Influence of organic nutrient sources and hydrogel on yield attributes and productivity of mustard (*Brassica juncea* L.)

ABSTRACT

The experiment was conducted to study the effect of organic manures and hydrogel on growth and productivity of mustard during the *rabi* season of 2023-24 at Agronomy Research Farm of School of Agricultural Sciences, Nirwan University, Jaipur, Rajasthan, India. The experiment was laid out in factorial randomized complete block design. There were two factors under the design *viz.*, different organic manures and levels of hydrogel. The first factor had three organic manures *viz*., FYM @ 5 t/ha, vermicompost @ 2.5 t/ha and poultry manure @ 1 t/ha. The different levels of hydrogel were no hydrogel (control), hydrogel @ 2.5 kg/ha and hydrogel @ 5 kg/ha. The growth and yield attributes as well as yield of mustard was significantly enhanced with the application of vermicompost @ 2.5 t/ha though this treatment was found to be at par with poultry manures @ 1.0 t/ha. Further results showed that the application of hydrogel @ 5.0 kg/ha over hydrogel @ 2.5 kg/ha and control significantly enhanced the productivity of mustard crop in the semi-arid areas of Rajasthan.

Keywords: *Hydrogel, mustard, oilseed organic nutrient sources*

INTRODUCTION

Indian mustard [*Brassica juncea* (L.) Czern & Coss] is a major *rabi* oilseed crop of the country and occupies a prominent place being next to soybean and groundnut, both in area and production. It belongs to family *Brassicacae* and has chromosome no. of 2n=36. Indian mustard gives edible oil which is used as cooking medium in north India (Prajapati *et al*., 2024). The seed and oil are used as condiment in the preparation of pickles and for flavouring curries and vegetables. The leaves of young plants are used as vegetable. The oil content in mustard seeds varies from 37 to 49 per cent and its oil is utilized for human consumption for cooking and frying purposes (Kaur *et al*. 2019; Sharma *et al.* 2024). It is also used in the preparation of vegetable ghee, hair oils, medicines, soap making, mixtures with mineral oils for lubrication and manufacture of greases. The oil cake left after extraction is utilized as cattle feed and manures. The oil cake contains 25-30 per cent crude protein, 5 per cent nitrogen, 1.8 - 2.0 per cent phosphorus and 1.0 - 1.2 per cent potassium. Conventional agriculture in India, heavily reliant on chemical fertilizers, has led to soil degradation, reduced biodiversity, and declining productivity over time (Naik *et al.* 2024a; Naik *et al.* 2024b). This unsustainable approach has also harmed environmental and human health, necessitating a shift in practices. Organic farming, combined with the use of farmyard manure (FYM), offers a sustainable alternative, revitalizing soil fertility and ensuring long-term agricultural resilience. The vermi-composting is an eco-friendly and effective way to recycle agricultural and kitchen wastes. The application of vermicompost not only adds plant nutrients (macro and micro) and growth regulators to one but also increases soil water retention, microbial population, humic substances of the soil, mineralization and release of nutrients. Besides these, vermicompost also improves soil aeration, reduction of soil erosion, reduces evaporation losses of water, accelerates the process of humification, stimulates the microbial activity, deodourification of obnoxious smell, destruction of pathogens, detoxification of pollutant in soil etc. FYM being the source of all essential elements, improves soil organic matter and humus part of soil. FYM also plays important role in inhabitation beneficial bacteria thus making the nutrients available to the crops. Most of the crops absorb N in the form of nitrate and this form is converted by soil bacteria only (Grzyb *et al* 2021). FYM containing humic acid helps to held plant nutrients in available/exchangeable form even in salt affected soils or soils having high pH. FYM has been traditionally used in farming to maintain soil fertility and yield. Hydrogel is an insoluble, cross-linked three-dimensional polymer which absorbs water more than 400 times of its weight and gradually releases it and also improves soil hydro-physical properties such as porosity, aggregate stability and hydraulic conductivity (Dabhi *et al*., 2013). Its swelling ratio increased with rise in temperature up to 50^0 C without any adverse effect on the polymer matrix structure. It is a boost for water conservation; help the plants by preventing stress both the drought and in times of excessive moisture. The studies revealed that hydrogel not only reduces amount of irrigation water but also frequency of irrigation from 55 to 80% of total water requirements to the crop and therefore, increases crop yield (El-Hady *et al.*, 2006).

2. MATERIAL AND METHODS

The present study was conducted during the *rabi* season of 2023-24 at Agronomy Research Farm of School of Agricultural Sciences, Nirwan University, Jaipur, Rajasthan. The farm is situated at an altitude of 211 meters above mean sea level at 27^o61” N latitude and 75^o13” E longitude. The experimental site falls under zone-IIIa of agroclimatic zone of Rajasthan characterized by alkaline soil (pH 7.9). The soil of the experimental field was low in available nitrogen (181.58 kg/ha) (Subia and Asija, 1956), medium in available phosphorus (18.71 kg/ha) (Olsen *et al*. 1954) and high in available potassium (291.20 kg/ha) (Jackson, 1973). The experiment was laid out in a randomized complete block design with factorial arrangement and replicated thrice. There were two factors *viz.,* organic manures and hydrogel, each factor comprising of three treatments (see Table 1). The variety under observation was RH 0406. The data recorded was subjected to analysis as prescribed by Gomez and Gomez. The statistical significance of data was assessed at 5% using F-test and means were subsequently reported (Fisher, R.A. 1950).

