Vegetable Science (2024) 51(2): 347-352
doi: 10.61180/vegsci.2024.v51.i2.21
ISSN- 0970-6585 (Print), ISSN- 2455-7552 (Online)
www.isvsvegsci.in

RESEARCH ARTICLE

Utilization of FYM and hydrogel to improve soil moisture retention, nutrient uptake and onion (*Allium cepa* L.) yield in semi-arid region of Punjab

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Abstract

Poor water holding capacity of soil, low soil organic matter, and limited fresh water supply are the major hurdles in increasing onion productivity in South-Western Punjab. Hydrogels are known to increase soil water retention, nutrient uptake and yield of crops under water stress conditions. Therefore, the present study was conducted to examine the effect of three doses of FYM (0, 25 and 50 t ha^{-1}) and five levels of hydrogel (0, 5, 7.5, 10 and 15 kg ha^{-1}) on the performance of *rabi* onion at Bathinda, Punjab. Application of FYM increased the soil moisture by 32 to 74%, whereas hydrogel enhanced it by 23 to 57%, irrespective of their doses. The maximum soil moisture was recorded with FYM @ 50 t ha^{-1} + hydrogel @ 15 kg ha^{-1}. Utilization of FYM @ 50 t ha^{-1} in combination with hydrogel @ 10 to 15 kg ha^{-1} exhibited the highest plant height, leaves $plant^{-1}$, P and S content in leaves, and P content in bulbs. Application of FYM @ 50 t ha^{-1} along with hydrogel @ 7.5 to 15 kg ha^{-1} manifested the maximum bulb equatorial diameter, neck thickness, bulb weight and K content in bulbs. Incorporation of FYM @50 t ha^{-1} in combination with hydrogel @ 5 to 15 kg ha^{-1} registered the maximum bulb yield, N and K content in leaves, along with N and S content in bulbs.

Keywords: FYM, hydrogel, nutrient content, onion, soil moisture, yield.

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Citation: Yadav, B.K. & Garg, N. (2024). Utilization of FYM and hydrogel to improve soil moisture retention, nutrient uptake and onion (*Allium cepa* L.) yield in semi-arid region of Punjab. Vegetable Science, 51(2), 347-352.

Source of support: Nil

Conflict of interest: None.

Received: 23/02/2024 **Revised:** 12/09/2024 **Accepted:** 18/09/2024

Introduction

Onion (*Allium cepa* L.) is one of the most important spice-cum-vegetable crops cultivated in almost all parts of the country, whose tunicated bulbs are used for local consumption and for export purposes (Gupta and Singh, 2016). India ranks first in onion production and export in terms of quantity and third in terms of export value after the Netherlands and China (Anonymous, 2024). In Punjab, the crop is cultivated over 10.66 thousand hectares. Although onion productivity in Punjab (23.7 t ha^{-1}) is already higher than the national average (18.6 t ha^{-1}), there is scope for its further increase (Anonymous, 2023). However, in semi-arid regions like South-Western Punjab, poor water holding capacity (WHC) of light textured soil, low soil organic matter, and limited supply of good quality canal water are the major problems in increasing onion productivity. Being a shallow-rooted crop, it has comparatively lower irrigation and fertilizer use efficiency, and the crop is highly responsive to irrigation and fertilizer application. However, excessive irrigation and rainfall runoff decreases the water and fertilizer use efficiency (Wei and Durian, 2014). Therefore, it is essential to increase light-textured soil's WHC and accessible water capacity (AWC), which measures how much water a plant can absorb, in order to ensure sustainable water use. The organic manures can be incorporated into the soil to improve its WHC and AWC, as there is a positive correlation between the soil's organic matter content and its WHC and AWC. However, it has been reported that Punjab has less farm yard manure (FYM) availability due to the state's declining livestock population (Dhawan and Kashish, 2016). Therefore, the major challenge for onion farmers is to produce a high yield using less water.

