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Effect of Hydrogel Application and Foliar Nutrition on Growth, Yield and Economics of Chickpea (*Cicer arietinum* L.)

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Abstract

Chickpea (*Cicer arietinum* L.) is one of the most important pulse crops cultivated in semi-arid regions, where water scarcity and nutrient limitations significantly constrain productivity. Efficient moisture conservation and nutrient management strategies are essential for improving crop performance. A field experiment was conducted to evaluate the response of hydrogel application and foliar nutrition on growth, yield attributes, yield, and economic returns of chickpea. The treatments consisted of three hydrogel levels (0, 1.5, and 3.0 kg ha^{-1}) and four foliar nutrition treatments (water spray, urea 2.5%, thiourea 500 ppm, and salicylic acid 100 ppm). Results revealed that hydrogel application significantly improved dry matter accumulation, branching, pod formation, seed index, and yield parameters. The highest seed yield (1734 kg ha^{-1}) and net returns (Rs. 80,171 ha^{-1}) were recorded with hydrogel application at 3.0 kg ha^{-1}. Among foliar treatments, urea (2.5%) spray resulted in maximum seed yield (1757 kg ha^{-1}), protein content (23.75%), and benefit-cost ratio (3.27). Interaction effects were non-significant. The study concludes that combined application of hydrogel and foliar nutrition enhances chickpea productivity and profitability under moisture-limited conditions.

Keywords: Hydrogel; Foliar nutrition; Urea spray; Thiourea; Salicylic acid; Seed yield; Protein content; Water stress management; Benefit-cost ratio

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Introduction

Chickpea (*Cicer arietinum* L.) is a major pulse crop contributing significantly to global food security and nutritional sustainability. It is rich in protein (20–25%), carbohydrates, and essential micronutrients, making it a vital component of diets, especially in developing countries such as India. India accounts for nearly 65–70% of global chickpea production [6]. Despite its importance, chickpea productivity remains relatively low, particularly in rainfed areas where moisture stress during critical growth stages limits yield potential. Climate variability, erratic rainfall, and declining soil fertility further exacerbate these challenges [4].

Water availability plays a critical role in chickpea growth, particularly during flowering and pod formation stages. Soil moisture stress reduces photosynthesis, nodulation, and assimilates translocation, ultimately affecting yield [2]. Therefore, strategies aimed at improving soil moisture retention are crucial. Hydrogels are superabsorbent polymers capable of retaining large amounts of water and releasing it gradually to plants. Their application in agriculture has gained attention due to their ability to enhance soil water-holding capacity, reduce irrigation frequency, and improve crop growth under drought conditions [3]. Hydrogels also improve soil structure and microbial activity.

In addition to soil moisture management, foliar nutrition is an effective approach to supplement plant nutrient requirements during critical growth stages. Foliar application ensures rapid nutrient uptake and can correct deficiencies more efficiently than soil application [1]. Urea, thiourea, and salicylic acid are commonly used foliar sprays known to enhance physiological processes such as photosynthesis, enzyme activity, and stress tolerance. Thiourea acts as a stress mitigator by improving antioxidant activity and nitrogen metabolism, while salicylic acid enhances plant defense mechanisms and growth regulation [5]. Foliar application of nitrogen, particularly urea, improves chlorophyll content and protein synthesis, leading to higher yield. Although several studies have investigated the individual effects of hydrogel and foliar nutrition, limited research exists on their combined impact on chickpea growth and productivity. Therefore, the present study was undertaken to evaluate the effect of hydrogel application and foliar nutrition on growth parameters, yield attributes, yield, and economics of chickpea.

Materials and Methods

Experimental Site

The field experiment was conducted during the rabi season of 2025–26 at the Research Farm of Vivekananda Global University, Jaipur, Rajasthan (26°55′ N latitude and 75°46′ E longitude). The region has a semi-arid climate with an average annual rainfall of about 557 mm, mostly received during July to September. The experimental soil was loamy in texture, slightly alkaline (pH 8.10), low in organic carbon (0.30%), and low to medium in available nitrogen (134.8 kg ha^{-1}), phosphorus (18.3 kg ha^{-1}), and potassium (252.12 kg ha^{-1}).

Experimental Design and Treatments

The experiment was laid out in a factorial randomized block design (FRBD) with three replications.

Factor A: Hydrogel Application

- H_0: No hydrogel application
- H_1: Hydrogel @ 1.5 kg ha^{-1}
- H_2: Hydrogel @ 3.0 kg ha^{-1}

Factor B: Foliar Nutrition

- F_1: Water spray (control)
- F_2: Urea (2.5%)
- F_3: Thiourea (500 ppm)
- F_4: Salicylic acid (100 ppm)

The hydrogel applied was a super absorbent polymer (SAP)-based agricultural hydrogel obtained from a commercial agricultural input source. It was incorporated into the soil at the time of sowing at the rates of 1.5 and 3.0 kg ha^{-1} as per treatment details.

