Indian Journal of Agricultural Sciences **88** (9): 1474–6, September 2018/Short Communication

Deficit irrigation scheduling and levels of hydrogel (SAPs) influence on productivity and economics of Indian mustard (*Brassica juncea*) under semi-arid conditions

S S RATHORE[1], KAPILA SHEKHAWAT[2], BHAGWAT SINGH RATHORE[3], R K SINGH[4], O P PREMI[5] and B K KANDPAL[6]

Directorate of Rapeseed-Mustard Research, Bharatpur, Rajasthan 321 303

Received: 03 March 2018; Accepted: 10 July 2018

Key words: Deficit irrigation, Hydrogel, Seed yield, Superabsorbent polymers, Soil moisture regimes, Soil moisture tension

Mustard [*Brassica juncea* (L.) Czern. and Coss.] is an important oilseed crop grown over an area of 5.76 Mha with production and productivity of 6.82 MT and 1184 kg/ha respectively (Anonymous 2016). In India, deficit irrigation is widely practiced in irrigated areas of Indian mustard. Although, water requirement of Indian mustard is comparatively low; however there are critical stages and soil conditions which determine the complete impact of irrigation management on crop productivity. The efficient use of limited irrigation water through deficit (or regulated deficit) irrigation is one way of maximizing water use efficiency (WUE) for higher yields (Rathore *et al.* 2014). Precise irrigation scheduling has immense significance for enhancing not only the crop productivity but also the overall irrigation water use efficiency under limited irrigation. It has been reported that hydrogel use in sandy soils, improved water availability to crop plants by increasing the retention pores and reduced saturated hydraulic conductivity. Therefore, information on effects of deficit irrigation scheduling and use of hydrogels for enhancing water use efficiency in Indian mustard is immensely important. Keeping these facts in view, field experiment was conducted to find out effect of hydrogel under deficit irrigation scheduling on crop growth, productivity, and water use efficiency under semi arid conditions.

The experiment was conducted at DRMR research farm during 2013-14 and 2014-15. The climate is sub-tropical and semi-arid. During both the years, there was consistent drop in maximum temperature from October to January and thereafter rise from January to March; similar was the trend with minimum temperature; however maximum and minimum temperatures were in October and January. The sandy loam soil of experimental field was saline-sodic (pH and EC varied from 8.5-9.5 and 1.2-1.5 dS/m). The soils were poor in organic carbon (2.2 g/kg), $KMnO_4$ oxidizable N (120 kg/ha), medium in 0.5N $NaHCO_3$ extractable P_2O_5 (18.5 kg/ha) and 1.0 N NH_4OAc exchangeable K_2O (240 kg /ha). The experiment was carried out in split plot design with three replications, main plots consisted of irrigation scheduling (No irrigation, 0.4 IW/CPE, 0.6 IW/CPE and 0.8 IW/CPE) and level of hydrogel were assigned in subplots (No Hg, Hg 2.5 kg/ha and Hg 5.0 kg/ha). Irrigation was scheduled as per treatments on the basis of IW/CPE ratio. Timely sown Indian mustard variety (Rohini) was sown between 10-12 October during both the years. Photosynthesis of mustard was measured using a portable photosynthesis system. The yield attributes and yield observations were recorded at maturity of the crop. Observations on yield attributes were recorded by selecting five random plants from each plot. The data were statistically analyzed using Fisher's analysis of variance technique and the treatments means were compared by Duncan's Multiple Range (DMR) test at level of 0.05 probabilities.

Growth, yield attributes, seed yield and economics

Irrigation scheduling and levels of SAP-hydrogel influenced the growth, physiological parameters of Indian mustard during both the years. Compared to rainfed mustard crop, the irrigation scheduling at 0.4, 0.6 and 0.8 IW/CPE significantly improved the photosynthetic rate at 30 days after sowing (DAS). However maximum photosynthetic rate was at irrigation scheduling of 0.8 IW/CPE ratios. Similarly irrigation scheduling at 0.4, 0.6 and 0.8 IW/CPE ratio increased primary and secondary branches. Main shoot length was increased significantly with irrigation scheduling at 0.4, 0.6 and 0.8 IW/CPE (Table 1). During both the years

[1,2,4](e mail: sanjayrathorears@gmail.com, drrathorekapila@gmail.con, rajiv1571975@rediffmail.com), Division of Agronomy, ICAR-Indian Agricultural Research Institute, New Delhi 110 012. [3](e mail: bhagwat80@gmail.com), DRMR-KVK, Bansur, Alwar, Rajasthan. [5,6](e mail: oppermi@gmail.com, bkkhandpaal@rediffmail.com), DRMR, Bharatpur.