Agricultural researchers have recently become more interested in hydrogel polymers since they are excellent soil supplements, retain water, mineral components, and soil aggregation, and have no adverse environmental effects. These are superabsorbent polymers (SAPs) that can store 332–465 times more water than their weight and release it gradually under drought stress (Dehkordi, 2016). The structural and physical characteristics of the soil, such as water retention, permeability, infiltration rate, drainage, and aeration, are improved by the addition of hydrogels. Hydrogels are frequently utilized in regions facing frequent harsh weather events or on slopes vulnerable to erosion (Lu et al., 2018). The application of hydrogels is especially advantageous on sandy and severely degraded soils, as well as in arid and semi-arid regions (Kulikowski et al., 2018). Moreover, these SAPs can store and release nutrients to plants like a slow-release fertilizer (Qiao et al., 2016). Thus, the SAPs are considered appropriate to supply additional water to plant roots during soil moisture stress thereby boosting plant survival rate and crop yield (Yang et al., 2014). In light of the aforementioned considerations, the present study was conducted to evaluate the effectiveness of hydrogel and FYM in enhancing soil moisture, nutrient uptake and yield of *rabi* onion grown in light-textured soils of semi-arid region of South-Western Punjab.

Materials and Methods

The present study was conducted at Punjab Agricultural University, Regional Research Station, Bathinda, during *rabi* 2021-22. The experimental soil was alluvial, loamy sand in texture (sand-76.3%, silt-16.2% and clay-7.5%) having 34.6% field capacity, slightly alkaline in reaction ($pH_{1:2}$-8.35), low in organic carbon (3.5 mg kg^{-1}), available N (112.6 kg ha^{-1}), P_2O_5 (11.5 kg ha^{-1}) and SO_4-S (13.8 kg ha^{-1}), and high in available K_2O (138.9 kg ha^{-1}). The climate of the site is characterized by sub-tropical and semi-arid with an average annual rainfall of 400 to 450 mm. During the crop period, minimum and maximum air temperatures ranged from 6.1 to 18.9°C and 15.9 to 41.2°C, respectively. The morning and afternoon relative humidity varied from 45.1 to 93.3% and 11.7 to 76.3%, respectively.

The experiment was laid out with three replications in a factorial randomized block design having fifteen treatments comprising three doses of FYM (0, 25, and 50 t ha^{-1}) and five levels of hydrogel (0, 5.0, 7.5, 10.0, and 15.0 kg ha^{-1}). The seedlings of *rabi* onion variety 'PRO-7' were transplanted at a spacing of 15 cm × 7.5 cm on 21st January 2022. The net plot size was 1.5 × 1.5 m, accommodating 200 plants. The recommended dose of N (100 kg ha^{-1}), P_2O_5 (50 kg ha^{-1}), and K_2O (50 kg ha^{-1}) was applied through urea, single super phosphate and muriate of potash, respectively, in all the treatments. The full dose of phosphorus and potassium was applied in the soil before transplanting, whereas nitrogen was applied in two equal splits, i.e., before transplanting and 30 days after transplanting. The super absorbent polymer (SAP) acro-magic hydrogel (Acuro Organics Ltd., New Delhi, India) was used in the study. It is a potassium poly-acrylate-based super absorbent suitable for agricultural use. The crop was harvested on 25th May 2022.

Observations recorded and data analysis

A total of 12 irrigations were provided to the crop and soil moisture (at 0–15 cm and 15–30 cm depth) was estimated by gravimetric method before every irrigation event and average soil moisture was calculated. Soil pH and electrical conductivity (EC) was estimated using 1:2 soil-water suspension by using a pH meter and EC meter, respectively. The soil organic carbon, available N, available P_2O_5, available K_2O (1N NH_4OAc,) and available SO_4-S were determined as per standard methods (Piper, 2011) from the soil samples taken at a depth of 0-15 cm. The field observations were recorded on 10 plants per plot for plant height (cm), number of leaves per plant (at 90 days after transplanting), bulb equatorial diameter (mm), neck thickness (mm) and bulb weight (g). The fresh onion bulb yield (kg) from each plot was converted to t ha^{-1}. After harvesting, the leaves and bulbs were washed with tap water and then with distilled water. Thereafter, they were first dried in shade and then in an oven at 60°C. The dried samples were ground and acid digested for estimation of their nutrient (N, P, K and S) content as per the procedure outlined by Piper (2011). The data were statistically analyzed using SPSS version 16.0. The effect of the main factors (FYM and hydrogel) was compared using Fisher's LSD test at a 5% level of significance. The interaction (FYM × hydrogel) effects were compared using Duncan's New Multiple Range Test.

