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Growth and yield of chickpea as influenced by sowing windows, moisture conservation practices and drought mitigation strategies

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Abstract

A field experiment entitled “Growth and yield of chickpea as influenced by sowing windows, moisture conservation practices and drought mitigation strategies” was conducted at Agricultural College Farm, Bapatla during two consecutive years *i.e.* *rabi* 2024-25 and 2025-26. The experiment was carried out in split split plot design and replicated thrice. It includes four sowing windows as main plots, three moisture conservation practices as sub plots and three drought mitigation strategies as sub sub plots. Among the sowing windows, plant height, Dry matter production and seed yield were found to be higher in second fortnight of November sowing. Among moisture conservation practices, deep ploughing to a depth of 30 cm with MB plough followed by two shallow ploughings recorded higher plant height, Dry matter production and seed yield of chickpea during both the years of study. However, drought mitigation strategies did not influence the plant height, Dry matter production and seed yield of chickpea. The interaction effect of sowing windows, moisture conservation practices and drought mitigation strategies on growth and yield of chickpea was found to be non-significant.

Keywords: Chickpea, sowing windows, moisture conservation, drought mitigation, growth, yield, dry matter production

Introduction

Chickpea is one of the most important *rabi* pulse crop grown in India. It is commonly known as gram or Bengalgram and is a rich source of protein, carbohydrates, fats and vitamins. In India, it is grown in an area of 9.12 million hectares with a production of 11.11 million tonnes and an average productivity of 1218 kg ha⁻¹. In Andhra Pradesh, chickpea is cultivated on 0.29 million hectares with a production of 0.31 million tonnes and productivity of 1063 kg ha⁻¹. (Agricultural statistics at a glance - 2024). Chickpea, being a rainfed crop, its productivity is often limited by inadequate and unevenly distributed rainfall. Among the major abiotic stresses, terminal drought stress is very important which restricts the growth and development of crop, ultimately reducing the yield of the crop. Time of sowing plays a major role in determining the crops exposure to prevailing temperature under different growth stages. Under rainfed conditions, improving the availability of soil moisture and conservation of soil moisture is essential for sustaining crop productivity under uncertain rainfall conditions. Agronomic practices such as tillage and biochar application play a crucial role in improving the soil moisture retention. Drought stress and high temperature during the spring season especially at the time of pollination adversely influenced chickpea growth and yield (Krishnamurthy *et al.*, 2011)^[4]. In addition to conserving soil moisture, foliar spray of plant growth regulators and nutrients act as drought mitigating chemicals and help plants to withstand the stress conditions. There is a need to develop integrated strategies to improve soil moisture availability to withstand the stress conditions and maintain the chickpea productivity under changing climatic conditions.

Materials and Methods

The present investigation was carried out in the Northern block of Agricultural College Farm, Bapatla during *rabi* 2024-25 and 2025-26.

The soil was clayey in texture, slightly alkaline in nature. The soil of the experimental site was low in available nitrogen, medium in available phosphorus, available potassium and organic carbon. The experiment was laid out in split split plot design and replicated thrice. Main plots include 4 sowing windows *i.e.* S₁: Second fortnight of November, S₂: First fortnight of December, S₃: Second fortnight of December and S₄: First fortnight of January and sub plots include Moisture conservation practices *i.e.* M₁: Two shallow ploughings, M₂: Deep ploughing to a depth of 30 cm with MB plough followed by two shallow ploughings and M₃: Rice husk biochar incorporation @ 5 t ha⁻¹ with rotavator, sub sub plots include drought mitigation strategies *i.e.* D₁: Salicylic acid @ 50 ppm spray at flowering and pod development stages, D₂: Homobrassinolide @ 0.25 ppm spray at flowering and pod development stages and D₃: 1 % KNO₃ spray at flowering and pod development stages. Crop was sown according to the treatments with a spacing of 30 cm × 10 cm. All the treatments were imposed accordingly. Application of pre emergence herbicide *i.e.*, Pendimethalin @ 1 L ha⁻¹ was done and later hand weeding was done at 30 days after sowing to eliminate weeds during the crop weed competition period. Recommended dosage of fertilizers *i.e.* 20 kg nitrogen, 50 kg phosphorus were applied to the field.