Crop Management

The experiment was conducted during the rabi season of 2025–26 at the Research Farm of Vivekananda Global University, Jaipur under semi-arid conditions. The experimental soil was loamy in texture, slightly alkaline in reaction (pH 8.10), low in organic carbon (0.30%), and low to medium in available nitrogen, phosphorus, and potassium status. The chickpea crop was sown using recommended agronomic practices and spacing under a Factorial Randomized Block Design with three replications. Hydrogel was applied at sowing and incorporated into the soil according to treatment specifications. Foliar spray treatments consisting of water spray, urea (2.5%), thiourea (500 ppm), and salicylic acid (100 ppm) were applied at critical crop growth stages using a knapsack sprayer.

Observations Recorded

Growth parameters

- Plant population (30 DAS and harvest)
- Dry matter accumulation (40 DAS, 60 DAS, harvest)
- Primary and secondary branches per plant

Yield attributes

- Number of pods per plant
- Number of seeds per pod
- Seed index (g)

Yield and economics

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

- Straw yield (kg ha^{-1})
- Biological yield (kg ha^{-1})
- Harvest index (%)
- Protein content (%)
- Net returns (Rs. ha^{-1})
- Benefit-cost ratio

Statistical Analysis

Data were analyzed using ANOVA at 5% significance level. Standard error of mean (SEm) and critical difference (CD) were calculated.

Results and Discussion

Effect of Hydrogel on Growth Parameters

Hydrogel application significantly influenced growth parameters except plant population. The highest dry matter accumulation was recorded with hydrogel @ 3.0 kg ha^{-1} (21.39 g at 60 DAS), which was statistically superior to control. Increased dry matter accumulation may be attributed to improved soil moisture availability due to hydrogel's water retention capacity. Primary and secondary branches were also significantly enhanced with hydrogel application. The maximum number of secondary branches (11.24) was observed under H_2 treatment. Improved branching is likely due to sustained water supply during vegetative growth stages, promoting cell division and elongation. These findings align with [3], who reported improved plant growth with hydrogel application due to enhanced water availability.

Effect on Yield Attributes

Hydrogel application significantly increased number of pods per plant, seeds per pod, and seed index. The highest number of pods per plant (42.59) and seed index (27.74 g) were recorded under H_2 treatment. Improved reproductive development under hydrogel treatments can be attributed to reduced moisture stress during flowering and pod formation stages. Adequate moisture ensures better pollination, fertilization, and seed development.

Effect on Yield

Seed yield increased significantly with hydrogel application. The highest seed yield (1734 kg ha^{-1}) was recorded under H_2, representing a substantial increase over control (1613 kg ha^{-1}). Straw and biological yields followed a similar trend. Improved yield under hydrogel application may be due to enhanced nutrient uptake, better photosynthesis, and reduced stress conditions. Protein content was also significantly higher (23.43%) under H_2, indicating improved nitrogen assimilation.

Effect on Economics

Hydrogel application significantly improved net returns and B:C ratio. Maximum net returns (Rs. 80,171 ha^{-1}) and B:C ratio (2.93) were recorded with H_2 treatment. This indicates that hydrogel application is economically viable despite its initial cost.

Effect of Foliar Nutrition on Growth

Foliar application significantly improved growth parameters. Urea (2.5%) spray resulted in highest dry matter accumulation and branching. The rapid absorption of nitrogen through foliar application enhances chlorophyll synthesis and photosynthetic activity, leading to better growth [1].

Effect on Yield Attributes

Foliar application of urea significantly increased number of pods (42.98), seeds per pod (1.58), and seed index (27.97 g). Thiourea and salicylic acid also improved these parameters compared to control. Thiourea enhances stress tolerance and enzyme activity, while salicylic acid regulates plant growth and defense mechanisms [5].

Effect on Yield

The highest seed yield (1757 kg ha^{-1}) was recorded with foliar application of urea, followed by thiourea (1732 kg ha^{-1}).

Increased yield may be due to improved nitrogen availability during reproductive stages. Protein content was also highest under urea treatment (23.75%), indicating enhanced nitrogen metabolism.

Effect on Economics

Foliar application of urea resulted in maximum net returns (Rs. 81,156 ha⁻¹) and B:C ratio (3.27), making it the most profitable treatment.

Interaction Effects

The interaction between hydrogel and foliar nutrition was non-significant for all parameters. This suggests that both factors independently contributed to growth and yield improvement.

Table 1 Response of foliar nutrition and hydrogel application on number of pods, seed and seed index of chickpea

