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Deen Dayal Bairwa
Ph.D. Research Scholar, Department of Agronomy, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan, India

PC Chaplot
Professor, Department of Agronomy, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan, India

Dilip Singh
Dean, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan, India

RH Meena
Associate Professor, Department of Soil Science and Agricultural Chemistry, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan, India

Mohan Lal Jat
Ph.D. Research Scholar, Department of Agronomy, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan, India

Ashish Meena
Ph.D. Research Scholar, Department of Agronomy, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan, India

Corresponding Author:
Deen Dayal Bairwa
Ph.D. Research Scholar, Department of Agronomy, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan, India

Effect of irrigation schedules based on IW-CPE ratio and hydrogel levels on nutrient uptake and total uptake of Isabgol (*Plantago ovata* Forsk.)

Deen Dayal Bairwa, PC Chaplot, Dilip Singh, RH Meena, Mohan Lal Jat and Ashish Meena

Abstract
A field experiment entitled "Response of Isabgol (*Plantago ovata* Forsk.) to hydrogel levels under different irrigation schedule" was conducted at Instructional Farm of Agronomy, Department of Agronomy, Rajasthan College of Agriculture, MPUAT, Udaipur during the *rabi* season of 2018-19 and 2019-20 to study the effect of hydrogel levels under different irrigation schedules. The soil of experimental field was clay loam in texture, slightly alkaline in reaction (pH 8.1), low in available nitrogen (270.60 to 271.30 kg ha^{-1}), medium in available phosphorus (18.07 to 18.90 kg ha^{-1}) and high in available potassium status (312.70 to 315.40 kg ha^{-1}). The experimental design split plot design was used comprises main plot factor four irrigation schedule *viz.*, IW-CPE ratio 0.20, 0.30, 0.40 and 0.50 sub plot factor hydrogel levels which also having four levels *viz*., control, 2.5, 5.0 and 7.5 kg ha^{-1} combined having 16 treatment combinations, which were replicated four time. Isabgol crop variety "Udaipur Isabgol- 89" was used as test crop. The results revealed that application of irrigation at IW-CPE ratio in Isabgol crop produced significantly increased nutrient uptake and total uptake. The crop irrigated at IW-CPE ratio of 0.50 accumulated highest quantum of nutrient in seed, straw thereby total accumulation which was found at par with IW-CPE ratio of 0.40 and both these ratio significantly increased total nitrogen uptake by 15.24, 25.61, phosphorus uptake by 11.96, 20.78 and potassium uptake by 10.46, 19.17 per cent, respectively over IW-CPE ratio of 0.30 and 0.20. Application of hydrogel up to 5.0 kg ha^{-1} significantly increased nitrogen, phosphorus and potassium uptake by seed and straw thereby total accumulation over application of 2.5 kg ha^{-1} and control. The magnitude of increase in total nitrogen, phosphorus and potassium uptake was 8.63, 7.68, 5.61 and 16.01, 14.95, 11.22 per cent, respectively. Further increase in hydrogel level to 7.5 kg ha^{-1} though positively influenced uptake of nutrients but failed to record statistical significance over 5.0 kg hydrogel ha^{-1}.

Keywords: irrigation schedule, Isabgol, hydrogel, nutrient uptake and total

Introduction
Blond psyllium (*Plantago ovata* Forsk) is a winter season medicinal crop. It belongs to the family Plantaginaceae and genus *Plantago*. It is known as Psyllium, Isabgol, Ispaghula, Spogel seed. Isabgol is a 30-35 cm tall short-stemmed annual herb. Isabgol is cultivated in about 417109 haectare area in Rajasthan with a production of 226480 tonnes (Anonymous, 2018-19) [1]. Its cultivation is mainly centralized in northern Gujarat and districts of South-west of Rajasthan namely Jalore, Barmer, Pali, Jaisalmer, Jhalawar and Sirohi. The seed husk is the commercial part and is separated by physical process. It contains colloidal mucilage (30%), mainly consisting xylose, arabinose, galacturonic acid with rhamnose, galactose etc. The husk has the property of absorbing and retaining water. The husk (epicarp) is used against constipation, irritation of digestive tract etc. In addition, these are also used in food industries for preparation of ice cream, candy etc. (Killedar *et al.*, 2016) [6].