Table 1 Yield attributing characters of Indian mustard (Rohini) under surface irrigation (Check basin) with and without HG under different irrigation scheduling regimes (2013-15)

Treatment	Photosynthetic rate (µ mol/m/S)		Main shoot length (cm)		1000 seed weight (g)		Seed yield (kg/ha)		Oil yield (kg/ha)		Net return (₹/ha)		B:C ratio	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
Irrigation scheduling														
No irrigation	7.1b	6.9a	60.8a	50.0a	5.50^{a}	5.4b	1875^{a}	1891a	783.3^{a}	790.0^{a}	50348^{a}	49377^{a}	2.27^{a}	2.37^{a}
0.4 IW/CPE	8.2ab	7.6a	65.4ab	52.2a	5.13^{b}	5.2a	1979^{ab}	2440c	828.5^{ab}	921.1^{c}	54491^{a}	61518^{b}	2.47^{ab}	2.95^{b}
0.6 IW/CPE	9.8a	9.8a	64.2ab	58.2a	5.62^{a}	5.5c	2014^{ab}	2125b	840.7^{ab}	855.1^{b}	56296^{ab}	70912^{c}	2.49^{ab}	3.40^{c}
0.8 IW/CPE	9.1c	9.2b	67.9b	68.7b	5.58^{a}	5.5bc	2148^{b}	2384c	895.0^{b}	915.0^{c}	61604	76945^{c}	2.68^{b}	3.69^{c}
Hydrogel (Hg)														
No Hg	8.16^{a}	7.9a	66.2a	44.0b	5.2a	4.8a	1872^{a}	1927^{a}	823.6^{a}	840.0^{a}	53280^{a}	58171^{a}	2.11^{a}	2.79^{a}
Hg 2.5 kg/ha	9.8^{b}	10.1b	63.2a	38.6a	5.7bc	5.2b	2025^{b}	2333^{b}	845.6^{a}	861.2^{b}	56025^{a}	67247^{b}	2.46^{b}	3.23^{b}
Hg 5.0 kg/ha	10.6^{b}	10.6b	64.3a	66.6c	5.51b	6.2c	2015^{ab}	2370^{b}	841.3^{a}	920.0^{bc}	57749^{b}	68647^{b}	2.85^{c}	3.30^{b}

(2013-14 and 2014-15) hydrogel levels influenced most of the growth, yield attributing parameters significantly. And 1000 seed weight was significantly increased with use of 2.5 and 5.0 kg/ha Hg over no Hg (Table 1).Maximum increase in seed yield (29%) was at 0.4 IW/CPE (2440 kg/ha). Similar was the trend in oil yield under different irrigation scheduling. Use of SAP-hydrogel influenced the seed, oil yield economics and sustainability of mustard production system (Tabel 1). Seed yield increased significantly with use of 2.5 kg hydrogel/ha, and this was statistically at par with 5.0 kg hydrogel during both the years. Higher profitability ₹/ha/day (395.5 and 473.0 during 2013-14 and 2014-15) was observed (Table 1).The interaction of levels of SAP-hydrogel with irrigation scheduling was significant ($P \leq 0.05$) . Maximum seed yield was recorded at 0.6 IW/CPE ratio with use of 2.5 kg SAP-hydrogel. Deficit irrigation scheduling at 0.4 IW/CPE ratio out yielded the effect of adequate irrigation with hydyogel. SAP, hydrogel express perfectly under moisture stress conditions, therefore its effect was only visible under deficit irrigation. The higher growth, photosynthesis and yield attributes under deficit irrigation scheduling was due to adequate soil moisture to crop plant during early crop growth (Jat *et al.* 2018, Rathore *et al.* 2017). Thus, the application of hydogel to soil may increase water-holding capacities and nutrient utilization efficiency and reduce water loss.This is the reason for efficient water use, water saving, cost minimization in addition to providing plants with eventful moisture and nutrients.

Water dynamics in plant-soil and irrigation water use efficiency

Pre-flowering and pod development phenological stages are critical for soil moisture stress for mustard and exact status of water in soil and plant system was analysed. Significant variation was also observed soil moisture tension at pre-flowering and pod development stage. Use of SAP-hydrogel significantly influenced the RLWC, soil moisture content and soil moisture tension at both the critical growth stages. At pre-flowering stage, significantly higher relative leaf water content (RLWC) was observed at 0.8 IW/CPE

Table 2 RWC, soil moisture content and tension of Indian mustard (Rohini) under surface irrigation (Check basin) with and without HG under different irrigation scheduling regimes (pooled data 2013-15)