Plant height was recorded from five randomly tagged plants in each treatment, their mean values were computed and expressed in cm. Dry matter data was taken from those plants which were taken from the destructive sampling area, plant samples were shade dried and then oven dried at 60° C until constant weight is obtained which is expressed as kg ha⁻¹. Seed yield was calculated from the net plot area and expressed as kg ha⁻¹.

Results and Discussion

Plant height (cm)

Plant height was found to be significantly influenced by sowing windows and moisture conservation strategies while drought mitigation strategies could not influence the plant height. (Table 1)

Among sowing windows, Significantly higher plant height was recorded in second fortnight of November sowing (41.7, 42.2 and 42.0 cm during 2024-25, 2025-26 and in pooled data respectively) and it was comparable with first fortnight of December sowing (40.5, 41.3 and 40.9 cm during 2024-25, 2025-26 and in pooled data). Lower plant height was recorded in first fortnight of January sowing (29.9, 30.9 and 30.4 cm during 2024-25, 2025-26 and in pooled data). This may be due to the favourable environmental conditions crop has experienced throughout the growth period. Similar results were reported by Sikdar *et al.* (2015)^[7] and Sagar *et al.* (2023)^[5].

Deep ploughing to a depth of 30 cm with MB plough followed by two shallow ploughings (38.5, 38.9 and 38.7 cm during 2024-25, 2025-26 and in pooled data) recorded significantly taller plants over the two shallow ploughings treatment (32.0, 32.7 and 32.4 cm during 2024-25, 2025-26 and in pooled data) but was statistically on par with rice husk biochar incorporation @ 5 t ha⁻¹ with rotavator (37.7, 38.6 and 38.2 cm during 2024-25, 2025-26 and in pooled data respectively). This might be due to deep ploughing break down the subsurface compaction and allow better root proliferation and good supply of moisture and nutrients for its growth. These results were in line with the findings of Boudh *et al.* (2023)^[2].

However, the interaction effect of sowing windows, moisture conservation practices and drought mitigation strategies was also found to be non-significant.

Dry matter production (kg ha⁻¹)

Sowing windows and soil moisture conservation practices influenced the Dry matter production of chickpea significantly and is presented in table 2.

Sowing of chickpea in second fortnight of November (5238, 5571 and 5405 kg ha⁻¹ during 2024-25, 2025-26 and in pooled data respectively) recorded significantly higher Dry matter production over second fortnight of December (4538, 4982 and 4760 during 2024-25, 2025-26 and in pooled data) and first fortnight of January (4386, 4801 and 4593 during 2024-25, 2025-26 and in pooled data). This might be due to congenial environment during second fortnight of November during both the years of study helped to maintain functional photosynthetic canopy for a longer period which led to more Dry matter accumulation. Similar results were reported by Thombre *et al.* (2019)^[8].

Among the moisture conservation practices, deep ploughing to a depth of 30cm with MB plough followed by two shallow ploughings (5047, 5462 and 5255 during 2024-25, 2025-26 and in pooled data) recorded significantly higher Dry matter production over the two shallow ploughings treatment (4382, 4794 and 4588 during 2024-25, 2025-26 and in pooled data). Deep ploughing might have increased the storage of moisture in the soil and its availability to the plant during the entire crop growth period. Consequently, the plants continued to synthesize and translocate the assimilates efficiently to all the plant parts which led to higher Dry matter accumulation. Similar results were reported by Boudh *et al.* (2023)^[3].

Drought mitigation strategies could not statistically influence the Dry matter production in chickpea during both the years of study and in pooled data. The interaction effect of all the treatments under study was also found to be non-significant.

Seed Yield (kg ha⁻¹)

The data pertaining to effect of sowing windows, moisture conservation practices and drought mitigation strategies is presented in fig.1

