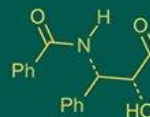


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Effect of different sowing dates and salicylic acid on morpho-physiological parameters and yield of chickpea (*Cicer arietinum* L.)

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Abstract

This investigation assessed the effect of sowing dates and salicylic acid on morpho-physiological parameters and yield of chickpea at the Department of Plant Physiology, College of Agriculture, JNKVV, Jabalpur, during the *rabi* season of 2024-25. Using a Factorial Completely Randomized Design with fifteen treatment combinations (three sowing dates and five salicylic acid levels), the study found that sowing in mid-November produced the highest growth and yield parameters. Application of 400 mg L⁻¹ salicylic acid resulted in the greatest improvements in chlorophyll content, relative water content, membrane stability, root biomass, and seed yield. The most effective result was achieved with mid-November sowing combined with 400 mg L⁻¹ salicylic acid, significantly increasing seed yield, harvest index, and protein content. Thus, the combination of 14 November sowing and foliar application of 400 mg L⁻¹ salicylic acid optimally enhances yield and quality traits of chickpea under Jabalpur agro-climatic conditions.

Keywords: Chickpea, MSI, RWC and salicylic acid

1. Introduction

Chickpea (*Cicer arietinum* L.), or garbanzo bean, ranks third among winter food legumes globally. About 96% of production occurs in developing countries, with India providing nearly 75%. In India, chickpea is grown on 10.91 million hectares, producing 13.72 million tonnes (1260 kg ha⁻¹), mainly in Madhya Pradesh, Uttar Pradesh, Rajasthan, Maharashtra, Gujarat, Andhra Pradesh, and Karnataka, which together account for nearly 95% of the national area. Globally, chickpeas cover 14.56 million hectares with 14.77 million tonnes produced annually. Australia, Turkey, and Pakistan are also major producers.

Chickpea is the most important pulse crop in India, accounting for nearly 75% of global production. Valued for its high protein, carbohydrate, and mineral content, it is a dietary staple and enhances soil fertility through nitrogen fixation. Despite its value, Indian chickpea productivity remains low due to abiotic stresses, such as drought and high temperatures, and biotic constraints, including pests and diseases (Jukanti *et al.*, 2012) [6].

Sowing date is crucial for crop establishment, phenology, and yield. Early or late sowing may expose crops to cold or heat stress, while optimal timing ensures favourable conditions during key growth stages. Salicylic acid (SA), a phenolic growth regulator, enhances plant defence against environmental stress. The SA application supports physiological processes such as chlorophyll synthesis, antioxidant enzyme activation, and improved water-use efficiency, helping crops cope with stress. Using optimal sowing with SA may improve chickpea growth, yield, and quality (Kumar *et al.*, 2003; Kumar *et al.*, 2017) [7, 8].

2. Materials and Methods

The experiment was conducted during the *rabi* season of 2024-25 at the Herbal Garden, Department of Plant Physiology, Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV), Jabalpur, Madhya Pradesh. The experimental site is geographically located at 23°90' N latitude and 79°58' E longitude, at an altitude of 411.8 m above mean sea level. The region experiences a subtropical climate characterised by cool winters, which is suitable for

chickpea cultivation. The soil at the experimental site is deep black soil (Vertisol) with a sandy clay-loam texture, known for its good moisture retention and fertility.

The experiment was laid out in a factorial Completely Randomised Design (CRD) comprising two factors, namely sowing dates and salicylic acid (SA) levels. Each treatment combination was replicated three times to ensure the reliability of the results. In total, fifteen treatment combinations were evaluated under controlled conditions. The details of the experimental treatments are presented in Table 1.

Table 1: Treatment details

Factors	Treatment	Treatment details
Sowing dates	D ₁	24 October
	D ₂	14 November
	D ₃	5 December
Salicylic acid levels	T ₁	Control
	T ₂	100 mg L ⁻¹
	T ₃	200 mg L ⁻¹
	T ₄	300 mg L ⁻¹
	T ₅	400 mg L ⁻¹

The test crop was chickpea (*Cicer arietinum* L.), variety JG 24, a widely cultivated, medium-duration variety. Seeds were sown in pots (0.101 m² surface area) with a soil: compost mixture (2:1). Recommended agronomic practices were uniformly followed.

2.1 Treatment Application: Salicylic acid was applied as a foliar spray at vegetative and pre-flowering stages using freshly prepared solutions, while control pots received only a water spray. Throughout the experiment, irrigation and intercultural operations were carried out as required.