Irrigation water is a costly and scarce resource and available of water to agriculture is expected to reduce. Isabgol are able to tolerate moderate levels of water stress. Soil moisture stress reduces the rate of photosynthesis and also the rate of translocation of nutrients, which ultimately influences the growth and yield of the crop. Thus, scheduling of irrigation on the basis of critical growth stages help in determing the time of irrigation. The application of agro-chemicals is known to play an important role in plant response to stresses. Hydrogel developed by the Indian Agricultural Research Institute (IARI), New Delhi. Hydrogel are macromolecular cross-linked hydrophilic polymeric chains with the ability to absorb water or aqueous fluids. The main function of this is it can absorb a minimum of 400 times of its dry

weight of pure water and gradually release it according to the needs of the crop plant. It acts like a sponge and absorb water which is releases slowly to the crops to get a sustained supply of moisture (Shikha *et al.*, 2019) [9].

Keeping in view the above facts, an investigation entitled "Response of Isabgol (*Plantago ovata* Forsk.) to hydrogel levels under different irrigation schedule" was conducted at RCA, MPUAT, Udaipur.

Materials and Methods

A field experiment was conducted during two consecutive *rabi* seasons of 2018-19 and 2019-20 to assess the effect of irrigation schedules based on IW-CPE ratio and hydrogel levels on nutrient uptake and total uptake of Isabgol (*Plantago ovate* Forsk.) at the Instructional Farm, Rajasthan College of Agriculture, Udaipur, situated at 24° 35' N latitude, 73° 42' E longitude with an altitude of 581.35 m above mean sea level. The region falls under NARP agro-climatic zone IV a (Sub- Humid Southern Plains and Arawali Hills) of Rajasthan. The soils of experimental site was clay loam in texture, slightly alkaline in reaction, low in available nitrogen (270.60 to 271.30 kg ha^{-1}), medium in available phosphorus (18.07 to 18.90 kg ha^{-1}) and high in available potassium status (312.70 to 315.40 kg ha^{-1}). The experiment was laid out in Split plot Design with total 16 treatment combination consisting of four irrigation schedule *viz.*, IW-CPE ratio 0.20, 0.30, 0.40 and 0.50 and four hydrogel levels *viz.*, 0.0, 2.5, 5.0 and 7.5 kg ha^{-1} and replicated four times . The treatments were allotted randomly in each replication. The plot size was 5.0 x 3.0 m. The seed of isabgol @ 6.0 kg ha^{-1} was sown in furrow manually by dropping the seed in the furrow row to row distance of 30 cm. The crop of isabgol was fertilized through Urea, SSP and MOP, respectively were applied into the already opened furrows before sowing. The half dose of nitrogen and full dose of phosphorus and potash was applied at the time of sowing, remaining half dose of nitrogen was top dressed after 1st irrigation.

Irrigation was applied as per treatment based on cumulative pan evaporation (CPE) values. The water was conveyed through open field cannel and measured by Parshall flume. The depth of each irrigation was kept 60 cm. The CPE was taken as a sum of daily evaporation from USWB class A pan evaporimeter minus the rainfall since the previous irrigation. A Common irrigation of 60 mm was applied uniformly in all the treatment just after sowing for germination of seed. Irrigation channels were presoaked before 24 hours of irrigation to avoid seepage losses at the time of irrigation. The whole quantity of hydrogel as per treatment was applied manually in furrows and incorporated into soil at the time of sowing. Other crop management practices were followed as per recommendation of area. The crop harvested from net plot at physiological maturity. The seed and straw samples collected from each plot at harvest were dried in oven at 65°C till a constant weight. These samples were grounded in laboratory mill, passed through 40 mm mesh sieve. Uptake of N, P and K by seed and straw was estimated by using following formula.

$$\text{Nutrient uptake by seed (kg ha}^{-1}) = \frac{\text{Nutrient content in seed x seed yield (kg ha}^{-1})}{100}$$

$$\text{Nutrient uptake by straw (kg ha}^{-1}) = \frac{\text{Nutrient content in straw x straw yield (kg ha}^{-1})}{100}$$

Result and Discussion

Nitrogen uptake

Seed

IW-CPE ratio: The isabgol crop irrigated at IW-CPE ratio of 0.50 accumulated highest quantum of nitrogen in seed which was found at par with the application of irrigation at IW-CPE ratio of 0.40 and both these irrigation levels significantly enhanced nitrogen uptake by seed over irrigation at IW-CPE ratio of 0.30 and 0.20. (Table 1).

The pooled data show that application of irrigation at IW-CPE ratio of 0.40 significantly improved it by 12.96 and 23.99 per cent over irrigation at IW-CPE ratio 0.30 and 0.20, respectively. The magnitude of increase in nitrogen uptake by seed under application of irrigation at IW-CPE ratio 0.50 was 15.27 and 26.02 per cent, respectively.

