Influence of different hydrogel levels and irrigation scheduling on Leaf Protein content of Chickpea (*Cicer arietinum* L.)

Abstract

The present research focuses on optimizing the water use efficiency and enhancing crop quality in chickpea cultivation. Hydrogels, known for their water retention capabilities, can potentially mitigate the effects of water stress in arid and semi-arid regions by maintaining soil moisture levels. When combined with precise irrigation scheduling, the application of hydrogels may not only improve the growth and yield of chickpeas but also enhance their leaf protein content, a crucial nutritional parameter. The field experiment was conducted during the Rabi seasons of 2019-20 and 2021-22 at the Department of Biological Sciences, Sam Higginbottom Institute of Agriculture, Technology and Sciences, U.P. which is characterized by a semi-arid climate. The experiment utilized a randomized block design with combinations of four levels of hydrogel and two levels of irrigation across 11 treatments, each replicated three times. Protein content in chickpea leaves was estimated using Bradford's method, which is based on the binding of proteins to Coomassie Brilliant Blue G-250. Results indicated that different levels of hydrogel application had a non-significant effect on the protein content of chickpea during both years. The highest protein content of protein content of 1.03, 1.07 and 1.05 was recorded in the treatment combination T_{10} during cropping year 2020, 2021 and in pooled respectively followed by treatment combination T_9 and recorded protein content as 1.02, 1.02and 1.02 in both the years of investigation as well as in pooled respectively.

KEY WORD: chickpea, pulse crop, fertilizer, health benefits, digestive diseases

Introduction

"In India, pulses are a significant source of protein for vegetarians and serve to supplement the diet's main cereals with proteins, vital amino acids, vitamins, and minerals" (Pingoliya *et al.*, 2013, Venkidasamy *et. al*., 2019). "They provide 22 to 24% protein, which is roughly twice as much as wheat and three times as much as rice" (Shukla *et al.*, 2013). "It is a readily available source of protein in the village, which is India's rural core. According to the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), chickpea leaf typically contain 5% fat, 6% crude fibre, 3% ash, and 21.1% protein out of their total 64%

carbs (47% starch, 6% soluble sugar). Phosphorus (340 mg per 100 g), calcium (190 mg), magnesium (140 mg), iron (7 mg), and zinc (3 mg) have all been observed to have high mineral content. For a sustainable production system to function, balanced fertilizer application in a roping system is essential, as is proper soil nutrient flexibility. he second-most significant legume crop consumed globally is the chickpea (Cicer arietinum L.), particularly in North Africa, South-East Asia, the Middle East, southern Europe, America, and Australia" (Iqbal *et al.*, 2006) Globally). "It is one of the most widely grown pulses in terms of global output, with 14.2 million t of total production and an average yield of 0.96 t ha^{-1}" (FAOSTAT, 2016). "In the human diet, chickpea has long been regarded as a significant source of proteins, carbs, minerals, vitamins, and health-promoting fatty acids" (Jukanti *et al*., 2012, Mhadhbi *et al*., 2004). "It is crucial for low-income customers worldwide and in developing nations where big populations have limited access to food of animal origin since it provides a less expensive source of protein" (Ramalho and Portugal, 1990). "Chickpea has significant amounts of all the essential amino acids except sulfur containing types, which can be complemented by adding cereals to daily diet. Starch is the major storage carbohydrate followed by dietary fibre, oligosaccharides and simple sugars like glucose and sucrose. Lipids are present in low amounts but chickpea is rich in nutritionally important unsaturated fatty acids like linoleic and oleic acid. β-sitosterol, campesterol and stigmasterol are important sterols present in chickpea oil. Calcium, magnesium, phosphorus and especially potassium are also present in chickpea leaf. Chickpea is a good source of important vitamins such as riboflavin, niacin, thiamin, folate and the vitamin A precursor, β-carotene. Like other pulses, chickpea leafs also contain anti-nutritional factors which can be reduced or eliminated by different cooking techniques. Chickpea has several potential health benefits and, in combination with other pulses and cereals, it could have beneficial effects on some of the important human diseases like cardiovascular disease, type-2 diabetes, digestive diseases and some cancers. Overall, chickpea is an important pulse crop with a diverse array of potential nutritional and health benefits. The research have significant due to its focus on optimizing water use efficiency and enhancing crop quality in chickpea cultivation. Hydrogels, known for their water retention capabilities, can potentially mitigate the effects of water stress in arid and semi-arid regions by maintaining soil moisture levels. When combined with precise irrigation scheduling, the application of hydrogels may not only improve the growth and yield of chickpeas but also enhance their protein content, a crucial nutritional parameter. Understanding the interaction between hydrogel application and irrigation practices could provide valuable insights into sustainable agricultural practices, leading to better resource management and improved food security. This research holds the promise of contributing to the development of climate-resilient crop production strategies that address the challenges posed by water scarcity and the growing demand for high-protein crops. “One of such successfully developed product is ‘Pusa hydrogel' which is first indigenous semi-synthetic superabsorbent technology for conserving water and enhancing crop productivity and thereby increases the water use efficiency. It performs its wetting or drying cycles over a longer period of time, maintaining its very high water swelling and releasing capacity against soil pressure. Consequently evaporation, deep water percolation and nutrient leaching can be avoided. Under rainfed condition, crops can better withstand drought condition without moisture stress by using hydrogel” [16]. Systematic field studies under arid and semi-arid conditions of India are needed to develop appropriate dose, frequency and method of application of different polymers to various crops and to assess economics of use of different polymers (Ashraf et al 2021).

