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Research Article

EFFECT OF IRRIGATION REGIMES AND HYDROGEL ON GROWTH PARAMETERS AND YIELD OF INDIAN MUSTARD (*Brassica juncea* L.)

GURJAR K.*, YADAV K.K., SINGH D.P., CHOUDHARY J., BAIRWA H.L. AND RAMESH BABU S.
Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, 313001, Rajasthan, India
*Corresponding Author: Email - kamalgurjar3600@gmail.com

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Abstract: The field experiment was conducted at Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan during *rabi* season of 2022-23 on effect of irrigation regimes and hydrogel on Indian mustard. The experiment was conducted in split plot design within three replications having three irrigation regimes (0.4 IW/CPE, 0.6 IW/CPE and 0.8 IW/CPE) in main plots and four doses of hydrogel (control, 10, 15 and 20 kg ha^{-1}) in subplots. Results revealed that maximum growth and yield of mustard was recorded by the 0.8 IW/CPE irrigation regime. Among hydrogel treatments, application of 20 kg hydrogel ha^{-1} recorded significantly higher plant height, branches $plant^{-1}$ and yield of Indian Mustard.

Keywords: *Hydrogel, Irrigation, IW/CPE, Mustard*

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Introduction

Mustard (*Brassica juncea*) stands as a versatile and economically significant crop [1], contributing substantially to global agriculture. Renowned for its adaptability to various climatic conditions, mustard holds a pivotal place in the cultivation practices of many regions. As a member of the *Brassicaceae* family, this cruciferous plant is cultivated primarily for its seeds, which are rich in oil and used in the production of mustard oil and condiments. Beyond its economic importance, mustard's agronomic characteristics, such as rapid growth and resilience, make it an intriguing subject for agricultural research. Understanding the nuanced factors influencing mustard growth and yield is essential for enhancing agricultural practices and ensuring sustainable crop production.

In this context, the investigation into the effects of hydrogel and irrigation regimes on mustard holds promise for not only advancing scientific knowledge but also offering practical insights for optimizing mustard cultivation in diverse agro-ecosystems. Water management stands as a cornerstone in modern agriculture, playing a pivotal role in ensuring the productivity and sustainability of crop cultivation. As a finite and essential resource, water scarcity poses a significant challenge to global food security [2]. Effective water management practices are crucial not only for maximizing crop yields but also for minimizing environmental impact [3]. Agriculture accounts for a substantial portion of global water consumption, and optimizing water use through efficient irrigation systems and sustainable practices is imperative. In this context, the exploration of innovative technologies, such as hydrogel, becomes crucial, as it holds the potential to enhance water retention in the soil, mitigate drought stress, and improve overall water use efficiency in agricultural systems [4].

Recognizing the significance of water management in agriculture is fundamental to addressing the evolving challenges of climate change, population growth, and resource conservation in the pursuit of resilient and sustainable food production [5]. Hydrogel technology represents a cutting-edge innovation in agricultural practices, offering a promising solution to optimize water use efficiency and enhance crop performance [6]. Hydrogels are polymer-based materials with the unique ability to absorb and retain large quantities of water, forming a gel-like substance. In agriculture, these hydrogels are incorporated into the soil to improve water retention, particularly in arid and semi-arid regions, thereby mitigating the impact of water scarcity on crop growth. This technology has garnered attention for its potential to revolutionize traditional irrigation methods, reduce water wastage, and contribute to sustainable farming. By providing a reservoir of moisture for plants, hydrogels enable more controlled water release, helping crops withstand periods of drought stress. As the agricultural sector faces increasing pressure to optimize resource use and adapt to changing environmental conditions, the integration of hydrogel technology presents a promising avenue for addressing water-related challenges and fostering resilience in crop production systems.