After treatment application, observations were recorded on phenological, morphological, physiological, yield, and quality parameters. The data were then analysed statistically using a factorial CRD ANOVA at a 5% significance level (CD_s%).

3. Results and Discussion

3.1 Morphological Traits

The data presented in Table 2 revealed that the number of primary, secondary, and tertiary branches per plant was significantly influenced by sowing dates and salicylic acid

(SA) levels at different growth stages.

3.1.1 Effect of Sowing Dates

Among the sowing dates, mid-November sowing (D₂: 14 November) recorded significantly higher values for the number of primary branches per plant at all stages, i.e., 30 DAS (5.13), 60 DAS (5.42), and at harvest (5.25), followed by D₁ (24 October), whereas the lowest values were observed under late sowing (D₃: 05 December). A similar trend was observed for the number of secondary branches per plant, where D₂ recorded the highest values at 60 DAS (7.49), 90 DAS (10.18), and at harvest (10.18), followed by D₁, while D₃ recorded the lowest values.

However, the number of tertiary branches per plant showed a different trend. Early sowing (D₁: 24 October) recorded the maximum tertiary branches at 90 DAS (6.49) and at harvest (5.31), followed by D₂, whereas the lowest values were observed under D₃. The differences among treatments were found to be significant as indicated by the CD values at 5% level.

3.1.2 Effect of Salicylic Acid Levels

Salicylic acid application significantly influenced branching parameters at all growth stages. Among the treatments, T₅ (400 mg L⁻¹) recorded the highest number of primary branches per plant at 30 DAS (4.80), 60 DAS (5.42), and at harvest (4.92), which was statistically at par with T₄ (300 mg L⁻¹) at certain stages. The lowest values were recorded under the control (T₁) condition. Similarly, the number of secondary branches per plant increased with increasing SA concentration, with T₅ recording the maximum values at 60 DAS (7.00), 90 DAS (9.94), and at harvest (9.76), followed by T₄, while T₁ recorded the minimum values.

For tertiary branches per plant, T₅ also recorded the highest values at 90 DAS (6.85) and at harvest (5.04), followed by T₄ and T₃, whereas the lowest values were observed under the control (T₁). Overall, the results indicated that mid-November sowing (D₂) and higher salicylic acid concentration (400 mg L⁻¹) significantly enhanced primary and secondary branching, while early sowing (D₁) favoured higher tertiary branching in chickpea. The findings are supported by Hussain *et al.* (2020) [5], who reported increased branching in chickpea under SA treatment, due to its role in breaking apical dominance and stimulating lateral meristem activity.

Table 2: Influence of sowing dates and salicylic acid on morphological traits of chickpea

Treatments	No. of primary branches plant ⁻¹			No. of secondary branches plant ⁻¹			No. of tertiary branch branches plant ⁻¹	
1 st factor (Sowing dates)								
	30 DAS	60 DAS	At harvest	60 DAS	90 DAS	At harvest	90DAS	At harvest
D ₁ (24 Oct)	4.40	4.95	4.52	6.27	9.32	9.21	6.49	5.31
D ₂ (14 Nov)	5.13	5.42	5.25	7.49	10.18	10.18	5.99	4.32
D ₃ (05 Dec)	3.90	4.47	4.02	5.38	8.27	7.82	4.46	3.16
S.Em.±	0.0917	0.115	0.081	0.148	0.051	0.0558	0.120	0.084
C.D. at 5%	0.265	0.331	0.233	0.427	0.148	0.161	0.348	0.242
2 nd factor (Salicylic acid)								
T ₁ (Control)	3.91	4.60	4.03	5.85	8.43	8.24	3.89	2.94
T ₂ (100 mgL ⁻¹)	4.37	4.88	4.48	6.07	9.17	8.98	5.15	4.17
T ₃ (200 mgL ⁻¹)	4.58	4.91	4.69	6.41	9.24	9.06	5.98	4.33
T ₄ (300 mgL ⁻¹)	4.74	4.93	4.85	6.58	9.50	9.32	6.35	4.83
T ₅ (400 mgL ⁻¹)	4.80	5.42	4.92	7.00	9.94	9.76	6.85	5.04
S.Em.±	0.1183	0.148	0.104	0.191	0.066	0.0720	0.155	0.108
C.D. at 5%	0.342	0.428	0.301	0.551	0.191	0.208	0.449	0.313

3.2 Physiological Traits

The data presented in Table 3 revealed that relative water content (RWC) and chlorophyll content (SPAD values) were significantly influenced by sowing dates and salicylic acid (SA) levels at different growth stages.