Material and methods:

The field experiment of present investigation was conducted during *Rabi* 2019-2020 and 2021-2022 under Department of Biological Sciences, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad (U.P). The climate of the experimental site is characterised by semi-arid type with hot and dry summer from April to June, hot and humid from July to September and cold winter from November to January. The experiment was conducted by the randomised block design with combinations of four level of hydrogel (2.5 kg /ha as 100% dose) and two level of irrigation i.e. T_0 (3 irrigation),T_1(1 irrigatin) T_2(1 irrigation + 25% hydrogel) T_3 (1 irrigation + 50% hydrogel) , T_4 (1 irrigation + 75% hydrogel), T_5 (1 irrigation + 100% hydrogel), T_6 (2 irrigatin) T_7 (2 irrigation + 25% hydrogel), T_8 (2 irrigation + 50% hydrogel), T_9 (2 irrigation + 75% hydrogel), T_{10} (2 irrigation + 100% hydrogel) are replicated thrice. The PUSA-362 variety of Chickpea, introduced by IARI was used for present experiment. The research aimed to assess how various hydrogel laden soil systems, under conditions of water deficit, influenced the growth and yield of chickpea crops. By conducting the experiment over two consecutive Rabi seasons, the researchers aimed to obtain comprehensive insights into the effects of hydrogel soil systems on chickpea cultivation, particularly under water deficit conditions. The hydrogel was applied as basal application before sowing of crop in different treatments as 25%, 50%, 75% and 100%.

Determination of Total Protein

Protein was estimated from Leaves using Bradford's method (Bradford method). The assay is based on the ability of proteins to bind coomassie brilliant blue G 250 and from a complex whose extinction coefficient is much greater than that of the free dye.

Materials / Reagents Preparation

Reagents A

Dye concentrate dissolve 100 mg of coomassie brilliant blue G 250 in 50 ml of 95% ethanol. Add 100 ml of conc. ortho phosphoric acid. Add distilled water to a final volume of 200 ml. store refrigerated in amber bottles; mix 1 volume of concentrated dye solution with 4 volumes of distilled water for use. Filter with whatman No. 1 paper if any precipitate occurs.

Reagents B

Phosphate-buffered saline (PBS)

Procedure

Prepare a series of protein samples in test tubes in the concentration. This is preferably prepared in PBS. Prepare the experimental samples (a few dilutions) in 100 µl of PBS. Add 5ml of diluted dye binding solution to each tube. Mix well and allow the colour to develop for at least 5 min but no longer than 30 min. the red dye turns blue when it binds protein. Read the absorbance at595 nm. Plot a standard curve using the standard protein absorbance V concentration. The protein was calculated in the experimental sample using the standard curve.

Fisher's ANOVA technique and least significance difference (LSD) test at 5% probability level were used to compare differences among treatment means.

Result and discussion:

An appraisal of the table-1 clearly shows that application of different levels of hydrogel laden in soil was found to be non-significant on leaf protein content of Chickpea during 2020 and

2021 in *ravi* season. The maximum leaf protein content 1.03, 1.07 and 1.05 was recorded in the treatment combination T_{10} during cropping year 2020, 2021 and in pooled respectively followed by treatment combination T_9 and recorded protein content as 1.02, 1.02and 1.02 in both the years of investigation as well as in pooled respectively. Similar findings also reported by Gupta et al 2020 as application of hydrogel @5 kg/ha significantly increased growth, yield attributes and yield of chickpea during both the year. The mean increases in grain yield and water productivity due to application of hydrogel were 17.54 per cent and 0.24 kg/m3 respectively over control.

