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Effect of hydrogel and irrigation scheduling on water use efficiency and productivity of Indian mustard (*Brassica juncea* L.) in Jammu region

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Abstract

A field experiment was conducted to study the effect of irrigation scheduling and hydrogel application in Indian mustard (*Brassica juncea L.*) of Jammu region, India. The application of hydrogel @ 5.0 kg/ha and irrigation scheduling at 0.8 and 0.6 IW/CPE resulted in significant increase in the yield attributes, oil yield and seed yield of Indian mustard during first and second year of experimentation respectively besides concomitant increase in the water use efficiency of Indian mustard than control and other treatments in comparison. However, no application of hydrogel and irrigation scheduling at 0.4 IW/CPE was found to be the most economical treatment than other treatments in comparison.

Keywords: *Hydrogel, cumulative water use efficiency, irrigation scheduling, Indian mustard*

Introduction

Rapeseed mustard is next only to soybean crop in terms of production among all edible oilseed crops. In India, area, production and yield of rapeseed-mustard was 6.34 million hectares, 7.82 million tonnes and 1233 kg/ ha, respectively, during 2012-13 whereas in Jammu and Kashmir, rapeseed mustard crops are grown on an area of 61000 hectare with an average productivity of 803 kg/ha as reported by Anonymous (2014). The climate change over a period of last few years have necessitated the development and refinement of existing package and practices for achieving increased production and productivity in all crops.

The Rapeseed mustard crops and the major contributor among all edible oilseed crop and would play a vital role in achieving self sufficiency in oilseed under changing climate scenario wherein rain fed and irrigated areas of Jammu will make a significant contribution in terms of area and productivity in coming years. Irrigation will play a vital role in increasing the crop yields under changing climate scenario (Oweis *et al*., 1998). Insufficient soil moisture either due to little or no rains during the crop growth period and owing to frequent moisture stress during the vegetative as well as reproductive phases of crop growth, thereby resulting in drastic reduction in the crop yield of Indian mustard thereby resulting in lowered productivity of rapeseed mustard crop (Devnarayan and Biswas, 2012). Therefore the present study was undertaken to study the effect of hydrogel under no irrigation and different irrigation levels besides irrigation schedules based on irrigation water and cumulative pan evaporation ratio for increased yield and profitability.

Materials and Methods

The field experiment was conducted during the *Rabi* season of 2014-15 and 2015-16 at the Research Farm, Chatha of the Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu which is situated at 32^0 40' N latitude and 74^0 58' E longitude with an altitude of 332 m above mean sea level. The soil of the experimental field was low in organic carbon (0.38%) and nitrogen (215.30 kg/ha), medium in available phosphorus (12.4 kg/ ha) and potassium (145 kg/ha) and neutral in pH (7.08). Indian mustard variety "NRCDR 2" was sown in second fortnight of October in rows 30 cm apart and 10±15 cm plant to plant distance using 5 kg seeds/ha during both the years of experimentation. Recommended dose of 60:30:15:20 kg/ha of N:P_2O_5:K_2O:S was uniformly applied to all the treatments using urea, DAP , MOP and Gypsum as fertilizers. Full dose of P, K and S besides half dose of N were applied as basal dose at the time of sowing whereas rest of the N was given as 2 split doses during both the years of experimentation. Crop was raised as per standard package and practices during both the years of experimentation and was harvested during the last week of March during both the years of experimentation. The experiment consisted of 4 main plots and 3 subplots with twelve treatment combinations which were arranged in a split plot design with 3 replications. The main plots consisted of 4 irrigation scheduling levels based on IW/

CPE ratio (Irrigation water/cumulative pan evaporation) namely No irrigation (I_0), Irrigation at 0.4 IW/CPE (I_1), irrigation at 0.6 IW/CPE (I_2) and irrigation at 0.8 IW/CPE (I_3). The sub plots consisted of 3 treatments namely no hydrogel (H_0) , application of hydrogel @ 2.5 kg/ha (H_1) and hydrogel @ 5 kg/ha (H_2). The soil depth of irrigation was 5 cm uniformly in all the plots as per specified IW/CPE ratio. Observations on moisture status of soils at 0-15 cm soil depth and 15-30 cm soil depth were taken just before sowing at harvest stage by using soil auger and computations were made by using soil gravimetric method.

