



Influence of irrigation scheduling and hydrogel application on growth and yield of Indian mustard (*Brassica juncea*)

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Received : March 2017; Revised accepted : February 2018

ABSTRACT

A field experiment was conducted during the winter (*rabi*) season of 2013–14 at Pantnagar, Uttarakhand, to study the effect of irrigation scheduling and hydrogel levels on growth, yield attributes, yield, quality, net returns and water-use efficiency (WUE) of Indian mustard [*Brassica juncea* (L.) Czernj. & Cosson]. Growth parameters, yield attributes, seed yield, WUE and net returns were influenced with the application of irrigation and hydrogel. Yield attributes as well as yield were higher under irrigated conditions. All these parameters were observed higher with application of hydrogel at 5 kg/ha.

Key words: Hydrogel, Oil content, Water-use efficiency, Yield

India is one of the largest oilseed-producing countries of the world, covering about one-fifth of the entire area under rapeseed–mustard group of crops, and contributes almost a similar share of the total oilseeds production in the world. Among various oilseeds of the world, rapeseed–mustard hold a prime position catering to the edible oil requirement of a large population in the countries like China, India, Canada, the European Union etc. Among the oilseeds in India, *Brassica* ranks second in area and production after groundnut (Parashar *et al.*, 2015). Sowing the crop under rainfed conditions on residual moisture in marginal and sub-marginal lands with limited nutrient use causes low productivity. The optimum soil-moisture needs to be maintained in the root zone to meet the crop water requirements for higher yields, which can be achieved through a proper irrigation management. Of course, during the winter (*rabi*) season, water requirement of Indian mustard is not so high but to exploit full potential of this crop we need to provide sufficient water balance at least at the time of the critical stages of the crop. Retaining moisture in the soil through supply of some water-absorbing materials could prove to be a better prospect in this aspect.

Based on a part of M.Sc. Thesis of the first author, submitted to Govind Ballabh Pant University of Agricultural Technology, Pantnagar, in 2014 (unpublished)

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Hydrophilic gels called hydrogels are cross-linked three dimensional materials absorbing large quantities of water without dissolving. Softness, smartness, and the capacity to store water make hydrogels unique materials (Shibayama and Tanaka, 1993). They absorb water and gradually release it according to the needs of the crop plant. The ability of hydrogels to absorb water arises from hydrophilic functional groups attached to the polymer backbone, while their resistance to dissolution arises from cross-links between network chains. In view of this, the present study was undertaken for enhancing the yield of Indian mustard with hydrogel under deficit and adequate irrigation scheduling.

The field experiment was conducted during the winter (*rabi*) season of 2013–14 at the Norman E. Borlaug Crop Research Centre of the Govind Ballabh Pant University of Agriculture and Technology, Pantnagar (29° N, 79.29° E, 243.83 m above mean sea-level), Uttarakhand. The soil of the experimental site was silty clay loam with pH 7.28, organic carbon 0.77%; and medium in N, P₂O₅ and K₂O. The climate of the region is broadly humid sub-tropical with harsh winters and hot dry summers. Frost is expected from late December to February. The mean relative humidity remains almost 80–90% from mid-June to end of February. The experiment was laid out in split-plot design with 3 replications, consisting of 12 treatments—4 levels of irrigation scheduling [no irrigation, 0.2, 0.4 and 0.6 irrigation : water cumulative pan evaporation (IW : CPE) ratios] in main plots at 6 cm of depth and 3 levels of hydrogel (no hydrogel, 2.5 kg and 5.0 kg hydrogel/ha) in subplots. In-

dian mustard crop was fertilized uniformly with 120 : 40 : 20 kg/ha of N, P₂O₅ and K₂O respectively. Half of the nitrogen (N) along with the full amount of phosphorous (P) and potassium (K) were applied basal at the time of sowing. The remaining N was top-dressed in 2 equal splits. The hydrogel was applied in the soil after opening furrows before sowing of the crop, and was covered with soil immediately. Indian mustard variety 'Kranti' was sown in rows, 30 cm apart. Only 1 irrigation was applied 30 days after sowing because there was sufficient rainfall received in the crop growth period which did not let any further irrigation required after the one applied at 30 days stage. Normal crop husbandry was carried out for successful raising of the crop. Further irrigations had to be given at 30 cm, 15 cm and 10 cm of evaporation levels under 0.2, 0.4 and 0.6 IW: CPE scheduling respectively. The evaporation rates, however, did not exceed 5.9 cm throughout the crop growth period owing to the rainfall and the low temperatures. Therefore, no further irrigations were required under 3 IW : CPE ratios. Data on growth parameters, yield attributes, yield and quality recorded during the experimental year were statistically analysed and interpreted as suggested by Gomez and Gomez (2010).