Table 1 Influence of different hydrogel levels on leaf Protein content of Chickpea (*Cicer arietinum* L.)

Protein content in leaf at maturity (mg/gFW)			
Treatment	**2019-20**	**2021-22**	**Mean**
T0	1.01	1.01	1.01
T1	0.83	0.83	0.83
T2	0.83	0.82	0.83
T3	0.86	0.84	0.85
T4	0.92	0.93	0.93
T5	0.93	0.93	0.94
T6	0.94	0.95	0.95
T7	0.95	0.94	0.95
T8	1.01	0.98	1.00
T9	1.02	1.02	1.02
T10	1.03	1.07	1.05
C.D.	NA	NA	NA
SE(m)	0.02	0.02	0.02
SE(d)	0.03	0.03	0.02
C.V.	3.82	4.18	2.86

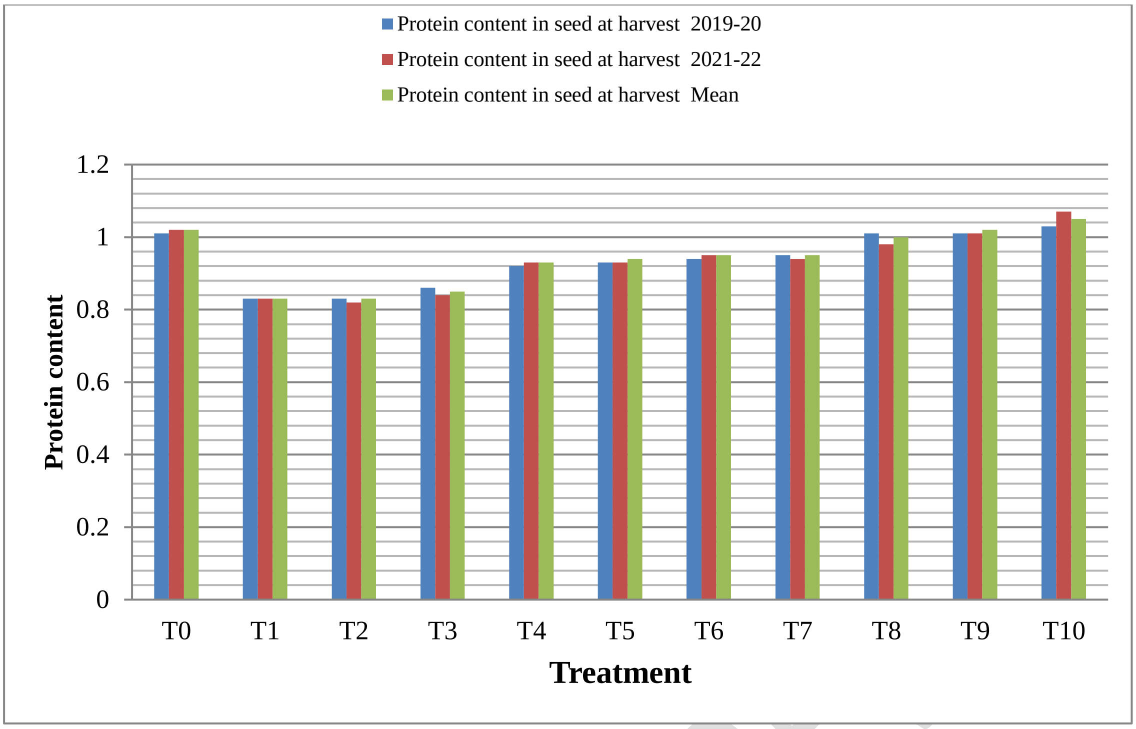

Fig 1 Influence of different hydrogel levels on leaf Protein content of Chickpea (*Cicer arietinum* L.)

Conclusion

The finding of present study concludes that different levels of hydrogel application had a non-significant effect on the protein content of chickpea during both years. The highest leaf protein content of 1.03, 1.07 and 1.05 was recorded in the treatment combination T_{10} during cropping year 2020, 2021 and in pooled respectively followed by treatment combination T_9 and recorded protein content as 1.02, 1.02and 1.02 in both the years of investigation as well as in pooled respectively.

Disclaimer (Artificial intelligence)

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 writing or editing of manuscripts.

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