Results and Discussion

Soil moisture content

Application of FYM and hydrogel significantly enhanced the soil moisture content (%) by 27.9 to 158.8% in 0–15 cm and 21.3 to 149.5% in 15-30 cm soil layer, irrespective of their doses (Table 1). Irrespective of hydrogel dose, application of FYM @ 25 and 50 t ha^{-1} enhanced the soil moisture content by 32.0% and 71.7% at 0 to 15 cm depth and 32.7% and 73.8% at 15 to 30 cm depth, respectively, over control i.e. without FYM. Similarly, irrespective of FYM dose, utilization of hydrogel @ 5.0, 7.5, 10.0, and 15.0 kg ha^{-1} improved the

Table 1: Effect of farmyard manure (FYM) and hydrogel on soil moisture content (%) at variable depths

FYM (t ha^{-1}) (A)	*Hydrogel (kg ha^{-1}) (B)*					
	0	*5*	*7.5*	*10*	*15*	*Mean*
Soil moisture (%) (0-15 cm depth)						
0	22.7^{l}	29.0^{k}	30.4^{jk}	32.2^{ij}	34.0^{i}	29.7
25	28.9^{k}	38.1^{k}	40.5^{g}	43.2^{f}	45.3^{e}	39.2
50	36.8^{h}	50.0^{d}	53.6^{c}	56.0^{b}	58.7^{a}	51.0
Mean	29.4	39.1	41.5	43.8	46.0	
CD (*P* = 0.05)	A = 0.87		B = 1.13	A × B = 1.95		
Soil moisture (%) (15-30 cm depth)						
0	24.6^{j}	29.8^{i}	31.3^{hi}	33.3^{gh}	35.4^{g}	30.9
25	32.2^{hi}	39.3^{f}	41.8^{f}	44.7^{e}	47.1^{e}	41.0
50	41.7^{f}	51.7^{d}	55.6^{c}	58.3^{b}	61.4^{a}	53.7
Mean	32.8	40.3	42.9	45.5	48.0	
CD (*P* = 0.05)	A = 1.090		B = 1.41	A × B = 2.44		

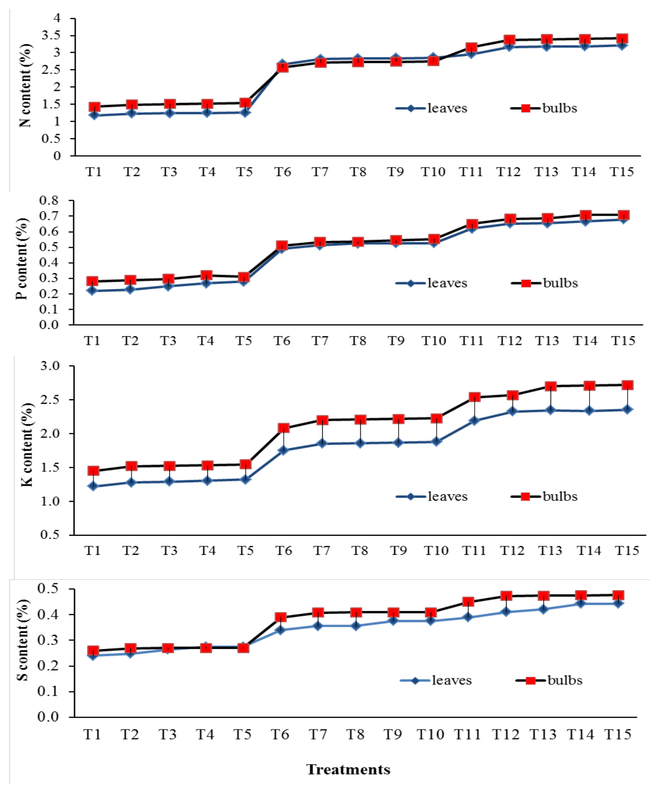
Mean values of interaction effects (A × B) for each trait superscripted by at least one common letter are not significantly different by Duncan's New Multiple Range Test at P = 0.05

soil moisture content by 33.0, 41.2, 48.9, and 56.5% at 0 to 15 cm depth, and by 22.9, 30.8, 38.7, and 46.3%, respectively, over control i.e. without hydrogel. The interaction effects revealed that the maximum soil moisture (58.7% at 0–15 cm and 61.4% at 15–30 cm depth) was recorded with the use of FYM @ 50 t ha^{-1} + hydrogel @ 15.0 kg ha^{-1}. The increase in soil water holding capacity by the addition of FYM may be caused due to improved soil structure and water-stable aggregates, whereas the soil moisture retention capacity is improved by increasing the total number of storage pores and organic matter (Mujdeci et al., 2017). The surface soil (0–15 cm) registered a higher increase in soil moisture as it contains a higher proportion of organic matter than the sub-surface (15–30 cm) layer.

