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Response of Foliar Nutrition and Hydrogel application on Growth, Yield and yield attributes of desi Chickpea (*Cicer arietinum* L.)

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Abstract

The research was conducted to check response of foliar nutrition and hydrogel application in chickpea during Rabi, 2023-24 at Research farm, Vivekananda Global University, Jaipur, Rajasthan. The experiment was designed in a split plot design with consisting two plots with 3 replications. Main consists three levels of hydrogel application viz., H_0-0kg/ha, H_1-2.5kg/ha, H_2-5kg/ha. Similarly, in sub plot consists four levels of foliar nutrition viz., F_0-Water spray, F_1-Urea 2%, F_2-Thiourea 400 ppm and F_3-Salysalic acid 50 ppm. The results showed hydrogel application at 5 kg/ha (H_2) significantly increased plant height and dry matter accumulation compared to lower concentrations and controls. Foliar application of Urea 2% demonstrated superior performance in enhancing plant height and dry matter accumulation over other foliar nutrition treatments. Numbers of pods per plant and seeds per pod, seed yield, straw yield, biological yield were significantly increased with the application of H_2-5kg/ha and Urea 2% foliar nutrition. Maximum net returns and B: C ratio was achieved with H_2-5kg/ha and Urea 2% foliar nutrition treatment, indicating their economic viability and profitability over other treatments. The combination of hydrogel application at 5 kg/ha and foliar nutrition with Urea 2% emerged as the optimal treatment regime for enhancing growth, yield, quality, and economic returns of desi Chickpea cultivation under the study's conditions.

Keywords: hydrogel, nutrition and seed yield

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Introduction

Among pulses, chickpea is member of the subfamily Faboideae of the family Fabaceae, thought to have been first grown in Mesopotamia up to 7,500 years ago, chickpeas are considered one of the earliest cultivated vegetables on Earth. It is also an important source of protein for the poor in semi-arid tropical areas which is also being used as an alternative to animal proteins. It is also a good source of calcium, iron and niacin. India is the leading producer in the world, approximately thirty percent of the nation's average and forty percent of its total pulse production. The second most often grown grain legume crop among smallholder farmers worldwide in semi-arid areas is chickpea. In semi-arid locations, it is often produced as a dry climate crop or as a cool-weather crop that is nourished by rain. India's agriculture and economy heavily rely on rain-fed agriculture. The stress trap of wasteful irrigation and rainfall preventing plant stress from drought and enhancing soil water conservation through suitable strategies are crucial in situations when plants are rainfed. For an improved production in rain fed condition, a larger percentage of the water must be stored in soil and the stored water must be used more efficiently to exploit its full potential.

Nutrient foliar application has been demonstrated to be a valuable tool for applying fertiliser with the particular goal of boosting nutrient availability when needed. While thiourea, a sulphydryl chemical, plays a vital role in optimising dry matter distribution for seed production [1], urea applied foliarly has been demonstrated to be efficient in boosting the nitrogen availability to developing seeds in pulses [2]. Thiourea lowers the activity of nitrate reductase and aids in the improved translocation of photosynthates from source to sink. Thus far, its primary application has been in promoting seed germination and breaking dormancy, as it has 36% nitrogen and 42% sulphur. Hydrogel is a type of cross-linked polymer that has the ability to absorb water by forming hydrogen bonds with water molecules. 400 times its dry mass of water is absorbed, and then gradually released [3]. This reduces the crop's need for irrigation under such circumstances. Before seeding, the hydrogel is drilled into the soil. It is thought that the hydrogel holds a

lot of water and nutrients, which are released when the plant needs them. It's also possible that a restricted supply of water and nutrients might enhance plant development.

Material and Methods

There are 12 treatments combinations were laid out in Split Plot Design and Treatments details of experiment are presented in **Table 1**.