Whereas, Cumulative water use (CWU) was worked out as per Allen *et al*. (1998) using Pan evaporation data wherein relationship between ETo and Pan evaporation (PE) with Kc values based on percent growing season. Determination of Etc was done using formula i.e.

$$ETc = Kp \times Ep$$

Where Ep = Pan evaporation (mm/day)

Kp = Pan coefficient

The oil content of the oven dried seeds was estimated by extracting oil using petroleum ether (60-80^{0}C) as solvent and Soxhlet apparatus as given by Sadasivam and Manickam (1992). The oil yield (kg/ha) was calculated using following formula

Oil yield (kg/ha) = Seed oil content (%) × Seed yield (kg/ha).

For economic evaluation the cost of cultivation, gross returns, net returns and B:C ratio were computed using standard procedure based on minimum support price of Indian mustard. The data on recorded observations was analyzed using standard procedures.

Results and Discussion

The seed yield and yield attributes were significantly influenced by different irrigation schedules and hydrogel application. Among the irrigation scheduling treatments, maximum seed yield and yield attributes viz. 1000 seed weight, siliqua per plant, seeds/siliqua and harvest index in Indian mustard was recorded with irrigation scheduling at 0.8 IW/CPE which was significantly higher than other treatments in comparison during the first year of experimentation. However, during the second year i.e. 2015-16, maximum seed yield and other yield attributes i.e. 1000 seed weight, no. of siliqua per plant , seeds per siliqua and oil yield were obtained with irrigation scheduling at 0.6 IW/CPE which was however found to be at par with irrigation scheduling at 0.4 IW/CPE and 0.8 IW/CPE respectively (Table 1 and 2). This may be due to the fact that irrigation scheduling at different intervals resulted in significant effects of cumulative water use efficiency (Table 2). Similar findings were reported by Singh *et al*. (2017). However, lowest seed yield and yield attributes were recorded in plots where no irrigation was applied.

Among the different hydrogel treatments, application of

Table 1. Effect of different irrigation schedules and doses of hydrogel on yield and yield attributes of Mustard cultivar NRCDR 2

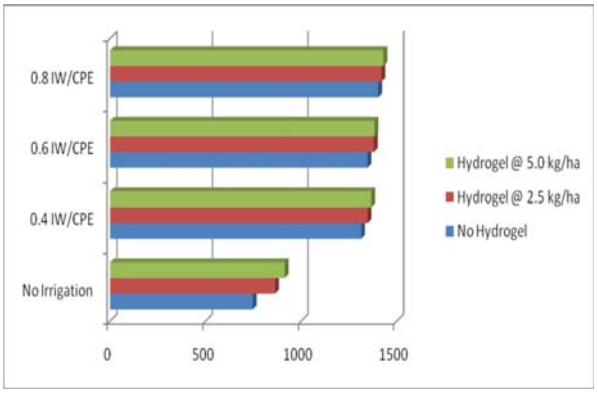
Treatments	1000-grain weight		No. of siliqua/plant		Seeds/ Siliqua		Seed yield (kg/ha)		Harvest Index (%)	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
Irrigation Scheduling										
No Irrigation	2.7	2.7	137.6	147.6	14.6	14.7	841.1	847.1	18.7	18.3
0.4 IW/CPE	3.5	3.6	235.1	245.3	18.0	17.2	1342.2	1383.7	22.8	23.3
0.6 IW/CPE	3.6	3.9	244.7	258.1	18.4	18.8	1370.0	1428.9	23.3	24.5
0.8 IW/CPE	3.7	3.8	251.6	255.8	18.5	18.4	1417.8	1394.2	24.1	24.2
CD (p=0.05)	0.3	0.4	5.6	24.9	0.7	1.8	43.5	81.6	0.6	2.9
Hydrogel										
No Hydrogel	3.2	3.2	210.4	220.1	16.8	16.7	1202.5	1205.3	21.4	21.8
Hydrogel @ 2.5 kg/ha	3.4	3.6	220.0	229.2	17.6	17.4	1252.5	1281.7	22.6	22.9
Hydrogel @ 5 kg/ha	3.5	3.6	221.3	230.8	17.8	17.8	1273.3	1303.4	22.7	23.2
CD (p=0.05)	0.2	0.2	2.5	8.8	0.5	00.7	22.1	55.0	0.8	0.5
Interaction: Factor A at same level of B	NS	NS	6.9	NS	1.1	NS	56.4	NS	NS	NS
Factor B at same level of A:	NS	NS	5.40	NS	1.03	NS	47.8	NS	NS	NS