Treatment	**Plant population (Number/ m^{-2})**		**Dry matter accumulation (g m^{-2})**			**Primary branches / plant**	**Secondary branches / plant**	**Number of pod/ plant**	**Number of seed/ pod**	**Seed index (g)**
	30 DAS	**At harvest stage**	**40 DAS**	**60 DAS**	**At harvest stage**					
A. Hydrogel application (H)										
H_0- No hydrogel application	32.59	31.82	5.58	15.01	19.32	5.78	9.45	40.13	1.44	26.6
H_1 - Hydrogel applied at 1.5 kg ha⁻¹	33.17	32.4	6.42	16.24	20.69	6.38	10.77	42.09	1.52	27.38
H_2 - Hydrogel applied at 3.0 kg ha⁻¹	33.34	32.58	6.8	16.85	21.39	6.6	11.24	42.59	1.56	27.74
SEm±	0.64	0.98	0.09	0.12	0.23	0.02	0.05	0.22	0.01	0.18
CD @5%	NS	NS	0.35	0.49	0.91	0.07	0.19	0.85	0.04	0.71
B. Foliar nutrition (F)										
F_1- Water spray	31.76	30.87	5.18	14.41	18.7	5.48	8.69	39.11	1.37	25.86
F_2- Foliar application of urea (2.5%)	33.6	32.9	6.93	16.98	21.7	6.72	11.56	42.98	1.58	27.97
F_3- Foliar application of thiourea (500 ppm)	33.49	32.79	6.65	16.73	21.11	6.55	11.19	42.54	1.55	27.71
F_4- Foliar application of salicylic acid (100 ppm)	33.28	32.49	6.3	16.01	20.35	6.26	10.51	41.78	1.53	27.41
SEm±	0.80	0.70	0.06	0.13	0.14	0.04	0.08	0.33	0.02	0.18
CD @5%	NS	NS	0.18	0.39	0.41	0.12	0.25	0.97	0.05	0.54
Interaction H×F	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2 Response of foliar nutrition and hydrogel application on yields, net returns and B:C ratio of chickpea

Treatment	Seed yield (kg/ ha)	Straw yield (kg/ ha)	Biological yield (kg/ ha)	Harvest index (%)	Protein content in seed (%)	Net returns (Rs./ ha)	B: C ratio
A. Hydrogel application (H)							
H_0- No hydrogel application	1613	2506	4095	39.39	21.77	61539	2.64
H_1 - Hydrogel applied at 1.5 kg ha^{-1}	1696	2600	4271	0.40	22.85	68937	2.72
H_2 - Hydrogel applied at 3.0 kg ha^{-1}	1734	2650	4360	0.40	23.43	80171	2.93
SEm±	13.29	12.71	22.61	0.16	0.12	563.72	0.02
CD @5%	52.18	49.90	88.75	NS	0.47	2213.11	0.09
B. Foliar nutrition (F)							
F_1- Water spray	1555	2437	3968	0.39	21.06	55656	2.27
F_2- Foliar application of urea (2.5%)	1757	2679	4412	0.40	23.75	81156	3.27
F_3- Foliar application of thiourea (500 ppm)	1732	2645	4353	0.40	23.35	77182	2.83
F_4- Foliar application of salicylic acid (100 ppm)	1679	2580	4235.00	0.40	22.57	66870	2.70
SEm±	16.44	15.95	24.01	0.26	0.22	436.23	0.03
CD @5%	48.83	47.38	71.32	NS	0.65	1295.91	0.08
Interaction H×F	NS	NS	NS	NS	NS	NS	NS

Conclusion

The study demonstrates that hydrogel application and foliar nutrition significantly improve growth, yield attributes, yield, and economic returns of chickpea.

Hydrogel application at 3.0 kg ha^{-1} proved most effective in enhancing moisture availability, resulting in higher yield and profitability. Foliar application of urea (2.5%) was the best treatment among foliar nutrition options. Thus, the combined use of hydrogel and foliar nutrition can be recommended as a sustainable strategy for improving chickpea productivity under moisture-limited conditions.

References

[1] Fernández, V., Sotiropoulos, T., & Brown, P. (2015). Foliar Fertilization: Scientific Principles and Field Practices. International Fertilizer Industry Association.

[2] Farooq, M., Hussain, M., & Siddique, K.H.M. (2017). Drought stress in chickpea during reproductive phase. Agronomy Journal, 109(3), 1–10.

[3] Islam, M.R., Hu, Y., Mao, S., Mao, J., & Eneji, A.E. (2019). Effect of hydrogel on soil moisture retention and crop productivity. Agricultural Water Management, 223, 105713.

[4] Kumar, S., Singh, R., & Singh, G.P. (2020). Climate resilience in pulse crops. Indian Journal of Agronomy, 65(2), 123–130.

[5] Khan, M.I.R., Fatma, M., Per, T.S., Anjum, N.A., & Khan, N.A. (2015). Salicylic acid-induced abiotic stress tolerance. Environmental and Experimental Botany, 114, 1–12.

[6] FAOSTAT (2022). Food and Agriculture Organization Database.

[7] Meena, R.S., et al. (2017). Integrated nutrient management in legumes. Legume Research, 40(2), 234–242.
[8] Singh, A., & Singh, B. (2018). Role of thiourea in crop productivity. Journal of Plant Stress Physiology, 4(1), 12–18.
[9] Yadav, M.R., et al. (2018). Enhancing pulse productivity under stress. Field Crops Research, 226, 36–44.
[10] Jat, M.L., et al. (2019). Climate-smart agriculture practices. Agricultural Systems, 172, 1–10.
[11] Gupta, V., & Sharma, R. (2021). Soil moisture conservation using hydrogels. Soil Use and Management, 37(3), 567–576.
[12] Singh, V.K., et al. (2020). Foliar nutrition in pulses. Journal of Plant Nutrition, 43(5), 712–725.

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