Table 1 Treatments details of the experiment

Treatments		Symbols
Main Plot-Hydrogel application		
1 : 0 kg/ha	:	H_0
2 : 2.5 kg/ha	:	H_1
3 : 5kg/ha	:	H_2
Sub-Plot-Foliar nutrition		
1. Water spray	:	F_1
2. Urea 2 %	:	F_2
3. Thiourea 400 ppm	:	F_3
4. Salicylic acid 50 ppm		F_4

The measured dose of foliar application of nutrients per hectare of urea 2% (10 kg /500lit.), thiourea 400 ppm (200 gm /500 lit.), salicylic acid 50 ppm (25 gm /500 lit.) dissolved in water than sprayed at flower initiation and pod development stages as per the requirement of treatments. The foliar spray of nutrients was done by knapsack sprayer having capacity of 15 litre**.** Hydrogel was drilled in soil before chickpea sowing in earmarked strips. The crop was sown manually at depth of 4-5 cm with a uniform spacing of 30 × 10 cm. The seed rate of 80 kg ha-1 was used. The crop was irrigated after sowing to provide desired moisture condition for seed germination. The data collected from the experiment were subjected to statistical analysis by the procedure of Split Plot Design as suggested by [4]. The standard error of mean was calculated and critical difference (C.D. at 5%) was worked out for comparing the treatment means, wherever "f" test was found significant. The analyses of variances have been given in the appendixes.

Result and Discussion

Effect of hydrogel and foliar nutrition on growth parameters

Vegetative growth of a plant is affected by physiological and metabolic processes in plants which are modified by environmental conditions, cultural practices and management. The analysis of treatments in terms of plant growth parameters revealed that all the treatments affected the plant population, plant height, number of primary and secondary branches per plant and dry matter accumulation (**Table 2**). The results showed that application of hydrogel with 5 kg ha^{-1} had positive effect on plant growth parameters as compared to no hydrogel application at various stages of chickpea. The plant height was significantly affected by hydrogel application and recorded maximum plant height in H_2-5kg/ha (43.85 cm) over H_0-control (41.28 cm) at harvest stage (Table 2). The maximum plant height i.e., 34.66, 44.30 and 44.28 at 60, 90 DAS and harvest stage, respectively was observed with the application of Urea @ 2 %. The dry matter accumulation of chickpea was significantly influenced by hydrogel application and maximum was observed with the application of H_2-5kg/ha i.e., 6.92, 16.97 and 21.51 g per m^2 at 40, 60 DAS and at harvest stage, respectively (Table 2). Application of various nutrients influenced significantly of dry matter accumulation of chickpea at 40, 60 DAS and harvest stage. Application of hydrogel 5.0 kg ha^{-1} recorded maximum and significantly tallest plant, number of primary and secondary branches per plants, dry matter accumulation per plant at various growth stages over control. This might be due to hydrogel increases efficient water consumption, decreasing irrigation costs and increasing irrigation intervals. Hydrogel creates a buffered environment being effectiveness in short term drought tension and losses reduction in early establishment phase in the chickpea plant. Hence, super absorbent polymers (hydrogel) cause improvement in plant growth by increasing water holding capacity in soils [5]. Therefore, totally proficiency in water consumption and dry matter production are positive plant reactions by the super absorbent application [6]. Similar result was found [7, 8] reported that growth parameters *viz*., plant height, number of branches, number of pod $plant^{-1}$ and dry matter of chickpea were significantly improved at vegetative stage.

Table 2 Response of foliar nutrition and hydrogel application on number of plant population, plant height, dry matter accumulation and branches / plant of desi chickpea

