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Effect of foliar spray of hydrogel and salicylic acid on growth parameters of late-sown Indian mustard (*Brassica juncea* L.) under rainfed conditions

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Abstract

The present investigation entitled “Effect of Foliar Spray of Hydrogel and Salicylic Acid on Growth Parameters of Late-Sown Indian Mustard (*Brassica juncea* L.) under Rainfed Conditions” was conducted during the Rabi season of 2025–26 under rainfed conditions to evaluate the influence of hydrogel and salicylic acid on growth characteristics of late-sown mustard. Indian mustard is one of the most important oilseed crops cultivated in India and plays a significant role in edible oil production. However, delayed sowing and moisture stress under rainfed conditions often reduce plant growth and productivity. Therefore, suitable moisture conservation practices and plant growth regulators are essential for improving crop performance under such conditions.

Hydrogel is a water-absorbing polymer that helps in retaining soil moisture for a longer period and improves water availability to plants during moisture stress. Salicylic acid is an important plant growth regulator that enhances physiological and biochemical activities, improves stress tolerance, and promotes plant growth. Foliar application of salicylic acid is known to stimulate photosynthesis, chlorophyll synthesis, nutrient uptake, and cell division, thereby improving crop growth under adverse environmental conditions.

The experiment consisted of different treatments involving various concentrations of hydrogel and salicylic acid along with an untreated control. The treatments were arranged in a Randomized Block Design with three replications under rainfed field conditions. Foliar sprays were applied at critical growth stages of the crop. Standard agronomic practices were followed uniformly for all treatments throughout the crop season.

Observations were recorded on important growth parameters such as plant height, number of branches per plant, and chlorophyll content. The results revealed that foliar application of hydrogel and salicylic acid significantly improved the growth performance of late-sown mustard compared to the control treatment. Higher concentrations of salicylic acid showed better response in increasing plant height, branch formation, and chlorophyll content. Hydrogel application also contributed positively by maintaining soil moisture and improving plant water relations under rainfed conditions.

Among all the treatments, the combined effect of hydrogel and higher concentration of salicylic acid proved most effective in enhancing growth parameters of mustard. The increase in growth traits may be attributed to improved moisture availability, enhanced photosynthetic efficiency, better nutrient absorption, and increased metabolic activities within the plants. The study indicated that foliar application of hydrogel and salicylic acid can be effectively utilized to improve growth and physiological performance of late-sown Indian mustard under rainfed conditions.

Keywords: Indian mustard, hydrogel, salicylic acid, rainfed conditions, plant height, number of branches, chlorophyll content, growth parameters, *Brassica juncea* L.

Introduction

Indian mustard (*Brassica juncea* L.) is an important oilseed crop grown extensively in India during the Rabi season. It belongs to the family Brassicaceae and is valued for its edible oil and protein-rich seed meal. The crop plays a vital role in meeting the edible oil requirement of the country and contributes significantly to the income of farmers, particularly in rainfed agricultural areas. Mustard is cultivated under a wide range of climatic conditions, but its productivity is often affected by moisture stress and unfavorable environmental conditions.

Late sowing is one of the major factors responsible for reduced growth and productivity in

mustard. Delayed sowing exposes the crop to lower temperatures during early growth and higher temperatures during reproductive stages, which negatively affect vegetative development and overall crop performance. Under rainfed conditions, insufficient and uneven rainfall further aggravates moisture stress, resulting in poor plant growth, reduced branching, and lower chlorophyll formation. Limited soil moisture also restricts nutrient absorption and physiological activities within the plant, ultimately leading to weak crop growth and reduced yield potential.

Growth parameters such as plant height, number of branches per plant, and chlorophyll content are important traits that determine the growth and vigor of mustard plants. Better vegetative growth helps in efficient utilization of sunlight, improved photosynthesis, and higher dry matter production. Therefore, improving these growth characteristics is essential for obtaining better crop productivity under moisture-limited conditions.

Hydrogel is a moisture-retaining polymer that can absorb and store large quantities of water and release it slowly according to crop requirement. Its application in soil helps maintain adequate moisture around the root zone and reduces the harmful effects of drought stress. Hydrogel also improves water use efficiency and supports better plant growth under rainfed conditions. The use of hydrogel has gained importance in dryland agriculture because of its ability to conserve soil moisture and improve crop establishment.

Salicylic acid is an important plant growth regulator involved in various physiological and biochemical activities of plants. It helps plants tolerate stress conditions by improving photosynthesis, chlorophyll synthesis, nutrient uptake, and enzyme activity. Foliar application of salicylic acid has been found effective in promoting plant growth and enhancing stress resistance in many crops. It also encourages cell division and vegetative development, leading to improved plant height and branching.