Table 2.Effect of different dates of sowing on economics of Indian Mustard

Treatments	Oil yield (Kg/ha)		Cumulative Water use (Y/ETc) (Kg/ha-mm)		Gross returns (Rs/ha)		Net returns (Rs/ha)		Benefit : Cost ratio	
	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16	2014-15	2015-16
Irrigation Scheduling										
No Irrigation	326.4	327.0	4.60	7.46	28177.2	28378.2	8652.2	8853.2	0.45	0.46
0.4 IW/CPE	520.8	534.1	7.35	12.19	44964.4	46352.8	23439.4	24827.8	1.11	1.17
0.6 IW/CPE	531.6	551.6	7.50	12.59	45895.0	47867.8	22370.0	24342.8	0.97	1.05
0.8 IW/CPE	550.1	538.2	7.76	12.28	47495.6	46706.4	21970.6	21181.4	0.88	0.85
CD (p=0.05)	16.9	31.5	0.24	0.72	1455.8	2732.9	1455.8	2732.9	0.06	0.11
Hydrogel										
No Hydrogel	466.6	465.3	6.58	10.62	40283.5	40378.7	20758.8	20853.7	1.04	1.05
Hydrogel @ 2.5 kg/ha	486.0	494.7	6.86	11.29	41985.6	42935.8	19433.8	20410.8	0.85	0.90
Hydrogel @ 5 kg/ha	494.1	503.1	6.97	11.48	42656.7	43664.5	17131.7	18139.5	0.66	0.70
CD (p=0.05)	8.6	21.2	0.12	0.48	741.6	1842.4	741.6	1842.4	0.04	0.09
Interaction: Factor A at same level of B	18.5	NS	0.26	NS	1600.1	NS	1600.1	NS	0.077	NS
Factor B at same level of A:	21.9	Ns	0.31	NS	1889.1	NS	1889.1	NS	0.083	NS

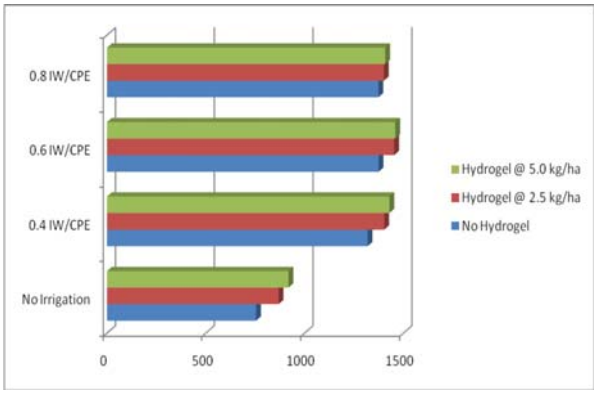
Note: MSP of rapeseed-mustard @ ₹ 3350/- per quintal

hydrogel @ 5 kg/ha though at par with application of hydrogel @ 2.5 kg/ha resulted in significant increase in the seed yield and yield attributes viz. 1000 seed weight, siliqua per plant, seeds/siliqua and harvest index than no application of hydrogel in comparison during both the years of experimentation. The interaction effect between different levels of Irrigation at same Hydrogel level and different levels of hydrogel at same level of irrigation was found to significant during the first year of experimentation only. However, a significant increase was recorded in plots with application of hydrogel where no irrigation during both the years of experimentation (Figure 1 and 2). Similar results were reported by Singh *et al*. (2017) and Kumar *et al*. (2016). However, lowest yield and yield attributes were recorded in plots where no hydrogel was applied.