The figure depicts that among sowing windows, significantly higher seed yield was obtained when the chickpea crop was sown during second fortnight of November (1782, 1892 and 1837 kg ha⁻¹ during 2024-25, 2025-26 and in pooled data) which was comparable with first fortnight of December sowing (1688, 1809 and 1749 kg ha⁻¹ during 2024-25, 2025-26 and in pooled data). This might be attributed to the better weather conditions during early sowings of crop which led to establishment of better canopy, maintain better photosynthetic activity, sufficient assimilates were produced and seed filling was done which ultimately led to better yields. Similar results were reported by Seth *et al.* (2020). Deep ploughing to a depth of 30cm with MB plough followed by two shallow ploughings (1665, 1771 and 1718 kg ha⁻¹ during 2024-25, 2025-26 and in pooled data) recorded significantly higher seed yield and was comparable to rice husk biochar incorporation @ 5 t ha⁻¹ with rotavator (1610, 1706 and 1658 kg ha⁻¹ during both the years of experimentation and in pooled data). The availability of moisture during the critical growth stages led to better seed filling and ultimately better yields of chickpea. These results were in line with the findings of Basha *et al.* (2020)^[2].

Drought mitigation strategies could not influence the seed yield statistically, however numerically higher seed yield was observed with foliar spray of homobrassinolide @ 0.25 ppm at flowering and pod development stages (1603, 1704 and 1654 kg ha⁻¹ during 2024-25, 2025-26 and in pooled data).

The interaction effect of sowing windows, moisture conservation practices and drought mitigation strategies on seed yield of chickpea was found to be non-significant.

Table 1: Plant height (cm) at harvest as influenced by sowing windows, moisture conservation practices and drought mitigation strategies in chickpea

Treatments	Plant height (cm)		
	2024-25	2025-26	Pooled data
Main plots: Sowing windows (S)			
S ₁ : Second fortnight of November	41.7	42.2	42.0
S ₂ : First fortnight of December	40.5	41.3	40.9
S ₃ : Second fortnight of December	32.1	32.7	32.4
S ₄ : First fortnight of January	29.9	30.9	30.4
SEm ±	0.7	0.7	0.6
CD (P = 0.05)	2.3	2.3	2.0
CV (%)	9.4	9.6	8.2
Subplots: Moisture conservation practices (M)			
M ₁ : Two shallow ploughings	32.0	32.7	32.4
M ₂ : Deep ploughing to a depth of 30 cm with MB plough <i>fb</i> two shallow ploughings	38.5	38.9	38.7
M ₃ : Rice husk biochar incorporation @ 5 t ha ⁻¹ with rotavator	37.7	38.6	38.2
SEm ±	0.6	0.4	0.4
CD (P = 0.05)	1.8	1.3	1.2
CV (%)	10.1	7.2	6.7
Sub-sub plots: Drought mitigation strategies (D)			
D ₁ : Salicylic acid @ 50 ppm spray at flowering and pod development stages	36.0	36.5	36.2
D ₂ : Homobrassinolide @ 0.25 ppm spray at flowering and pod development stages	36.1	36.9	36.5
D ₃ : 1 % KNO ₃ spray at flowering and pod development stages	36.1	36.9	36.5
SEm ±	0.5	0.4	0.3
CD (P = 0.05)	NS	NS	NS
CV (%)	9.0	5.8	5.2
Interaction			
S x M	NS	NS	NS
M x D	NS	NS	NS
S x D	NS	NS	NS
S x M x D	NS	NS	NS

Table 2: Dry matter production (kg ha⁻¹) at harvest as influenced by sowing windows, moisture conservation practices and drought mitigation strategies in chickpea

Treatments	Dry matter production (kg ha ⁻¹)		
	2024-25	2025-26	Pooled data
Main plots: Sowing windows (S)			
S ₁ : Second fortnight of November	5238	5571	5405
S ₂ : First fortnight of December	4916	5392	5154
S ₃ : Second fortnight of December	4538	4982	4760
S ₄ : First fortnight of January	4386	4801	4593
SEm ±	107.2	92.3	99.2
CD (P = 0.05)	371	319	343
CV (%)	11.7	9.2	10.4
Subplots: Moisture conservation practices (M)			
M ₁ : Two shallow ploughings	4382	4794	4588
M ₂ : Deep ploughing to a depth of 30 cm with MB plough <i>fb</i> two shallow ploughings	5047	5462	5255
M ₃ : Rice husk biochar incorporation @ 5 t ha ⁻¹ with rotavator	4879	5302	5091
SEm ±	63.5	64.5	63.6
CD (P = 0.05)	190	193	191
CV (%)	8.0	7.5	7.7
Sub-sub plots: Drought mitigation strategies (D)			
D ₁ : Salicylic acid @ 50 ppm spray at flowering and pod development stages	4737	5144	4941
D ₂ : Homobrassinolide @ 0.25 ppm spray at flowering and pod development stages	4822	5243	5033
D ₃ : 1 % KNO ₃ spray at flowering and pod development stages	4748	5172	4960
SEm ±	59.1	60.3	59.2
CD (P = 0.05)	NS	NS	NS
CV (%)	7.4	7.0	7.1
Interaction			
S x M	NS	NS	NS
M x D	NS	NS	NS
S x D	NS	NS	NS
S x M x D	NS	NS	NS