3.2.1 Effect of Sowing Dates

Among the sowing dates, early sowing (D₁: 24 October) recorded the highest relative water content at both vegetative (68.13%) and flowering stages (61.03%), which was significantly superior to late sowing (D₃: 05 December), while D₂ (14 November) remained statistically at par with D₁ at certain stages. The lowest RWC was observed under D₃ (63.73% at the vegetative stage and 58.90% at the flowering stage).

Chlorophyll content differed significantly among sowing dates. Mid-November sowing (D₂) recorded the highest chlorophyll content at both vegetative (45.25 SPAD) and flowering stages (46.97 SPAD), followed closely by D₁, whereas the lowest values were recorded under late sowing (D₃: 43.38 and 45.95 SPAD at respective stages).

3.2.2 Effect of Salicylic Acid Levels

Salicylic acid levels significantly influenced both RWC and chlorophyll content. The highest relative water content was recorded under the control (T₁: 67.56% at the vegetative stage and 64.39% at the flowering stage), while RWC decreased slightly with increasing SA concentration, with the lowest values observed under T₅ (65.04% and 58.44% at the vegetative and flowering stages, respectively).

In contrast, chlorophyll content increased significantly with increasing SA concentration. The highest chlorophyll content was recorded under T₅ (400 mg L⁻¹) at both vegetative (46.20 SPAD) and flowering stages (47.73 SPAD), followed by T₄, whereas the lowest values were observed under T₁ (control).

The differences among treatments were statistically significant, as indicated by the CD values at the 5% level. This corresponds with earlier findings of Sinha *et al.* (2018)^[11], who reported that foliar SA enhances radiation use efficiency by increasing photosynthetic pigments and leaf expansion.

Table 3: Influence of sowing dates and salicylic acid on relative water content and chlorophyll content of chickpea

Treatments	Relative water content%		Chlorophyll content (SPAD 502)	
	1 ST Factor (Sowing dates)			
	Vegetative stage	Flowering stage	Vegetative stage	Flowering stage
D ₁ (24 Oct)	68.13	61.03	45.22	46.78
D ₂ (14 Nov)	67.13	60.61	45.25	46.97
D ₃ (05 Dec)	63.73	58.90	43.38	45.95
S.Em.±	0.605	0.400	0.234	0.507
C.D. at 5%	1.749	1.156	0.677	1.464
2 nd Factor (Salicylic acid)				
T ₁ (Control)	67.56	64.39	43.85	45.48
T ₂ (100 mg L ⁻¹)	66.89	59.82	43.76	45.39
T ₃ (200 mg L ⁻¹)	66.20	59.53	44.10	47.23
T ₄ (300 mg L ⁻¹)	65.96	58.72	45.18	47.00
T ₅ (400 mg L ⁻¹)	65.04	58.44	46.20	47.73
S.Em.±	0.782	0.517	0.303	0.654
C.D. at 5%	2.258	1.492	0.874	1.890

3.3 Yield Components

The data presented in Table 4 indicated that chickpea seed yield and yield attributes were significantly influenced by sowing date and salicylic acid (SA) level.

3.3.1 Effect of Sowing Dates

Among the sowing dates, mid-November sowing (D₂: 14 November) recorded significantly higher seed yield both on a plant basis (11.45 g plant⁻¹) and hectare basis (2035.33 kg ha⁻¹), followed by D₁ (24 October), whereas the lowest yield was observed under late sowing (D₃: 05 December) with 7.22 g plant⁻¹ and 1286.67 kg ha⁻¹, respectively.

The number of pods per plant was also significantly higher under D₂ (20.30), followed by D₁ (17.83), while D₃ recorded the lowest value (15.38). However, the number of seeds per pod was not significantly influenced by sowing dates, although numerically higher values were observed under D₁

(1.08), followed by D₂ (1.07), and the lowest under D₃ (1.04).