Nutrient (N, P, K and S) content in onion leaves and bulbs

The FYM and hydrogel significantly increased the nutrient content in onion leaves and bulbs, whereas their interaction was non-significant (Fig. 1). Irrespective of hydrogel, the application of FYM @ 25 t ha^{-1} and 50 t ha^{-1} increased the N content in leaves by 2.28 and 2.55 times, and K content by 1.44 and 1.80 times compared with control i.e. without FYM. Irrespective of FYM, hydrogel enhanced the N and K content in leaves by 5.7-7.5% and 5.8-7.6%, respectively, compared with control, i.e., without hydrogel. Significantly higher N (3.13%) and K (2.33%) content in onion leaves was recorded with FYM @ 50 t ha^{-1} + hydrogel @ 5.0 kg ha^{-1}. Further increase in hydrogel dose non-significantly increased the N and K content in leaves. Irrespective of hydrogel, incorporation of FYM @ 25 t ha^{-1} and 50 t ha^{-1} increased the P content in leaves by 2.08 and 2.64 times, and S content by 1.37 and 1.61 times compared with the control, i.e., without FYM. Irrespective of FYM, hydrogel improved the P and S content in leaves by 4.6 to 11.4% and 4.7 to 13.3%, respectively, compared with control, i.e., without hydrogel. Significantly higher P (0.67%) and S (0.44%) content in onion leaves were registered with FYM @ 50 t ha^{-1} + hydrogel @ 10 kg ha^{-1}. Further increase in hydrogel dose non-significantly increased P and S content in onion leaves.

Irrespective of hydrogel, application of FYM @ 25 t ha^{-1} and @ 50 t ha^{-1} increased the N content of leaves by 1.80 and 2.33 times, K content by 1.45 and 1.75 times compared with the control i.e., without FYM. Irrespective of FYM, N and K content in bulbs were improved by 5.4-7.5% and 4.0-6.9%, respectively, over control with the use of hydrogel. Significantly higher N content (3.38%) in bulbs was recorded with FYM @ 50 t ha^{-1} + hydrogel @ 5 kg ha^{-1}, whereas significantly higher K content (2.70%) in bulbs was registered with FYM @ 50 t ha^{-1} + hydrogel @ 7.5 kg ha^{-1}. Further increase



T_1 = Control; T_2 = Without FYM + Hydrogel @ 5 kg ha^{-1}; T_3= Without FYM + Hydrogel @ 7.5 kg ha^{-1}; T_4= Without FYM + Hydrogel @ 10 kg ha^{-1}; T_5= Without FYM + Hydrogel @ 15 kg ha^{-1}; T_6= FYM @ 25 t ha^{-1} + Without hydrogel; T_7= FYM @ 25 t ha^{-1} + Hydrogel @ 5 kg ha^{-1}; T_8= FYM @ 25 t ha^{-1} + Hydrogel @ 7.5 kg ha^{-1}; T_9= FYM @ 25 t ha^{-1} + Hydrogel @ 10 kg ha^{-1}; T_{10}= FYM @ 25 t ha^{-1} + Hydrogel @ 15 kg ha^{-1}; T_{11}= FYM @ 50 t ha^{-1} + Without hydrogel; T_{12}= FYM @ 50 t ha^{-1} + Hydrogel @5 kg ha^{-1}; T_{13}= FYM @ 50 t ha^{-1} + Hydrogel @ 7.5 kg ha^{-1}; T_{14}= FYM @ 50 t ha^{-1} + Hydrogel @ 10 kg ha^{-1}; T_{15}= FYM @ 50 t ha^{-1} + Hydrogel @ 15 kg ha^{-1}.

Figure 1: Nutrient content (%) in onion leaves and bulbs as influenced by FYM and hydrogel.

in hydrogel level manifested a non-significant increase in N and K content of bulbs. Irrespective of hydrogel, application of FYM @ 25 t ha^{-1} and 50 t ha^{-1} increased the P content of bulbs by 1.8 and 2.3 times and S content by 1.48 and 1.74 times compared with control, i.e., without FYM. Irrespective of FYM, hydrogel improved the P and S content in bulbs by 4.2 to 7.4% and 2.7 to 5.4%, respectively, compared with control, i.e., without hydrogel. Significantly higher P content in bulbs (0.71%) was manifested with FYM @ 50 t ha^{-1} + hydrogel @ 10 kg ha^{-1}. Significantly higher S content in bulbs (0.47%) was recorded with FYM @ 50 t ha^{-1} + hydrogel @ 5 kg ha^{-1}. Further increase in hydrogel level non-significantly increased the P and S content of bulbs.