The present investigation holds significant implications for agricultural sustainability and productivity. Understanding how hydrogel applications and various irrigation strategies impact mustard growth and yield is crucial for several reasons. Firstly, mustard is a widely cultivated crop with economic importance, and optimizing its growth conditions contributes directly to agricultural productivity and the livelihoods of farmers. Secondly, water scarcity is a growing concern in agriculture, making it imperative to explore innovative solutions like hydrogels to improve water use efficiency. This research aims to provide practical insights for farmers and policymakers on how to enhance mustard cultivation under varying environmental conditions. The findings could potentially lead to more resource-efficient and resilient agricultural practices, addressing challenges related to water availability and climate variability. Moreover, the study contributes to the broader scientific understanding of how hydrogel technology can be effectively integrated into irrigation practices, offering a pathway toward sustainable and climate-resilient agriculture.

Material and methods

The field experiment was carried out during rabi 2022-23 at Maharana Pratap University of Agriculture and Technology, Udaipur, India. The soil of the experimental field was clay-loam in texture, slightly alkaline in nature (pH 8.30), low in organic carbon (0.46%), medium in available nitrogen (282.35 kg ha^{-1}), medium in available phosphorus (20.62 kg ha^{-1}) and high in available potassium (346.50 kg ha^{-1}).

Table-1 Effect of hydrogel and irrigation regime on growth of mustard

Treatment details	Plant height		Branches plant^{-1}	Plant population	
	At 45 DAS	At harvest		At 30 DAS	At harvest
Irrigation regime					
0.4 IW/CPE	141.00	231.81	11.27	326351.7	302132.4
0.6 IW/CPE	144.39	236.25	12.75	326681.4	300546.9
0.8 IW/CPE	155.25	249.25	13.25	328404.8	300243.6
SEm±	2.433	3.392	0.181	2085.6	1918.7
C.D. at 0.05	9.551	13.318	0.711	NS	NS
Hydrogel					
Control	139.56	225.33	8.33	326517.1	300768.1
10 kg/ha	147.11	240.02	10.35	326921.9	300934.2
15 kg/ha	149.51	244.39	15.00	327102.4	300395.7
20 kg/ha	151.33	246.67	16.00	328042.6	301799.2
SEm±	1.450	2.847	0.171	2174.4	2000.4
C.D. at 0.05	4.307	8.458	0.508	NS	NS

Table-2 Effect of hydrogel and irrigation regimes on yield of mustard

Treatments	Seed yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Biological yield (kg ha^{-1})
Irrigation Regime			
0.4 IW/CPE	2068.51	4839.08	6907.60
0.6 IW/CPE	2318.00	5336.76	7654.76
0.8 IW/CPE	2372.50	5474.19	7846.69
SEm±	54.781	116.126	65.341
C.D. at 0.05	215.098	455.968	256.560
Dose of hydrogel			
Control	1703.33	4157.92	5861.25
10 kg/ha	2380.00	5415.62	7795.62
15 kg/ha	2440.00	5583.62	8023.62
20 kg/ha	2488.69	5709.54	8198.23
SEm±	38.003	77.340	101.191
C.D. at 0.05	112.913	229.790	300.654

The trial was conducted in split plot design, main plots contained three irrigation regimes (0.4 IW/CPE, 0.6 IW/CPE and 0.8 IW/CPE) and four doses of hydrogel (control, 10, 15 and 20 kg ha^{-1}) applied in sub plots and replicated thrice. Plot size was 4.0 m × 3.0 m. Hydrogel was applied directly in soil before sowing. The irrigation was applied to the field based on cumulative pan-evaporation reading by ratio of irrigation water applied (IW) to the pan evaporation (CPE). Nitrogen was supplied through urea and DAP, phosphorus through DAP and potassium through muriate of potash. Only 1/3 dose of nitrogen was applied at the time of sowing as basal dose and remaining dose of nitrogen was top dressed in two equal splits to crop. Full dose of phosphorus and potassium was applied at the time of sowing as basal dose. Relevant statistical analysis was done to find out the variations in the treatments.