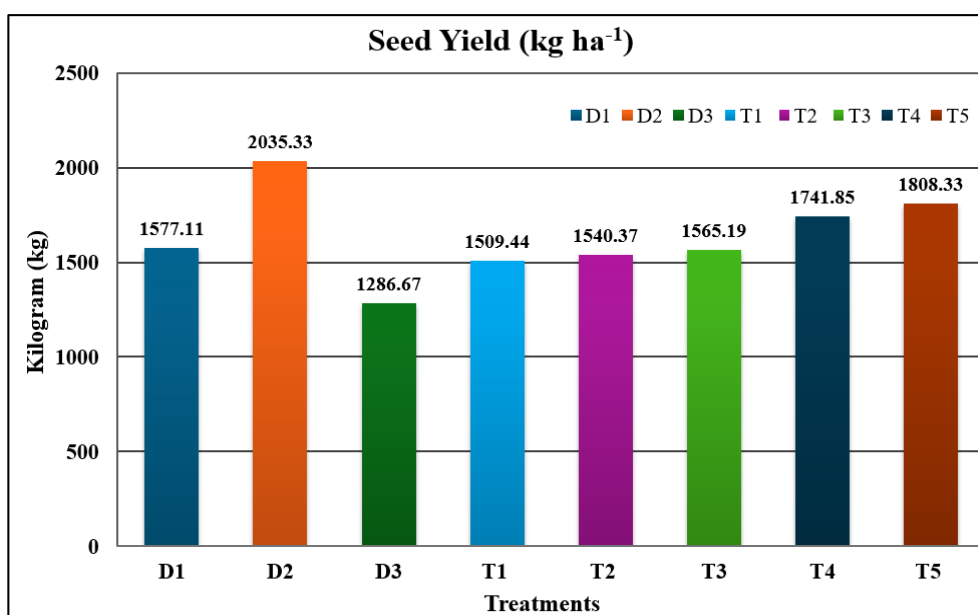
3.3.2 Effect of Salicylic Acid Levels

Salicylic acid application significantly improved seed yield and yield attributes. Among the treatments, T₅ (400 mg L⁻¹) recorded the highest seed yield (10.48 g plant⁻¹ and 1808.33 kg ha⁻¹), followed by T₄ (300 mg L⁻¹), while the lowest yield was observed under control (T₁). Similarly, the number of pods per plant increased with increasing SA concentration, with T₅ recording the maximum value (19.81), followed by T₄ (18.57), whereas the lowest was observed under T₁ (15.87).

The number of seeds per pod was not significantly affected by SA levels, although a slight increasing trend was observed with higher SA concentrations; T₅ recorded the highest value (1.08).

Table 4: Influence of sowing dates and salicylic acid on yield components of chickpea

Treatments	Seed yield (g plant ⁻¹)	Seed yield (kg ha ⁻¹)	No. of seed pods ⁻¹	No. of pods plant ⁻¹
1st Factor (Sowing dates)				
D ₁ (24 Oct)	9.25	1577.11	1.08	17.83
D ₂ (14 Nov)	11.45	2035.33	1.07	20.30
D ₃ (05 Dec)	7.22	1286.67	1.04	15.38
S.E.m.±	0.192	48.40	0.017	0.236
C.D. at 5%	0.555	139.79	0.049	0.682
2nd Factor (Salicylic acid)				
T ₁ (Control)	8.46	1509.44	1.06	15.87
T ₂ (100 mg L ⁻¹)	8.88	1540.37	1.06	16.98
T ₃ (200 mg L ⁻¹)	8.93	1565.19	1.07	17.94
T ₄ (300 mg L ⁻¹)	9.80	1741.85	1.07	18.57
T ₅ (400 mg L ⁻¹)	10.48	1808.33	1.08	19.81
S.E.m.±	0.248	62.49	0.022	0.305
C.D. at 5%	0.716	180.47	0.063	0.880

**Fig 1:** Response of seed yield (kg ha⁻¹) of chickpea to different sowing dates and salicylic acid levels

4. Conclusion

The study demonstrated that sowing date and salicylic acid (SA) application significantly influence chickpea growth, physiology, yield, and quality. Mid-November sowing (14 November) proved optimal, ensuring favourable weather during critical growth stages. Foliar application of SA at 400 mg L⁻¹ enhanced plant water status, chlorophyll stability, and seed quality. The combined treatment D₂T₅ (mid-November sowing + 400 mg L⁻¹ SA) produced the highest yield and seed protein content.

The results clearly indicate that synchronising the optimal sowing time with the appropriate SA concentration improves physiological efficiency and yield attributes of chickpea. Therefore, salicylic acid can be effectively utilised as a low-cost agronomic strategy to enhance chickpea productivity and resilience under central Indian agro-climatic conditions. Further studies under field conditions and across different agro-climatic zones are recommended to validate these findings.

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