13.82 | 10.82 | 7.73 | **11.85** |
| Mean of S2 | 55.67 | 46.33 | 44.00 | 36.67 | **45.67** | 2.06 | 2.02 | 2.01 | 2.01 | **2.02** | 14.2 | 13.07 | 9.90 | 7.30 | **11.12** |
| Mean of S3 | 50.83 | 41.33 | 37.00 | 32.50 | **40.42** | 2.07 | 2.04 | 2.02 | 2.01 | **2.04** | 12.22 | 11.09 | 9.11 | 5.94 | **9.59** |
|  | **Mean** | **56.00** | **47.56** | **44.11** | **37.28** |  | **2.06** | **2.02** | **2.01** | **2.01** |  | **13.81** | **12.66** | **9.94** | **6.99** |  |
| Sources | SEm± | CD (0.05) | S. Em± | CD (0.05) | SEm± | CD (0.05) |
| Variety (V)Seed rate (S)Dates of sowing (D)VxSVxDSxDVxSxD | 0.750.911.061.291.491.832.59 | 2.122.603.00NSNSNSNS | 0.010.010.010.020.020.020.03 | NSNSNSNSNSNS | 0.100.120.140.170.190.240.34 | 0.280.340.40NSNSNSNS |
| CV (%) | 9.69 | 5.63 | 5.50 |

**Table 6 Effect of varieties, seed rate and dates of sowing on thousand seed weight, seed and haulm yield of chickpea**

|  |  |  |  |
| --- | --- | --- | --- |
| Treatments | **Thousand seed weight (g)** | **Seed yield (kg per ha)** | **Haulm yield (kg per ha)** |
| Variety (V) | Seed rate (S) | Dates of sowing (D) | Dates of sowing (D) | Dates of sowing (D) |
| D1 | D2 | D3 | D4 | **Mean** | D1 | D2 | D3 | D4 | **Mean** | D1 | D2 | D3 | D4 | **Mean** |
| V1 | S1S2S3 | 253.00 | 239.33 | 200.33 | 186.67 | **219.83** | 1622 | 1462 | 1164 | 757 | **1251** | 1785 | 1665 | 1366 | 1041 | **1461** |
|  | 235.00 | 216.67 | 194.67 | 178.00 | **206.08** | 1832 | 1675 | 1296 | 900 | **1425** | 2065 | 1958 | 1552 | 1224 | **1699** |
|  | 213.33 | 207.67 | 184.33 | 165.00 | **192.58** | 1990 | 1759 | 1403 | 1045 | **1549** | 2289 | 2212 | 1728 | 1450 | **1919** |
|  | **Mean** | **233.78** | **221.22** | **193.10** | **176.56** | **206.17** | **1814** | **1632** | **1288** | **900** | **1408** | **2046** | **1941** | **1548** | **1238** | **1693** |
| V2 | S1 | 270.33 | 264.67 | 241.67 | 229.67 | **251.58** | 1500 | 1434 | 1115 | 728 | **1194** | 1640 | 1596 | 1300 | 911 | **1362** |
|  | S2 | 267.67 | 258.33 | 231.67 | 220.67 | **244.58** | 1719 | 1594 | 1210 | 861 | **1346** | 1999 | 1940 | 1479 | 1133 | **1637** |
|  | S3 | 256.33 | 243.00 | 218.67 | 211.33 | **232.33** | 1875 | 1693 | 1330 | 922 | **1455** | 2207 | 2087 | 1806 | 1227 | **1832** |
|  | **Mean** | **264.78** | **255.33** | **230.67** | **220.56** | **242.83** | **1698** | **1574** | **1218** | **837** | **1332** | **1948** | **1874** | **1528** | **1090** | **1610** |
| Mean of S1 | 261.67 | 252.00 | 221.00 | 208.17 | **235.71** | 1561 | 1448 | 1139 | 742 | **1222** | 1712 | 1625 | 1333 | 976 | **1411** |
| Mean of S2 | 251.33 | 237.50 | 213.17 | 199.33 | **225.33** | 1775 | 1634 | 1253 | 880 | **1386** | 2032 | 1949 | 1515 | 1178 | **1668** |
| Mean of S3 | 234.83 | 225.33 | 201.5 | 188.17 | **212.46** | 1932 | 1726 | 1367 | 983 | **1502** | 2248 | 2150 | 1767 | 1338 | **1876** |
|  | **Mean** | **249.28** | **238.28** | **211.89** | **198.57** |  | **1756** | **1603** | **1258** | **869** |  | **1997** | **1908** | **1538** | **1164** |  |
| Sources | SEm± | CD (0.05) | SEm± | CD (0.05) | SEm± | CD (0.05) |
| Variety (V)Seed rate (S)Dates of sowing (D)VxSVxDSxDVxSxD | 2.563.133.624.435.116.278.86 | 7.288.9210.30NSNSNSNS | 16192328323956 | 465665NSNSNSNS | 26323745536591 | 7592106NSNSNSNS |
| CV (%) | 6.84 | 7.14 | 9.64 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Treatments | Cost of cultivation (Rs./ha) | Gross returns(Rs./ha) | Net returns (Rs./ha) | B:C ratio |
| V1S1D1 | 18234 | 60901 | 42667 | 2.34 |
| V1S2D1 | 18856 | 68258 | 49402 | 2.62 |
| V1S3D1 | 19758 | 74882 | 55124 | 2.79 |
| V2S1D1 | 18484 | 68390 | 49906 | 2.70 |
| V2S2D1 | 19296 | 78534 | 59238 | 3.07 |
| V2S3D1 | 20108 | 85660 | 65552 | 3.26 |
| V1S1D2 | 18234 | 54884 | 36650 | 2.01 |
| V1S2D2 | 18996 | 63066 | 44070 | 2.32 |
| V1S3D2 | 19758 | 66386 | 46628 | 2.36 |
| V2S1D2 | 18484 | 65248 | 46764 | 2.53 |
| V2S2D2 | 19296 | 72938 | 53642 | 2.78 |
| V2S3D2 | 20108 | 77415 | 57307 | 2.85 |
| V1S1D3 | 18234 | 43761 | 25527 | 1.40 |
| V1S2D3 | 18996 | 48819 | 29823 | 1.57 |
| V1S3D3 | 19758 | 52951 | 33193 | 1.68 |
| V2S1D3 | 18484 | 50831 | 32347 | 1.75 |
| V2S2D3 | 19296 | 55186 | 35890 | 1.86 |
| V2S3D3 | 20108 | 61128 | 41020 | 2.04 |
| V1S1D4 | 18234 | 28627 | 10393 | 0.57 |
| V1S2D4 | 18996 | 34002 | 15006 | 0.79 |
| V1S3D4 | 19758 | 39516 | 19758 | 1.00 |
| V2S1D4 | 18484 | 33271 | 14787 | 0.80 |
| V2S2D4 | 19296 | 39363 | 20067 | 1.04 |
| V2S3D4 | 20108 | 42226 | 22118 | 1.10 |
| S.Em±CD (0.05)CV (%) | --- | 111631776.79 | 1117318110.24 | 0.1170.33410.33 |

**Table 7 Effect of varieties, seed rate and dates of sowing on economics of chickpea**

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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Details of the AI usage are given below:

1.

2.

3

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