Plant height and dry-matter accumulation were significantly influenced by different treatments (Table 1). Application of irrigation influenced the plant height significantly at harvesting over no irrigation. The different levels of IW : CPE scheduling, however, remained statistically at par with each other. Application of hydrogel increased the plant height significantly and the tallest plants were found with 5.0 kg hydrogel/ha which, however, remained at par statistically those recorded with 2.5 kg hydrogel/ha. Such increase in plant height was owing to water supplies with irrigation at a critical stage (30 DAS) providing a congenial growth environment. There was a decline in the plant height with no irrigation scheduling which might have exposed the crop to relatively more water stress at its critical stage of water requirement. Application of irrigation increased the dry-matter accumulation per plant significantly over no irrigation. The irrigation scheduling based on IW : CPE ratio, however, did not differ significantly owing to high rainfall and low evaporation rates subsequently during the crop growth period. Application of hydrogel increased the dry-matter accumulation significantly with application of 5.0 kg hydrogel/ha, however it, remained at par with that of 2.5 kg hydrogel/ha. Such increase in dry-matter was due to water supplies with irrigation at a critical stage which provided a congenial growth environment that improved the cell elongation, cell turgidity, opening of stomata and finally the partitioning of photosynthates efficiently to the sink (Chauhan *et al.*, 2002).

Moghadam *et al.* (2009) reported that application of super absorbent increases all agronomic traits.

The yield attributes, viz. total number of branches/plant, siliquae/plant, seeds/siliqua, siliqua length and 1,000-seed weight, were influenced by irrigation and hydrogel application (Fig. 1 and Table 1). Application of irrigation increased the total number of branches/plant, siliquae/plant, seeds/siliqua and siliqua length over no irrigation. Yield attributes were found maximum with the application of 5.0 kg hydrogel/ha. Irrigation and hydrogel application resulted in the higher yield attributes over no irrigation and no hydrogel application. This might be owing to the better moisture availability which favoured the development of branches by way of maintaining a better moisture regime. Application of irrigation and hydrogel not only enhanced the growth and development of crop plants but also ensured a higher availability of nutrients which resulted in more number of branches and culminated in a better sink development leading to more siliquae/plant. More 1,000-seed weight might be owing to the better availability of nutrients along with a better translocation of photosynthates from source to sink which in

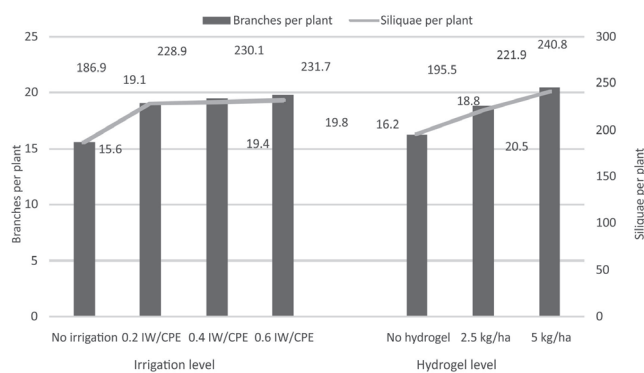


Fig. 1. Influence of irrigation level and hydrogel application on branches per plant and siliquae/plant of Indian mustard

turn helped in higher accumulation of photosynthates in the seeds with the application of irrigation and hydrogel. Yadav *et al.* (2010) also reported similar findings.