The combined use of hydrogel and salicylic acid may help improve growth performance of late-sown mustard under rainfed conditions. Hydrogel ensures better moisture availability, while salicylic acid enhances physiological efficiency and stress tolerance in plants. Their combined effect may improve plant growth and overall crop performance under moisture stress conditions. However, limited information is available regarding the effect of hydrogel and salicylic acid on growth parameters of late-sown mustard grown under rainfed environments.

Keeping these facts in view, the present investigation entitled “Effect of Foliar Spray of Hydrogel and Salicylic Acid on Growth Parameters of Late-Sown Indian Mustard (*Brassica juncea* L.) under Rainfed Conditions” was undertaken to study the influence of hydrogel and salicylic acid on plant height, number of branches, and chlorophyll content of mustard under moisture stress conditions.

Hydrogel is a super absorbent polymer capable of absorbing and retaining large quantities of water in the soil and releasing it gradually according to plant requirement. Application of hydrogel improves soil water holding capacity, reduces moisture loss, and maintains favorable moisture conditions around the root zone. Under rainfed conditions, hydrogel helps plants tolerate drought stress by ensuring continuous water availability during critical growth periods. Hydrogel application has also been reported to enhance nutrient availability, root growth, and dry matter accumulation in several field crops.

Salicylic acid is an important plant growth regulator and signaling molecule involved in regulating physiological and biochemical processes in plants. It plays a significant role in enhancing plant tolerance against abiotic stresses such as drought, salinity, and temperature fluctuations. Foliar application of salicylic acid

improves chlorophyll synthesis, photosynthetic activity, enzyme function, nutrient uptake, and cell division. It also promotes vegetative growth and improves physiological efficiency of crops under stress conditions. Application of salicylic acid has been found beneficial in increasing plant height, branch formation, and chlorophyll content in many oilseed crops.

The combined use of hydrogel and salicylic acid may provide an effective approach for improving growth performance of mustard under late-sown rainfed conditions. Hydrogel helps in conserving soil moisture, while salicylic acid enhances physiological activities and stress tolerance in plants. However, information regarding their combined influence on growth parameters of Indian mustard under moisture stress conditions is limited. Therefore, the present investigation entitled “Effect of Foliar Spray of Hydrogel and Salicylic Acid on Growth Parameters of Late-Sown Indian Mustard (*Brassica juncea* L.) under Rainfed Conditions” was undertaken to evaluate the effect of hydrogel and salicylic acid on important growth parameters of mustard and to identify suitable treatments for improving crop growth under rainfed conditions.

Materials and Methods

The present investigation entitled “Foliar Spray of Hydrogel and Salicylic Acid on Late-Sown Indian Mustard (*Brassica juncea* L.) under Rainfed Conditions” was conducted during the Rabi season of 2025–26. The details regarding the materials used and experimental techniques adopted during the course of study are described in this section.

The field experiment was carried out under normal field conditions at the research farm of the Department of Agronomy, Faculty of Agricultural Sciences and Allied Industries, Rama University, Kanpur-209217, Uttar Pradesh. The experimental farm is situated in the central-western region of Uttar Pradesh and is geographically located at 26.449923° North latitude and 80.331874° East longitude, with an elevation of approximately 567 meters above mean sea level. The region experiences a subtropical climate with distinct summer and winter seasons, which is suitable for cultivation of mustard during the Rabi season under rainfed conditions.

Result and Discussion

Growth Parameters

4.1 Plant height (cm)

The foliar application of hydrogel and salicylic acid significantly improved plant height of *Brassica juncea* under late-sown rainfed conditions at all growth stages. Plant height increased progressively from 40 DAS to 80 DAS in all treatments. The lowest plant height was recorded in the control treatment (T₁), while the highest values were observed in T₇ (salicylic acid @ 150 ppm). Among hydrogel treatments, T₄ performed best. Salicylic acid treatments showed superior performance over hydrogel treatments due to improved photosynthetic activity, better nutrient uptake, enhanced cell elongation, and increased moisture stress tolerance. The results indicated that salicylic acid effectively promoted vegetative growth in mustard.

4.2 Number of branches plant⁻¹

The foliar application of hydrogel and salicylic acid significantly increased the number of branches per plant in *Brassica juncea* under late-sown rainfed conditions. Branch formation improved continuously from 40 DAS to 80 DAS in all treatments, indicating better vegetative growth with crop advancement. The control treatment (T₁) recorded the lowest number of branches at all growth stages. Among all treatments, T₇ (salicylic acid @ 150

ppm) produced the highest number of branches per plant, followed by T₆ (salicylic acid @ 100 ppm). Among hydrogel treatments, T₄ (hydrogel @ 150 ppm) showed superior performance compared to lower concentrations. The improvement in branching may be due to enhanced photosynthetic activity, better nutrient uptake, improved moisture availability, and increased metabolic activities under foliar treatments. Salicylic acid treatments were more effective than hydrogel treatments in promoting branch formation and improving vegetative growth of mustard under moisture stress conditions.