Table 1. Treatment details

Notation	**Treatment**
Organic Manures	
M_1	FYM @ 5.0 t/ha
M_2	Vermicompost @ 2.5 t/ha
M_3	Poultry manure @ 1.0 t/ha
Hydrogel	
H_1	Control
H_2	Hydrogel @ 2.5 kg/ha
H_3	Hydrogel @ 5.0 kg/ha

3. RESULTS AND DISCUSSION

Plant population: There were no significant effect of organic manures and hydrogel on plant population.

Plant height: The data pertaining to plant height of mustard at 30, 60, 90 DAS and at harvest as influenced due to application of organic manures are presented in table 2. The data indicated that plant height of mustard at 30, 60, 90 DAS and at harvest was affected significantly by organic manures of vermicompost @ 2.5 t/ha (M_2), as compared to FYM @ 5.0 t/ha (M_1). Vermicompost @ 2.5 t/ha being at par with poultry manure @ 1.0 t/ha (M_3). The increase in plant height of mustard due to vermicompost @ 2.5 t/ha was 12.19, 15.29, 19.43 and 16.17 per cent at 30, 60, 90 DAS and at harvest over FYM @ 5.0 t/ha, respectively.

A close perusal of data presented in table 2 showed that the plant height was affected significantly by different levels of hydrogel at 30, 60, 90 DAS and at harvest of mustard. Among the various levels of hydrogel, maximum plant height of mustard at 30, 60, 90 DAS and at harvest was recorded with the application of hydrogel at 5.0 kg/ha which was significantly higher than hydrogel at 2.5 kg /ha and control. The increase in plant height of mustard due to application of hydrogel at 5.0 kg/ha and 2.5 kg/ha was 40.30 and 12.69 per cent at 30 DAS, 30.11 and 10.81 per cent at 60 DAS, 32.42 and 7.90 per cent at 90 DAS and 27.84 and 7.85 per cent at harvest, respectively over control. Applying poultry manure enriches the soil with nutrients, improving plant growth (Shakywal *et al*. 2023), while hydrogel retains water, ensuring consistent moisture availability (Agaba *et al*. 2010). Together, they enhance mustard plant height by optimizing nutrient uptake and hydration.

Dry matter accumulation: The data related to dry matter accumulation of mustard at 30, 60, 90 DAS and at harvest as influenced due to application of organic manures and hydrogel are presented in table 3. The data indicated that, among the organic manures, poultry manure @ 1.0 t/ha (M_3) gives highest dry matter accumulation which was at par with vermicompost @ 2.5 t/ha (M2). Whereas lowest found in FYM @ 5.0 t/ha (M_1). In hydrogel treatments, applying hydrogel @ 5.0 kg/ha (H_2) consistently enhanced dry matter accumulation at all growth stages. This indicates that integrating organic manure like poultry manure with a higher hydrogel dose maximizes growth, while FYM combined with no hydrogel lags significantly. Poultry manure supplies essential nutrients and organic matter, enhancing soil fertility, while hydrogel retains moisture, ensuring consistent water availability (Agaba *et al*. 2010). Together, they boost nutrient uptake and physiological processes, increasing mustard's dry matter accumulation.

Table 2. Effect of organic manures and hydrogel on plant population and plant height of mustard

Treatments	Plant population m^{-1} row length		Plant height (cm)			
	20 DAS	At harvest	30 DAS	60 DAS	90 DAS	At Harvest
Organic manures						
M_1	9.14	8.69	31.92	62.31	94.92	145.00
M_2	9.60	9.03	35.81	71.84	113.36	168.44
M_3	9.62	9.14	36.64	74.96	117.18	172.47
SEm±	0.23	0.24	0.68	2.03	2.85	4.06
LSD	NS	NS	1.96	5.86	8.24	11.72
Hydrogel						
H_1	9.11	8.72	28.61	60.17	91.64	140.28
H_2	9.55	8.99	35.62	70.65	112.47	166.29
H_3	9.70	9.15	40.14	78.29	121.35	179.34
SEm±	0.23	0.24	0.68	2.03	2.85	4.06
LSD	NS	NS	1.96	5.86	8.24	11.72

Yield attributes: The results from the table 4 indicate significant differences. Among the organic manures, poultry manure @ 1.0 t/ha (M_3) achieved the highest values for primary branches per plant (5.65), number of siliquae per plant (184.36), number of seeds per siliqua