Interaction of different levels of Irrigation at same Hydrogel level : 56.4
Interaction of different hydrogel levels at same Irrigation level : 47.8

Figure 1. Interaction effect of irrigation scheduling and hydrogel on seed yield in Indian mustard during 2014-15



Interaction of different levels of Irrigation at same Hydrogel level : NS
Interaction of different hydrogel levels at same Irrigation level : NS

Figure 2. Interaction effect of irrigation scheduling and hydrogel on seed yield in Indian mustard during 2015-16

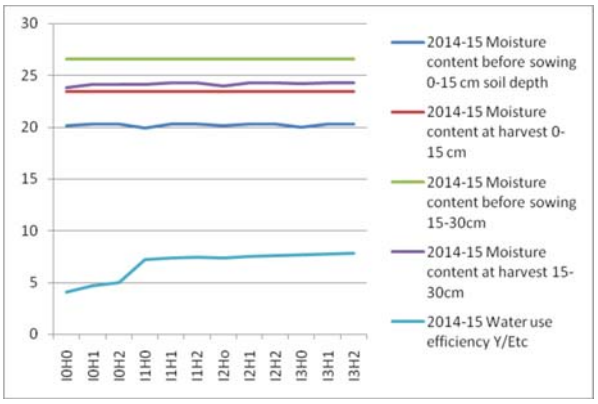


Figure 3: Effect of different irrigation scheduling and hydrogel treatments on moisture content in Indian mustard during 2014-15

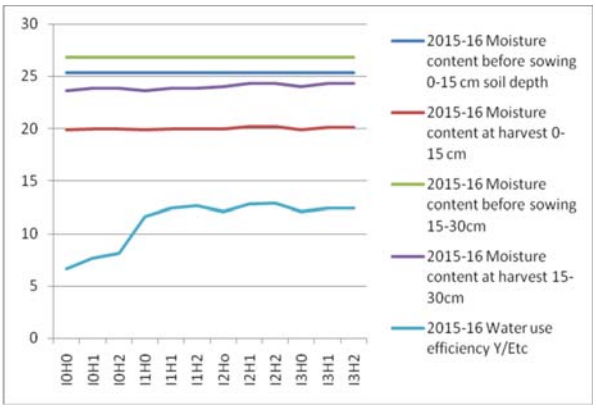


Figure 4: Effect of different irrigation scheduling and hydrogel treatments on moisture content in Indian mustard during 2015-16

This may be due to the fact that hydrogel may have resulted in absorption/storage of moisture during the period of abundant supply viz. field capacity for release during the time of moisture stress thereby with increased soil matric potential providing the crop with sufficient moisture supply during the entire vegetative and reproductive phases thereby augmenting the photosynthates accumulation in the crops which results in significant increase in the seed yield as well as yield attributes in Indian mustard crop during both the years of experimentation (Figure 3&4). Similar, views have been expressed by bharat *et al*. (2017).

However, irrigation scheduling at 0.4 IW/CPE with maximum benefit:cost ratio (1.11 and 1.17) and no application of hydrogel with maximum benefit :cost ratio (1.04 and 1.05) was found to be the most economical treatment during both the years of experimentation.

Conclusion

Based on two years of experimentation, irrigation scheduling @ 0.4 IW/CPE may be recommended for obtaining maximum seed yield besides increasing the cumulative water use efficiency in irrigated conditions of Jammu region. However, application of hydrogel is recommended for rain fed areas of Jammu for increased seed yield and productivity and enhanced water use efficiency.

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