Treatment	Plant population (Number/ m^{-2})		Plant height (cm)			Dry matter accumulation (g m-2)			Branches / plant	
	30 DAS	At harvest stage	60 DAS	90 DAS	At harvest stage	40 DAS	60 DAS	At harvest stage	Primary branches / plant	Secondary branches / plant
A. Hydrogel application (H)										
H_0 - 0 kg/ha	33.61	32.84	32.36	41.29	41.28	5.70	15.13	19.44	4.64	8.31
H_1 - 2.5 kg/ha	34.19	33.42	33.73	43.13	43.14	6.54	16.36	20.81	5.24	9.63
H_2 - 5kg/ha	34.36	33.60	34.35	43.83	43.85	6.92	16.97	21.51	5.46	10.10
SEm±	0.64	0.98	0.13	0.09	0.26	0.09	0.12	0.23	0.02	0.05
CD @5%	NS	NS	0.50	0.36	1.04	0.35	0.49	0.91	0.07	0.19
B. Foliar nutrition (F)										
F_1- Water spray	32.78	31.89	31.44	40.07	40.12	5.30	14.53	18.82	4.34	7.55
F_2- Urea 2 %	34.62	33.92	34.66	44.30	44.28	7.05	17.10	21.82	5.58	10.42
F_3- Thiourea 400 ppm	34.51	33.81	34.28	43.78	43.79	6.77	16.85	21.23	5.41	10.05
F_4- Salicylic acid 50 ppm	34.30	33.51	33.55	42.85	42.83	6.42	16.13	20.47	5.12	9.37
SEm±	0.80	0.70	0.30	0.30	0.42	0.06	0.13	0.14	0.04	0.08
CD @5%	NS	NS	0.88	0.89	1.26	0.18	0.39	0.41	0.12	0.25
Interaction H×F	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Effect of hydrogel and foliar nutrition on yield and yield attributing parameters

The yield attributing parameters like pod per plant, seed per plant and seed index were increased significantly under different foliar treatments at various crop growth stages and hydrogel treatment. The hydrogel application concentrations obtained significantly maximum number of pod per plant of chick pea and maximum was observed with the application of H_2-5Kg/ha (40.58) and minimum in control H_0-0kg/ha (38.12) (**Table 3**). The maximum number of pod per plant (40.97) was observed in Urea 2 % and it was followed by Thiourea 400 ppm (40.53). The maximum number of seed per pod was observed with the application of H_2-5Kg/ha (1.58) and minimum in control H_0-0kg/ha (1.46). The maximum number of seed per pod (1.60) was observed in Urea 2 % and it was followed by Thiourea 400 ppm (1.57). The effect of hydrogel application and foliar nutrition were non-significant on harvest index of chickpea (Table 3). 5 kg ha^{-1} hydrogel found superior on yield attributing parameters over no hydrogel. Values of pod per plant and seed per plant were recorded higher under 5 kg ha^{-1} hydrogel application as compared to 0 kg ha^{-1} hydrogel application (H_0) (Table 3). As concerned to effect of foliar application of nutrients at the time of flower initiation and pod development stages of plant on number of pods and grain $plant^{-1}$ of chickpea exhibited a greater number of pods and seed per plant compared to water spray or control. Results indicated that there was significant difference among the foliar treatments with respect to yield attributes. Urea 2 % (F_2) sprays recorded significantly a greater number of pod per plant and seed per pod followed by Thiourea 400 ppm. Foliar spray of nutrients is the fastest way to boost up crop growth and yield parameters because nutrients are available to plants in critical stages and the nutrients will reach the site of food synthesis directly leading reduce the requirement of fertilizers. The maximum seed yield (1733 kg/ha) was observed in Urea 2 % and it was followed by Thiourea 400 ppm (1708 kg/ha). The hydrogel concentration, straw yield obtained significantly maximum with the application of H_2-5kg/ha (2626 kg ha^{-1}) of chick pea and minimum was noted in H_0-0 kg/ha (2482 kg ha^{-1}) (Table 3). The maximum straw yield (2655 kg ha^{-1}) was observed with the application of Urea 2% and it was followed by Thiourea 400 ppm (2621 kg ha^{-1}). [9] super absorbent polymer (hydrogel) application was caused to increase at pod number in plant compared to control in chickpea. Urea 2% (F_2) spray stood out as the single best treatment recording significantly higher value of seed pod^{-1} compared to all other treatments respectively. This might be mainly ascribed to significant improvement of productive pods per plant. These regulators increase the photosynthetic activities of plants, which in turn increase the active leaf

surface during the grain filling period [10], facilitating the best partitioning of the source and sink and creating the congenial atmosphere in plants for enhancing the yield [11].