Plant growth, bulb parameters and yield

Application of FYM significantly improved the plant growth, yield and bulb parameters of *rabi* onion (Table 2). Irrespective of hydrogel dose, application of FYM @ 25 and 50 t ha^{-1} enhanced the plant height of onion by 84.3 and 118.4%, number of leaves by 50.0 and 75.0%, bulb equatorial diameter by 100.9 and 125.6%, neck thickness by 123.9 and 182.6%, bulb weight by 52.5 and 80.9%, and bulb yield by 68.4 and 115.4%, respectively, over control i.e. without FYM. However, FYM @ 50 t ha^{-1} gave significantly better plant growth, yield and bulb parameters than with 25 t ha^{-1}. Similarly, the use of hydrogel significantly improved the plant growth, yield and bulb parameters of *rabi* onion (Table 2). Irrespective of FYM dose, utilization of hydrogel @ 5.0, 7.5, 10.0, and 15.0 kg ha^{-1} improved the plant height of onion by 15.9, 22.9, 29.9, and 34.2%, number of leaves by 16.3, 23.3, 25.6 and 27.9%, bulb equatorial diameter by 15.0, 22.9, 25.1 and 28.2%, neck thickness by 12.2, 15.9, 19.5 and 20.7%, bulb weight by 11.3, 13.4, 16.4% and 17.8%, and bulb yield by 12.4, 14.6, 17.7 and 19.1%, respectively, over control, i.e., without hydrogel. However, hydrogel @ 15 and 10 kg ha^{-1} gave statistically at par growth, yield, and bulb parameters.

The interaction (FYM × hydrogel) effects were significant for all the traits (Table 2). The maximum plant height (45.1 cm) and leaves/plant (6.8) were observed with FYM @ 50 t ha^{-1} + hydrogel @ 15 kg ha$^{-1,}$ which were statistically at par with the use of FYM @ 50 t ha^{-1} + hydrogel @ 10 kg ha^{-1}. Similarly, the highest bulb equatorial diameter (52.3 mm), neck thickness (13.8 mm) and bulb weight (63.9 g) were recorded with FYM @ 50 t ha^{-1} + hydrogel @ 15 kg ha^{-1} which were statistically at par with the treatment combinations of FYM @ 50 t ha^{-1} + hydrogel @ 10 kg ha^{-1} and FYM @ 50 t ha^{-1} + hydrogel @ 7.5 kg ha^{-1}. The maximum bulb yield (26.23 t ha^{-1}) was registered with the use of FYM @ 50 t ha^{-1} + hydrogel @ 15 kg ha^{-1}, which was statistically at par with the treatment combinations of FYM @ 50 t ha^{-1} + hydrogel @ 10 kg ha^{-1}, FYM @ 50 t ha^{-1} + hydrogel @ 7.5 kg ha^{-1} and FYM @ 50 t ha^{-1} + hydrogel @ 5.0 kg ha^{-1}.

The improvement in plant growth of onion with the application of FYM may be attributed to enhanced nutrient

Table 2: Effect of farmyard manure (FYM) and hydrogel on plant growth, yield and bulb parameters of rabi onion variety 'PRO-7'