Hydrogel levels: Nitrogen uptake by seed was significantly influenced due to hydrogel levels as compared to control (Table 1). The maximum nitrogen uptake by seed was estimated under the influence of 7.5 kg hydrogel ha^{-1} which was significantly higher over application of 2.5 kg hydrogel ha^{-1} and control but at par with application of 5.0 kg hydrogel ha^{-1}.

Thus when compared to mean nitrogen uptake by seed under application of 2.5 kg hydrogel ha^{-1} and control, application of 5.0 kg hydrogel ha^{-1} significantly increased it by 11.25 and 19.80 per cent, respectively. The magnitude of increase in nitrogen uptake by seed due to application of 7.5 kg hydrogel ha^{-1} was to the extent of 11.89 and 20.37 per cent, respectively.

Interaction: It is evident from data (Table 2) that interaction effect of IW-CPE ratio and different hydrogel levels brought about significant variation on nitrogen uptake by seed. The isabgol crop accumulated highest quantum of nitrogen in seed under the combined application of irrigation at IW-CPE ratio of 0.50 + 7.5 kg hydrogel ha^{-1} which was significantly higher over rest of treatment combinations but at par with application of irrigation at IW-CPE ratio of 0.40 + 5.0 / 7.5 kg hydrogel ha^{-1} and IW-CPE ratio of 0.50 + 5.0 kg hydrogel ha^{-1}.

Straw

IW-CPE ratio: Scheduling of irrigation at IW-CPE ratio of 0.50 recorded highest nitrogen uptake by straw which was found at par with application of irrigation at IW-CPE ratio of 0.40 and both these irrigation levels significantly enhanced nitrogen uptake by straw over irrigation at IW-CPE ratio of 0.30 and 0.20 (Table 1).

Two years mean data indicate that application of irrigation at IW-CPE ratio of 0.40 and 0.50 significantly enhanced nitrogen uptake by straw to the extent of 13.69, 23.79 and 15.25, 21.17 per cent, respectively over irrigation at IW-CPE ratio of 0.30 and 0.20.

Hydrogel levels: Data (Table 1) reflects that application of 7.5 kg hydrogel ha^{-1} recorded highest nitrogen uptake by straw which was found at par with application of 5.0 kg hydrogel ha^{-1} and both these levels significantly enhanced nitrogen uptake by straw over application of 2.5 kg hydrogel ha^{-1} and control.

On pooled basis, the significant increases in nitrogen uptake by straw due to application of 5.0 kg hydrogel ha^{-1} was 5.82 and 12.02 per cent over application of 2.5 kg hydrogel ha^{-1} and control, respectively. While the magnitude of increase in

nitrogen uptake by straw due to application of 7.5 kg hydrogel ha^{-1} was 6.78 and 12.92 per cent, respectively.

Total uptake

IW-CPE ratio: It is explicit from data (Table 1) that scheduling of irrigation brought about significant influence on total nitrogen uptake. The highest quantum of total nitrogen was estimated when crop was irrigated at IW-CPE ratio of 0.50 which was found at par with irrigation at IW-CPE ratio of 0.40, however, both these irrigation levels significantly increased total nitrogen uptake by crop over irrigation at IW-CPE ratio of 0.30 and 0.20.

On pooled basis, the extent of improvement in total nitrogen uptake with the application of irrigation at IW-CPE ratio of 0.40 was 5.22 and 9.38 kg ha^{-1} over irrigation at IW-CPE ratio of 0.30 and 0.20, respectively. While the magnitude increase in total nitrogen uptake under the application of irrigation at IW-CPE ratio of 0.50 was 6.12 and 10.28 kg ha^{-1}, respectively.

Hydrogel levels: Data (Table 1) show that application of hydrogel at varying level caused significant influence on total nitrogen uptake as compared to control. Application of hydrogel at 7.5 kg ha^{-1} accumulated highest quantum of total nitrogen which remained at par with application of hydrogel at 5.0 kg ha^{-1} and both these levels significantly increased total nitrogen uptake over application of hydrogel of 2.5 kg ha^{-1} and control.

On pooled basis, application of 5.0 kg hydrogel ha^{-1} significantly increased total nitrogen uptake by 3.29 and 6.10 kg ha^{-1} over application of 2.5 kg hydrogel ha^{-1} and control, respectively. The corresponding increase in total nitrogen uptake due to application of 7.5 kg hydrogel ha^{-1} was to the tune of 3.63 and 6.44 kg ha^{-1}.