Results and Discussion

The effect of irrigation regimes and hydrogel on plant height at 45 DAS presented in [Table-1]. Highest plant height at 45 DAS was observed with 0.8 IW/CPE, which was significantly superior over rest of the treatment. Among the soil applied hydrogel, maximum height was recorded with 20 kg ha^{-1} dose of hydrogel and it was statistically at par with 15 and 10 kg ha^{-1} doses of hydrogel but superior over control. Maximum plant height at harvest was also observed with 0.8 IW/CPE, which was statistically at par with 0.6 IW/CPE and superior over rest of the treatment. Among the soil applied hydrogel, maximum height at harvest was recorded with 20 kg ha^{-1} dose of hydrogel and it was statistically at par with 15 and 10 kg ha^{-1} doses of hydrogel but superior over control. The effect of irrigation regimes and hydrogel on branches plant^{-1} also presented in [Table-1]. Maximum branch plant^{-1} was observed with 0.8 IW/CPE, which was statistically at par with 0.6 IW/CPE and superior over rest of the treatment. Among the soil applied hydrogel, highest branches plant^{-1} was recorded with 20 kg ha^{-1} dose of hydrogel and it was superior over control. The results pertaining to plant population is also given in [Table-1]. The results show that irrigation regimes don't have any significant impact on the aforementioned property. Further, hydrogel didn't show any influence on the plant population. Similar were the results for plant population at harvest stage for both the treatments

The maximum seed yield [Table-2] was observed in 0.8 IW/CPE irrigation regimes and it was statistically at par with 0.6 IW/CPE but superior over 0.4 IW/CPE. Among the doses of hydrogel, application of hydrogel @ 20 kg ha^{-1} was recorded maximum seed yield, which was found at par with the seed yield found under 10 kg ha^{-1} and 15 kg ha^{-1} dose of hydrogel. The maximum seed yield was observed in 0.8 IW/CPE irrigation regimes, which was statistically at par with 0.6 IW/CPE but superior over 0.4 IW/CPE. Among the doses of hydrogel, stover yield with the application of hydrogel @ 20 kg ha^{-1} was recorded maximum and it was at par with the stover yield obtained under15 kg ha^{-1} dose of hydrogel but superior over stover yield recorded under 10 kg ha^{-1} and control. The maximum biological yield was also observed under 0.8 IW/CPE irrigation regimes and it was statistically at par with 0.6 IW/CPE but superior over 0.4 IW/CPE. Further the application of 20 kg ha^{-1} gave the maximum biological yield followed by biological yield recorded under 15 kg ha^{-1} dose of hydrogel and 10 kg ha^{-1}.

Such increase in plant height was due to water supplies with irrigation at a critical stage (45 DAS) providing a congenial growth environment which improved the cell elongation, cell turgidity, opening of stomata and finally the partitioning of photosynthates efficiently to the sink [7]. Moslemi *et al.* (2011) [8] reported that application of super absorbent increases all agronomic traits. Irrigation and hydrogel application produced a greater number of total numbers of branches per plant over no irrigation and no hydrogel application. This might be due to the better moisture availability which favoured the development of branches by the way of maintaining a better moisture regime. Similar results were found by Jat *et al.* (2018) [9] and Yadav *et al.* (2021b) [10]. The results shows that corresponding increase in irrigation regimes and dose of hydrogel significantly influence the seed, stover and biological yield. The seed yield was more with 0.8 IW/CPE irrigation regimes, and the highest value was obtained with 20 kg hydrogel ha^{-1}. This might be attributed to the timely and adequate moisture availability which helped in proper utilization of nutrients and also a better formulation and accumulation of photosynthates.

Conclusion

Study concluded that higher dose of hydrogel (20 kg ha^{-1}) and irrigation regimes 0.8 IW/CPE gave best results on growth parameters and yield of Indian mustard.

Application of research: Study of managing our scarce water resources profitably to attain higher yield

Research Category: Irrigation Management

Abbreviations: IW- Irrigation water
CPE-Cumulative pan evaporation ratio

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****Research Guide or Chairperson of research: Dr K.K. Yadav**
University: Maharana Pratap University of Agriculture and Technology, Udaipur, 313001, Rajasthan, India
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Study area / Sample Collection: Experimental Field, Maharana Pratap University of Agriculture and Technology, Udaipur, 313001, Rajasthan, India

Cultivar / Variety / Breed name: Indian Mustard (*Brassica juncea* L.)

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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