Table 3 Response of foliar nutrition and hydrogel application on yield and yield attributes of desi chickpea

Treatment	Number of pod/ plant	Number of seed/ pod	Seed index (g)	Seed yield (kg/ ha)	Straw yield (kg/ha)	Biological yield (kg/ ha)	Harvest index (%)
A. Hydrogel application (H)							
H_0 - 0 kg/ha	38.12	1.46	24.59	1589	2482	4071	39.02
H_1 - 2.5 kg/ha	40.08	1.54	25.37	1672	2576	4247	39.35
H_2 - 5kg/ha	40.58	1.58	25.73	1710	2626	4336	39.43
SEm±	0.22	0.01	0.18	13.29	12.71	22.61	0.16
CD @5%	0.85	0.04	0.71	52.18	49.90	88.75	NS
B. Foliar nutrition (F)							
F_1- Water spray	37.10	1.39	23.85	1531	2413	3944	38.81
F_2- Urea 2 %	40.97	1.60	25.96	1733	2655	4388	39.49
F_3- Thiourea 400 ppm	40.53	1.57	25.70	1708	2621	4329	39.45
F_4- Salicylic acid 50 ppm	39.77	1.53	25.40	1655	2556	4211	39.30
SEm±	0.33	0.02	0.18	16.44	15.95	24.01	0.26
CD @5%	0.97	0.05	0.54	48.83	47.38	71.32	NS
Interaction H×F	NS	NS	NS	NS	NS	NS	NS

Effect on economic analysis

The higher cost of cultivation was recorded with the application of 5 hydrogel kg ha^{-1} owing to the higher cost of hydrogel and foliar application of Urea. The highest net returns were recorded with the foliar spray of 2% Urea (Rs. 81156 ha^{-1}) and B: C ratio (3.27) over water spray/control (Rs. 55656 ha^{-1}) (2.27) (**Table 4**). The increase in returns is the result of the higher yield with respective treatment, and the spray of Urea @ 2% improved nutrient supply to the leaf by foliar absorption, which might have delayed the senescence of leaves and allowed greater assimilation and carbon remobilization to the vegetative and economic plant parts, which improved the production of a greater number of pods, ultimately increasing yield and net return [12, 10, 8].

Table 4 Response of foliar nutrition and hydrogel application on net returns and B: C ratio of desi chickpea.

Treatment	Net returns (Rs./ ha)	B: C ratio
A. Hydrogel application (H)		
H_0 - 0 kg/ha	61539	2.64
H_1 - 2.5 kg/ha	68937	2.72
H_2 - 5kg/ha	80171	2.93
SEm±	563.72	0.02
CD @5%	2213.11	0.09
B. Foliar nutrition (F)		
F_1- Water spray	55656	2.27
F_2- Urea 2 %	81156	3.27
F_3- Thiourea 400 ppm	77182	2.83
F_4- Salicylic acid 50 ppm	66870	2.70
SEm±	436.23	0.03
CD @5%	1295.91	0.08
Interaction H×F	NS	NS

Conclusion

Hydrogel application at 5 kg/ha (H_2) significantly increased plant height and dry matter accumulation compared to lower concentrations and controls. Foliar application of Urea 2% demonstrated superior performance in enhancing plant height and dry matter accumulation over other foliar nutrition treatments. Numbers of pods per plant and seeds

per pod, see yield, straw yield and biological yield were significantly increase with the application of H_2-5kg/ha and Urea 2% foliar nutrition. Maximum net return and B: C ratio were achieved with H_2-5kg/ha and Urea 2% foliar nutrition treatment indicating their economic viability and profitability over other treatments.

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