Interaction: Interaction effect of IW-CPE ratio and different hydrogel levels recorded significant variation on total nitrogen uptake. The highest quantum of total nitrogen was estimated when crop was irrigated at IW-CPE ratio of 0.50 alongwith application of 7.5 kg hydrogel ha^{-1} which was significantly higher over rest of treatment combinations but at par with application of irrigation at IW-CPE ratio of 0.40 /0.5 + 5.0 kg hydrogel ha^{-1} and IW-CPE ratio of 0.40 + 7.5 kg hydrogel ha^{-1} (Table 3).

Phosphorus

Seed

IW-CPE ratio: The isabgol crop irrigated at IW-CPE ratio of 0.50 accumulated highest quantum of phosphorus in seed which was found at par with application of irrigation at IW-CPE ratio of 0.40 and both these irrigation levels significantly increased phosphorus uptake by seed over irrigation of IW-CPE ratio of 0.30 and 0.20. (Table 1).

The pooled data show that application at IW-CPE ratio of 0.40 significantly improved phosphorus uptake by seed to the tune of 9.74 and 18.80 per cent over irrigation at IW-CPE ratio of 0.30 and 0.20, respectively. The magnitude increase in phosphorus uptake by seed with the application of irrigation at IW-CPE ratio 0.50 was 11.85 and 20.70 per cent, respectively.

Hydrogel levels: The maximum phosphorus uptake by seed was estimated under the influence of 7.5 kg hydrogel ha^{-1} which was found at par with application of 5.0 kg hydrogel ha^{-1} and both these levels significantly increased phosphorus uptake by seed over application of 2.5 kg hydrogel ha^{-1} and control.

On pooled basis, application of 5.0 kg hydrogel ha^{-1} significantly increased phosphorus uptake by seed to the tune of 10.82 and 19.96 per cent over application of 2.5 kg hydrogel ha^{-1} and control, respectively. The corresponding increase in phosphorus uptake by seed due to application of 7.5 kg hydrogel ha^{-1} was 11.72 and 20.77 per cent.

Interaction: It is explicit from data (Table 4) that interaction effect of IW-CPE ratio and different hydrogel levels brought about significant variation on phosphorus uptake by seed. The isabgol crop accumulated highest quantum of phosphorus in seed under the combined application of irrigation at IW-CPE ratio of 0.50 + 7.5 kg hydrogel ha^{-1} which was significantly higher over rest of treatment combinations but at par with application of irrigation at IW-CPE ratio of 0.40 + 5.0 / 7.5 kg hydrogel ha^{-1} and IW-CPE ratio of 0.50 + 5.0 kg hydrogel ha^{-1}.

Straw

IW-CPE ratio: A reference of data (Table 1) indicate that scheduling of irrigation at IW-CPE ratio of 0.50 recorded highest phosphorus uptake by straw which was found at par with the application of irrigation at IW-CPE ratio of 0.40 and both these irrigation levels significantly enhanced phosphorus uptake by straw as compared to irrigation at IW-CPE ratio of 0.30 and 0.20.

On pooled basis, the significant increases in phosphorus uptake by straw due to application of irrigation at IW-CPE ratio of 0.40 and 0.50 were 10.25, 19.13 and 12.15, 20.84 per cent over irrigation at IW-CPE ratio of 0.30 and 0.20, respectively.

Hydrogel levels: Data (Table 1) show that application of 7.5 kg hydrogel ha^{-1} recorded highest phosphorus uptake by straw which remained at par with the application of 5.0 kg hydrogel ha^{-1}, however, both these levels significantly increased phosphorus uptake by straw as compared to application of 2.5 kg hydrogel ha^{-1} and control.

Two years mean data indicate that application of 5.0 and 7.5 kg hydrogel ha^{-1} significantly enhanced phosphorus uptake by straw to the tune of 5.39, 11.38 and 6.16, 12.10 per cent over application of 2.5 kg hydrogel ha^{-1} and control, respectively.

Total uptake

IW-CPE ratio: It is evident from data (Table 1) that scheduling of irrigation through IW-CPE ratio brought about significant influence on total phosphorus uptake by crop. The highest quantum of total phosphorus was estimated when crop was irrigated at IW-CPE ratio of 0.50 which was found at par with irrigation at IW-CPE ratio of 0.40 and both these ratio significantly increased total phosphorus uptake by crop over irrigation at IW-CPE ratio of 0.30 and 0.20.