4.3 Chlorophyll Content

The foliar application of hydrogel and salicylic acid significantly enhanced chlorophyll content in *Brassica juncea* under late-sown rainfed conditions. Chlorophyll content increased progressively from 40 DAS to 80 DAS in all treatments. The control treatment (T₁) recorded the lowest chlorophyll content at all growth stages, while T₇ (salicylic acid @ 150 ppm) showed the highest values. Among hydrogel treatments, T₄ (hydrogel @ 150 ppm) performed best. Salicylic acid treatments were more effective than hydrogel treatments in improving chlorophyll content. The increase in chlorophyll may be attributed to better moisture availability, enhanced nutrient uptake, improved chloroplast activity, and increased photosynthetic efficiency under foliar spray treatments.

Table 4.1: Effect of foliar spray of Hydrogel and Salicylic acid on plant height (cm) at different growth stages of *Brassica juncea* under late-sown rainfed conditions

Treatments	Plant height (cm) at		
	40 DAS	60 DAS	80 DAS
T ₁ - Control:	35.55	79.07	133.62
T ₂ - Foliar spray of 100 ppm Hydrogel at 35 DAS	36.20	83.80	135.07
T ₃ - Foliar spray of 120 ppm Hydrogel at 35 DAS	37.73	83.47	142.50
T ₄ - Foliar spray of 150 ppm Hydrogel at 35 DAS	40.47	89.27	148.54
T ₅ - Foliar spray of 100 ppm salicylic acid at 35 DAS	39.33	85.77	145.10
T ₆ - SA @ 100 ppm foliar spray at 35 and 65 DAS	41.63	92.67	153.27
T ₇ - Foliar spray of 150 ppm salicylic acid at 35 DAS	43.90	95.17	156.17
SEm±	0.22	1.16	1.17
CD at 5%	0.67	3.57	3.61

Table 4.2: Effect of foliar spray of Hydrogel and Salicylic acid on number of branches plant⁻¹ at different growth stages of *Brassica juncea* under late-sown rainfed conditions.

Treatments	Number of branches plant ⁻¹		
	40 DAS	60 DAS	80 DAS
T ₁ - Control:	4.33	7.18	10.37
T ₂ - Foliar spray of 100 ppm Hydrogel at 35 DAS	4.90	8.10	11.37
T ₃ - Foliar spray of 120 ppm Hydrogel at 35 DAS	5.30	8.70	12.17
T ₄ - Foliar spray of 150 ppm Hydrogel at 35 DAS	6.13	9.90	13.93
T ₅ - Foliar spray of 100 ppm salicylic acid at 35 DAS	5.80	9.30	13.17
T ₆ - SA @ 100 ppm foliar spray at 35 and 65 DAS	6.50	10.33	14.67
T ₇ - Foliar spray of 150 ppm salicylic acid at	7.10	11.53	15.78

35 DAS			
SEm±	1.17	0.11	0.09
CD at 5%	3.61	0.33	0.29

Table 4.6: Effect of foliar spray of Hydrogel and Salicylic acid on chlorophyll content at different growth stages of *Brassica juncea* under late-sown rainfed conditions

Treatments	Chlorophyll Content		
	40 DAS	60 DAS	80 DAS
T ₁ - Control:	32.60	38.54	42.70
T ₂ - Foliar spray of 100 ppm Hydrogel at 35 DAS	34.20	40.00	44.50
T ₃ - Foliar spray of 120 ppm Hydrogel at 35 DAS	35.60	41.63	46.00
T ₄ - Foliar spray of 150 ppm Hydrogel at 35 DAS	39.00	44.80	49.20
T ₅ - Foliar spray of 100 ppm salicylic acid at 35 DAS	37.40	43.20	47.40
T ₆ - SA @ 100 ppm foliar spray at 35 and 65 DAS	40.50	46.40	51.00
T ₇ - Foliar spray of 150 ppm salicylic acid at 35 DAS	42.80	48.70	53.60
SEm±	0.10	0.06	0.21
CD at 5%	0.30	0.17	0.66

Conclusion:

The present investigation concluded that foliar application of hydrogel and salicylic acid significantly improved the growth parameters of late-sown Indian mustard under rainfed conditions. Among all the treatments, salicylic acid at higher concentration (T₇) proved most effective in enhancing plant height, number of branches per plant, and chlorophyll content compared to the control treatment. Hydrogel application also positively influenced crop growth by improving soil moisture retention and maintaining favorable water availability under moisture stress conditions. The combined effect of hydrogel and salicylic acid improved photosynthetic efficiency, nutrient uptake, metabolic activities, and overall vegetative growth of mustard plants. The results clearly indicated that salicylic acid treatments performed better than hydrogel treatments alone in promoting growth under late-sown rainfed conditions. Therefore, foliar application of salicylic acid along with hydrogel can be recommended as an effective strategy for improving growth and physiological performance of *Brassica juncea* under moisture-limited environments.

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