(10.87), and test weight (4.36 g), while significantly lowest in FYM @ 5.0 t/ha (M_1), and at par with vermicompost @ 2.5 t/ha (M_2). In case of hydrogel treatments, the application of hydrogel @ 5.0 kg/ha (H_2) resulted in the highest yield attributes, with primary branches per plant (5.75), siliquae per plant (188.64), seeds per siliqua (11.11), and test weight (4.45 g) being significantly higher than the control (H_0), while hydrogel @ 2.5 kg/ha (H_1) was at par with H_2. The lowest values across all parameters were consistently observed with FYM @ 5.0 t/ha (M_1) among organic manures and the control (H_0) for hydrogel application. Poultry manure enhances mustard yield by enriching soil with organic matter, nitrogen, phosphorus, and micronutrients. It improves soil structure, moisture retention, and microbial activity, promoting healthier growth and higher productivity (Shakywal *et al*. 2023).

Table 3. Effect of organic manures and hydrogel on dry matter accumulation of mustard

Treatments	Dry matter accumulation (g m^{-1} row length)			
	30 DAS	60 DAS	90 DAS	At harvest
Organic manures				
M_1	30.85	70.16	138.77	164.91
M_2	38.48	81.46	165.22	194.01
M_3	39.66	85.57	169.39	203.89
SEm±	0.88	2.01	5.40	3.61
LSD	2.55	5.81	15.58	10.42
Hydrogel				
H_1	28.42	62.81	132.62	160.74
H_2	38.00	81.24	162.14	191.25
H_3	42.58	93.14	178.62	210.82
SEm±	0.88	2.01	5.40	3.61
LSD	2.55	5.81	15.58	10.42

Table 4. Effect of organic manures and hydrogel on yield attributes of mustard

Treatments	Primary branches per plant	Number of siliquae per plant	Number of seeds per siliqua	Test weight (g)
Organic manures				
M_1	4.39	152.82	9.49	4.05
M_2	5.41	173.18	10.35	4.29
M_3	5.65	184.36	10.87	4.36
SEm±	0.14	4.37	0.24	0.07
LSD	0.40	12.61	0.69	0.20

Hydrogel				
H_1	4.38	150.36	9.15	4.01
H_2	5.33	171.36	10.45	4.24
H_3	5.75	188.64	11.11	4.45
SEm±	0.14	4.37	0.24	0.07
LSD	0.40	12.61	0.69	0.20

Yield: The effects of organic manures and hydrogel on mustard yield show significant variation among treatments (Table 5). Among organic manures, poultry manure @ 1.0 t/ha (M_3) resulted in the highest seed yield (1584.84 kg/ha), straw yield (3175.63 kg/ha), and biological yield (4760.47 kg/ha), significantly lowest in FYM @ 5.0 t/ha (M_1). However, it was at par with vermicompost @ 2.5 t/ha (M_2) for straw and biological yields. In hydrogel treatments, the application of hydrogel @ 5.0 kg/ha (H_2) recorded the highest yields, with seed yield (1696.00 kg/ha), straw yield (3421.00 kg/ha), and biological yield (5117.00 kg/ha), significantly highest than the control (H_0) and at par with hydrogel @ 2.5 kg/ha (H_1) for straw and biological yields. The lowest yields were observed with FYM @ 5.0 t/ha (M_1) and control (H_0) for hydrogel. The harvest index was unaffected by treatments, remaining statistically non-significant. Overall, poultry manure @ 1.0 t/ha and hydrogel @ 5.0 kg/ha showed superior yield performance.

Table 5. Effect of organic manures and hydrogel on yield of mustard

Treatments	Seed yield (kg/ha)	Straw yield (kg/ha)	Biological yield (kg/ha)	Harvest index (%)
Organic manures				
M_1	1267.29	2633.52	3900.81	32.41
M_2	1539.86	3151.85	4691.71	32.74
M_3	1584.84	3175.63	4760.47	33.22
SEm±	44.46	84.38	117.49	0.68
LSD	128.40	243.67	339.29	NS
Hydrogel				
H_1	1132.00	2398.00	3530.00	32.04
H_2	1564.00	3142.00	4706.00	33.21
H_3	1696.00	3421.00	5117.00	33.12
SEm±	44.46	84.38	117.49	0.68
LSD	128.40	243.67	339.29	NS

4. CONCLUSION

Plant height, dry matter accumulation, yield attributes, and yield of mustard were significantly influenced by the application of organic manures and hydrogel. Among organic manures, poultry manure @ 1.0 t/ha consistently outperformed others, resulting in the highest plant height, dry matter accumulation, primary branches, siliquae per plant, seeds per siliqua, and test weight, as well as maximum seed yield, straw yield, and biological yield. It was at par with vermicompost @ 2.5 t/ha for many parameters, while FYM @ 5.0 t/ha recorded the lowest values. In hydrogel treatments, the application of hydrogel @ 5.0 kg/ha showed a significant advantage across all growth stages, yield attributes, and yield, surpassing hydrogel @ 2.5 kg/ha and the control. These results underline the combined efficacy of poultry manure and hydrogel in optimizing growth and productivity of mustard.

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