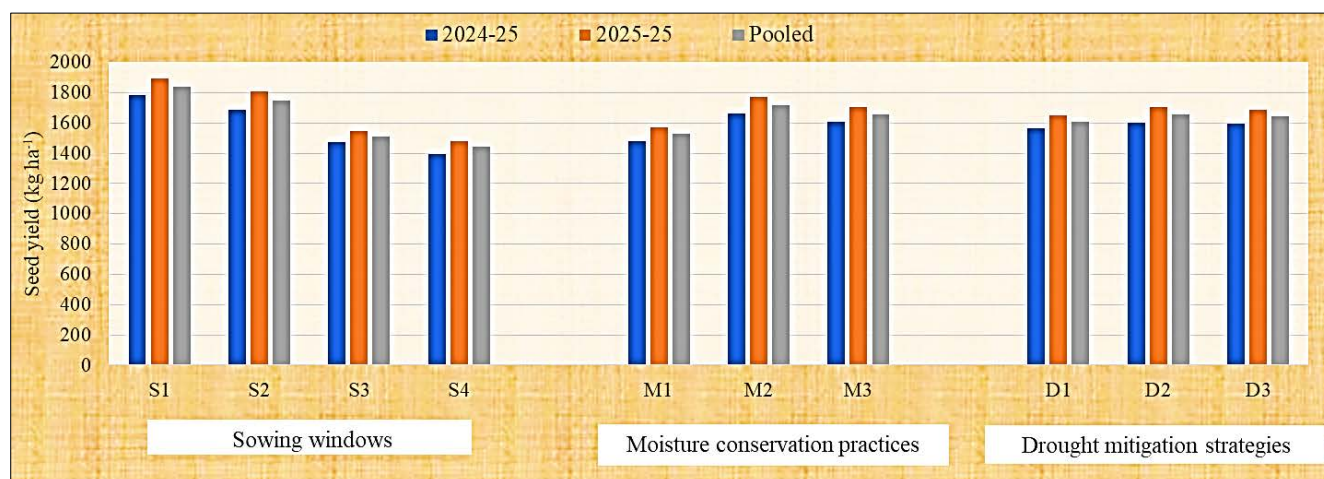


Fig 1: Seed yield (kg ha⁻¹) of chickpea as influenced by sowing windows, moisture conservation practices and drought mitigation strategies

Main plots: Sowing windows

- **S₁:** Second fortnight of November
- **S₂:** First fortnight of December
- **S₃:** Second fortnight of December
- **S₄:** First fortnight of January

Sub plots: Moisture conservation practices

- **M₁:** Two shallow ploughings
- **M₂:** Deep ploughing to a depth of 30 cm with MB plough followed by two shallow ploughings
- **M₃:** Rice husk biochar incorporation @ 5 t ha⁻¹ with rotavator

Sub-sub plots: Drought mitigation strategies

- **D₁:** Salicylic acid @ 50 ppm spray at flowering and pod development stages
- **D₂:** Homobrassinolide @ 0.25 ppm spray at flowering and pod development stages
- **D₃:** 1 % KNO₃ spray at flowering and pod development stages

Conclusion

The study revealed that the sowing time and moisture conservation practices significantly influenced the growth and yield of chickpea. However, the drought mitigation strategies could not influence the growth and seed yield of chickpea during both the years of study. Sowing during second fortnight of November resulted in superior plant height, Dry matter production and seed yield which was comparable with sowing during first fortnight of December. Among moisture conservation practices, deep ploughing to a depth of 30cm with MB plough followed by two shallow ploughings improved growth and yield of chickpea. The interaction among sowing windows, moisture conservation practices and drought mitigation strategies was found to be non-significant during both the years of study and in pooled data.

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