FYM (t ha^{-1}) (A)	*Hydrogel (kg ha^{-1}) (B)* 0	*5*	*7.5*	*10*	*15*	*Mean*
Plant height (cm)						
0	15.9^{k}	17.8^{j}	18.6^{ij}	19.5^{hi}	20.5^{h}	18.5
25	28.4^{g}	32.8^{f}	34.8^{e}	36.8^{d}	38.0^{cd}	34.1
50	32.9^{f}	38.9^{c}	41.3^{b}	43.9^{a}	45.1^{a}	40.4
Mean	25.7	29.8	31.6	33.4	34.5	
CD (P = 0.05)	A = 0.66	B = 0.85	A×B = 1.48			
Number of leaves plant^{-1}						
0	3.2^{i}	3.5^{h}	3.7^{gh}	3.7^{g}	3.9^{g}	3.6
25	4.6^{f}	5.3^{e}	5.6^{d}	5.7^{d}	5.9^{c}	5.4
50	5.2e	6.1^{c}	6.6^{b}	6.7^{ab}	6.8^{a}	6.3
Mean	4.3	5.0	5.3	5.4	5.5	
CD (P = 0.05)	A = 0.09	B = 0.11	A×B = 0.20			
Bulb equatorial diameter (mm)						
0	18.9^{g}	21.0^{fg}	22.0^{f}	22.3^{f}	23.1^{f}	21.5
25	36.5^{e}	42.1^{d}	44.6^{c}	45.7^{bc}	47.3^{b}	43.2
50	40.5^{d}	47.1^{b}	50.8^{a}	51.6^{a}	52.3^{a}	48.5
Mean	31.9	36.7	39.2	39.9	40.9	
CD (P = 0.05)	A = 1.00	B = 1.29	A×B = 2.23			
Neck thickness (mm)						
0	4.2^{h}	4.6^{gh}	4.7^{gh}	4.8^{gh}	4.9^{g}	4.6
25	9.1^{f}	10.2^{e}	10.5^{de}	10.8^{cd}	10.9^{cd}	10.3
50	11.3^{c}	12.9^{b}	13.5^{a}	13.7^{a}	13.8^{a}	13.0
Mean	8.2	9.2	9.5	9.8	9.9	
CD (P = 0.05)	A = 0.23	B = 0.30	A × B = 0.52			
Bulb weight (g)						
0	31.0^{g}	33.1^{fg}	33.6^{fg}	34.5^{f}	35.1^{f}	33.5
25	45.4^{e}	50.5^{d}	51.9^{cd}	53.4^{c}	54.0^{c}	51.1
50	53.4^{c}	60.8^{b}	61.7^{ab}	63.3a^{b}	63.9^{a}	60.6
Mean	43.3	48.2	49.1	50.4	51.0	
CD (P = 0.05)	A = 1.18	B = 1.52	A × B = 2.64			
Fresh bulb yield (t ha^{-1})						
0	10.34^{f}	11.52^{ef}	11.69^{ef}	12.00^{e}	12.22^{e}	11.55
25	17.29^{d}	19.25^{c}	19.79^{c}	20.35^{c}	20.57^{c}	19.45
50	21.92^{b}	24.96^{a}	25.32^{a}	25.98^{a}	26.23^{a}	24.88
Mean	16.52	18.57	18.93	19.44	19.67	
CD (P = 0.05)	A = 0.568	B = 0.733	A × B = 0.617			

Mean values of interaction effects (A × B) for each trait superscripted by at least one common letter are not significantly different by Duncan's New Multiple Range Test at P = 0.05

availability, improved soil physical characteristics, and increased soil microbial activity (Gererufael et al., 2020). The increased neck thickness, bulb diameter and bulb weight may have resulted from increased levels of major elements, especially nitrogen, which may have accelerated the synthesis of amino acids and chlorophyll, leading to increased translocation of photosynthates from leaves to the bulb (Shedeed et al., 2014).

The high N content in onion leaves and bulbs due to FYM application suggested that the crop's nutritional needs could be adequately met by mineralized nitrogen from FYM. The crop's superior response to FYM could be attributed to its higher nutritional content and lower C: N ratio. In comparison to chemical fertilizers, integrated treatments enhance soil organic carbon, accessible N, P, and K, and improve soil biological activity as measured by the dehydrogenase enzyme (Singh and Pandey, 2006). The addition of organic manure raises the NPK content of plants because organic acids work to build an organic matter complex, some of which not only alter soil pH but also combine with cations to produce chelated compounds or stable complexes that aid in phosphate fixing (Prabhu et al., 2002). Another possibility is that the solubility impact of the organic acids created by the decaying organic manures increased the availability of P. According to Somashekar and Choudhuri (2015), FYM may have decreased P fixation and increased P availability in soil solution for better absorption, thereby increasing P uptake in onions. Due to their complementary actions, N and K may have an impact on the K content of leaves and bulbs. The enhanced availability of nutrients from both native and mineralized organic manures may have contributed to the rise in K content by raising the concentration of K in the soil solution and making it more easily absorbed. Since onion bulbs are regarded as a storehouse of plant nutrients, it is evident that their utilization of K has increased after FYM application (Pachouri et al., 2005). These results corroborate the findings of Jayathilake et al. (2002) and Negi et al. (2022) in onion.