Application of irrigation increased the seed yield significantly over no irrigation (Table 1). The differences in various treatments on irrigation scheduling based on IW : CPE ratio were not recorded significant, as these treatments stood out to be the same practically owing to sufficient rainfall received in the crop growth period. Application of hydrogel increased the seed yield significantly over no hydrogel. The maximum seed yield was recorded with 5.0 kg hydrogel/ha which was significantly superior to 2.5 kg hydrogel/ha. Significant improvement in seed yield might be the result of the increased siliquae/plant, seeds/siliqua, length of siliqua and the 1000-seed weight. The

Table 1. Growth parameters, yield attributes, seed yield, CUW, WUE, quality and economics of Indian mustard as influenced by irrigation and hydrogel levels

Treatment	Plant height (cm)	Dry matter accumulation (g/plant)	Siliqua length (cm)	Seeds/siliqua	1,000-seed weight (g)	Seed yield (kg/ha)	CUW (cm)	WUE (kg/ha-cm)	Oil content (%)	Net returns (₹/ha)
<i>Irrigation levels</i>										
No irrigation	178.6	37.0	2.9	10.8	3.20	1,278	28.2	45.3	38.8	13,010
0.2 IW : CPE	184.6	40.5	3.5	13.5	3.41	1,844	28.8	64.1	39.0	29,593
0.4 IW : CPE	186.0	40.7	3.5	13.6	3.45	1,867	28.8	64.8	39.3	30,312
0.6 IW : CPE	187.3	40.9	3.6	13.8	3.49	1,891	29.0	65.2	39.0	31,056
SEm±	1.4	0.4	0.1	0.2	0.04	62	0.2	2.0	0.1	1,946
CD (P=0.05)	4.9	1.2	0.3	0.8	0.13	213	NS	7.0	NS	6,726
<i>Hydrogel levels (kg/ha)</i>										
No hydrogel	180.3	38.1	3.1	11.7	3.23	1,539	28.2	54.6	39.0	24,882
2.5	183.7	40.1	3.4	13.1	3.42	1,700	28.7	59.2	39.0	25,340
5.0	188.3	41.2	3.6	14.1	3.51	1,921	29.2	65.8	39.1	27,756
SEm±	1.9	0.7	0.05	0.3	0.02	48	0.2	1.8	0.1	1,541
CD (P=0.05)	5.7	2.0	0.15	0.9	0.07	143.8	0.6	5.4	NS	NS

CUW, Consumptive use of water; WUE, water-use efficiency

interaction between irrigation scheduling and hydrogel application on seed yield was non-significant. Availability of more moisture to plants might have resulted in production of more photosynthates, helping in translocation of more photosynthates to the seeds.

The consumptive use of water was not influenced significantly by irrigation (Table 1). However, the treatments receiving irrigation recorded more consumptive use of water than that of the unirrigated (no irrigation). Since the rainfall was sufficiently high before and during the crop growth period, it could be taken as a reason for the non-significant variations among the unirrigated and irrigated treatments with respect to the consumptive use of water. Dudwal *et al.* (2013) reported that, the consumptive use of water of Indian mustard increased with the increasing number of irrigations. An application of 5.0 kg hydrogel/ha increased the consumptive use of water significantly over that of no hydrogel application. Hydrogel retained water for a longer period in the soil which was instrumental in improving the consumptive use significantly. The water-use efficiency (WUE) was influenced significantly by irrigation scheduling and hydrogel application (Table 1). Application of irrigation increased the WUE significantly over no irrigation. The differences in various treatments on irrigation scheduling based on IW : CPE ratio did not differ statistically among themselves, as the low levels of evaporation did not leave a scope for any further irrigation as stated earlier. Application of hydrogel up to 5.0 kg increased the WUE significantly. Water-use efficiency depends on the seed yield and the consumptive use of water by the crop plants. Accordingly, the increase in

water-use efficiency might be owing to the greater yields with irrigation and 5.0 kg hydrogel/ha over no irrigation and no hydrogel application, respectively. Moghadam *et al.* (2009) also reported similar findings.

Application of irrigation and hydrogel could not influence the oil content in seeds significantly (Table 1). However, slightly more oil content was recorded with application of irrigation and hydrogel. Application of irrigation registered significantly higher net returns over that of no irrigation (Table 1). The irrigation scheduling based on IW: CPE, however, did not make any significant difference statistically. The application of different hydrogel levels could not influence the net returns statistically. However, the net returns were registered higher with application of hydrogel in comparison with that without hydrogel.

It could be concluded that the irrigation scheduling based on IW : CPE ratio does not hold significance in the foothills (*tarai*) region of Uttarakhand. However, an irrigation at the critical stage remains a beneficial practice for getting a higher seed yield and water-use efficiency of Indian mustard. Use of hydrogel could be helpful in improving soil moisture but its usage shall be optimized due to its higher costs. As the investigation was carried out for one crop season only, it needs to be repeated for at least one more season for reconfirmation of the results.

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