Treatment	At early stage			At pod development stage		
	RWC (%)	Moisture soil (%)	Soil moisture tension, (cb)	RWC (%)	Moisture soil (%)	Soil moisture tension (cb)
Main plot (IS)						
No irrigation	67.4^{ab}	9.5^{a}	75.8^{b}	71.6^{a}	10.0^{a}	73.9^{c}
0.4 IW/CPE	74.9^{a}	10.5^{b}	30.0^{a}	80.3^{a}	13.3^{a}	44.1^{b}
0.6 IW/CPE	81.1^{b}	11.3^{c}	29.4^{a}	88.4^{b}	17.7^{b}	38.9^{a}
0.8 IW/CPE	92.0^{c}	16.9^{d}	29.3^{a}	90.1^{b}	14.3^{a}	31.8^{a}
Hydrogel (Hg)						
No Hg	77.5^{a}	11.4^{a}	58.3^{c}	79.3^{a}	13.8^{a}	49.1^{c}
Hg 2.5 kg/ha	80.9^{a}	11.8^{b}	41.3^{b}	88.6^{a}	14.1^{a}	41.5^{b}
Hg 5.0 kg/ha	85.7^{b}	13.0^{c}	38.8^{a}	89.7^{a}	16.8^{b}	36.0^{a}

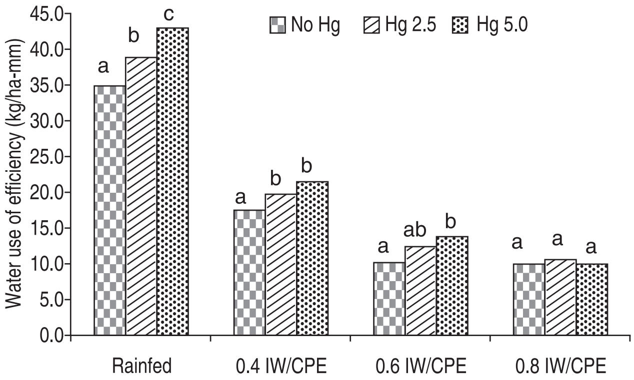

Fig 1 Overall water use efficiency of Indian mustard under different irrigation scheduling and use of SAP-hydrogel.

and soil moisture was significantly higher at 0.4, 0.6 and 0.8 IW/CPE irrigation scheduling compared to rainfed mustard crop, however maximum soil moister (16.9%)was estimated at 0.8 IW/CPE (Table 2). Use of SAP-hydrogel levels and irrigation scheduling influenced the water use efficiency significantly ($P<0.05$) during both the years. Under regular water stress areas limited irrigation water can be efficiently utilized with the use of 5.0 kg SAP-hydrogel. Among irrigation scheduling 0.4 IW/CPE resulted in maximum WUE over 0.6 and 0.8 IW/CPE. Overall average WUE across all the SAP-hydrogel and irrigation scheduling was 20.0 kg/ha-mm (Fig 1).Rathore *et al.* 2016 also reported soil application of SAP-hydrogel improved soil moisture regimes under water stress conditions enhanced mustard growth and productivity.

SUMMARY

Indian mustard [*Brassica juncea* (L.) Czern. and Coss.] is mainly grown under water deficit conditions and moisture stress at sensitive stages resulted in severe growth and yield decline. The available limited irrigation water and soil moisture can be efficiently utilized for enhancing mustard productivity, profitability and irrigation water use efficiency with the use of SAP-Hydrogel. The dose of 5.0 kg/ha of SAP-hydrogel under deficit irrigation 0.4,0.6 IW/CPE and under rainfed conditions consequence enormous stimulus on growth, seed productivity, water use efficiency and economic viability. Thus use of SAP-hydrogel may act as a savior under water scarce mustard growing areas in enhancing overall crop productivity and profitability.

REFERENCES

Anonymous. 2016. Agricultural statistics at a glance, Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Government of India.

Jat A L, Rathore B S , Desai A G and Shah S K. 2018. Production potential, water productivity and economic feasibility of Indian mustard (*Brassica juncea*) under deficit and adequate irrigation scheduling with hydrogel. *Indian Journal of Agricultural Sciences* **88**(2): 212–5.

Rathore S S, Kapila Shekhawat, Kandpal B K and Premi O P. 2017. Improvement of physiological and productivity traits of Indian mustard (*Brassica juncea*) through micro-irrigation and fertigation under hot semi-arid eco-region. *Indian Journal of Agricultural Sciences* **87**(9): 1257–62.

Rathore S S, Shekhawat Kapila and Singh V K. 2016.Increasing water use efficiency through use of hydrogel in Indian mustard (Brassica juncea). (*In*) *Proceedings of Natural Resource Management*: Ecological Perspectives. IES: International Conference 2016. p 63.

Rathore Sanjay Singh, Shekhawat Kapila, Kandpal Basant Kumar and Premi Om Prakash. 2014. Micro-irrigation and fertigation improves gas exchange, productivity traits and economics of Indian mustard (*Brassica juncea* (L.) Czernj and Cosson) under semi-arid conditions. *Australian Journal of Crop Sciences* **8**(4): 582–95.