Plant damage caused by salt-induced and water-deficient stress is mitigated by the use of poly (ethylene oxide) hydrogel, polyacrylamide hydrogel, and cross-linked poly (ethylene oxide)-co-polyurethane hydrogel (Shi et al., 2010). These super absorbent polymers (SAP) conserve water, boost soil water-holding capacity, and improve soil nutrient status, thereby increasing plant growth (Boatright et al., 1997). Hydrogel has been reported to enhance cell division and elongation, which in turn increases plant height, leaf number, bulb weight, root growth, and plant biomass of onion (Pattanaaik et al., 2015). The application of hydrogel boosted soil water retention, resulting in greater nutrient use efficiency, thereby increasing nutrient content in the leaves and bulbs of onions (Shi et al., 2016).

Conclusion

The application of FYM and hydrogel, independently or in combination, significantly improved the soil moisture content, nutrient (N, P, K, and S) concentration in leaves and bulbs, plant growth, yield, and bulb parameters of *rabi* onion. The maximum soil moisture was manifested with the highest doses of FYM and hydrogel, i.e., 50 t ha^{-1} and 15.0 kg ha^{-1}, respectively. However, FYM @ 50 t ha^{-1} in combination with hydrogel @ 5 and 7.5 kg ha^{-1} gave significantly higher yield, bulb parameters, and nutrient concentration in leaves and bulbs. On the other hand, to improve plant growth traits, FYM @ 50 t ha^{-1}, along with hydrogel @ 10 kg ha^{-1}, was the best treatment combination.

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सारांश

दक्षिण-पश्चिमी पंजाब में प्याज की उत्पादकता बढ़ाने में मिट्टी की खराब जल धारण क्षमता, मिट्टी में कम कार्बनिक पदार्थ और सीमित साफ पानी की आपूर्ति प्रमुख बाधाएं हैं। हाइड्रोजेल, जल की कमी की स्थिति में मिट्टी में नमी बनाए रखने, पोषक तत्व धारण करने और फसलों की पैदावार बढ़ाने के लिए जाना जाता है। इसलिए वर्तमान अध्ययन बठिंडा, पंजाब में रबी मौसम की प्याज पर गोबर की खाद की तीन खुराक (0, 25 और 50 टन प्रति हैक्टेयर) और हाइड्रोजेल के पांच स्तरों (0, 5, 7.5, 10 और 15 किग्रा प्रति हैक्टेयर) के प्रभाव की जांच के लिए किया गया। गोबर की खाद के प्रयोग से मिट्टी की नमी 32 से 74 प्रतिशत तक बढ़ गई, जबकि हाइड्रोजेल ने इसे 23 से 57ः तक बढ़ा दिया, चाहे उनकी खुराक कुछ भी हो। मिट्टी में अधिकतम नमी 50 टन प्रति हैक्टेयर गोबर की खाद और 15 किग्रा प्रति हैक्टेयर हाइड्रोजेल के साथ दर्ज की गई। हाइड्रोजेल 10 से 15 किग्रा प्रति हैक्टेयर के साथ संयोजन में 50 टन प्रति हैक्टेयर गोबर की खाद का उपयोग उच्चतम पौधों की ऊंचाई, पौधों में पत्तियों की अधिकतम संख्या, पत्तियों में उच्चतम फास्फोरस और गंधक और बल्ब में उच्चतम फास्फोरस को प्रदशर्ति करता है। 7.5 से 15 किग्रा प्रति हैक्टेयर की दर से हाइड्रोजेल के साथ 50 टन प्रति हैक्टेयर की दर से गोबर की खाद के प्रयोग से अधिकतम बल्ब भूमध्यरेखिय व्यास, गर्दन की मोटाई, बल्ब का वजन और अधिकम पोटेशियम की माला देखी गई। 5 से 15 किग्रा प्रति हैक्टेयर की दर से हाइड्रोजेल के साथ 50 टन प्रति हैक्टेयर की दर से गोबर की खाद को शामिल करने पर अधिक बल्ब उपज, पत्तियों में उच्च नाइट्रोजन और पोटेशियम की माला के साथ-साथ बल्ब में उच्च नाइट्रोजन और गंधक की माला दर्ज की गई।