On pooled basis, the extent of improvement in total phosphorus uptake with the application of irrigation at IW-CPE ratio of 0.40 was 1.46 and 2.78 kg ha^{-1} over irrigation at IW-CPE ratio of 0.30 and 0.20, respectively. While the magnitude of increase in total phosphorus under the irrigation at IW-CPE ratio of 0.50 was 1.79 and 3.11 kg ha^{-1}, respectively.

Hydrogel levels: Data (Table 1) show that application of hydrogel at varying level caused significant influence on total phosphorus uptake as compared to control. Application of hydrogel at 7.5 kg ha^{-1} accumulated highest quantum of total phosphorus which remained at par with application of hydrogel at 5.0 kg ha^{-1} and both these levels significantly increased total phosphorus uptake over application of hydrogel of 2.5 kg ha^{-1} and control.
On pooled basis, application of 5.0 kg hydrogel ha^{-1} significantly increased total phosphorus uptake by 1.11 and 2.16 kg ha^{-1} over application of 2.5 kg hydrogel ha^{-1} and control, respectively. The corresponding increase in total phosphorus uptake by crop due to application of 7.5 kg hydrogel ha^{-1} was 1.24 and 2.29 kg ha^{-1}, respectively.

Interaction: A reference to data (Table 5) indicate that interaction effect of IW-CPE ratio and different hydrogel levels brought about significant variation on total phosphorus uptake by crop. The highest quantum of total phosphorus was estimated under the combined application of irrigation at IW-CPE ratio of 0.50 alongwith application of 7.5 kg hydrogel ha^{-1} which was significantly higher over rest of treatment combinations but at par with application of irrigation at IW-CPE ratio of 0.40 + 5.0 / 7.5 kg hydrogel ha^{-1} and IW-CPE ratio of 0.50 + 5.0 kg hydrogel ha^{-1}.

Potassium

Seed

IW-CPE ratio: The isabgol crop irrigated at IW-CPE ratio of 0.5 accumulated highest quantum of potassium in seed which was found at par with application of irrigation at IW-CPE ratio of 0.40 and both these ratio significantly increased potassium uptake by seed over irrigation of IW-CPE ratio 0.30 and 0.20 (Table 1).
The pooled data show that application of irrigation at IW-CPE ratio of 0.40 significantly improved potassium uptake by seed to the tune of 15.82 and 26.10 per cent over irrigation at IW-CPE ratio of 0.30 and 0.20, respectively. The corresponding increase in potassium uptake by seed with the application of irrigation at IW-CPE ratio of 0.50 was 17.83 and 27.86 per cent.

Hydrogel levels: The maximum potassium uptake by seed was estimated under the influence of 7.5 kg hydrogel ha^{-1} which was found at par with application of 5.0 kg hydrogel ha^{-1} and both these levels significantly increased potassium uptake by seed over application of 2.5 kg hydrogel ha^{-1} and control (Table 1).
On pooled basis, application of 5.0 kg hydrogel ha^{-1} significantly increased potassium uptake by seed to the tune of 12.62 and 21.59 per cent over application of 2.5 kg hydrogel ha^{-1} and control, respectively. The corresponding increase in potassium uptake by seed due to application of 7.5 kg hydrogel ha^{-1} was 13.62 and 22.49 per cent.

Straw

IW-CPE ratio: Scheduling of irrigation at IW-CPE ratio of 0.50 recorded highest potassium uptake by straw which was found at par with the application of irrigation at IW-CPE ratio of 0.40 and both these irrigation levels significantly enhanced potassium uptake by straw as compared to application of irrigation at IW-CPE ratio of 0.30 and 0.20 (Table 1)
On pooled basis, the significant increases in potassium uptake by straw due to application of irrigation at IW-CPE ratio of 0.40 and 0.50 were 8.65, 17.39 and 9.95, 18.57 per cent over irrigation at IW-CPE ratio of 0.30 and 0.20, respectively.

Hydrogel levels: It is explicit from data (Table 1) that application of 7.5 kg hydrogel ha^{-1} recorded highest potassium uptake by straw which remained at par with the application of 5.0 kg hydrogel ha^{-1}, however, both these levels significantly increased potassium uptake by straw as compared to application of 2.5 kg hydrogel ha^{-1} and control.
Two years mean data indicate that application of 5.0 and 7.5 kg hydrogel ha^{-1} significantly enhanced potassium uptake by straw to the tune of 5.11, 10.49 and 5.55, 10.90 per cent over application of 2.5 kg hydrogel ha^{-1} and control, respectively.

Total uptake

IW-CPE ratio: A perusal of data (Table 1) reveals that scheduling of irrigation brought about significant influence on total potassium uptake by crop. The highest quantum of total potassium was estimated when crop was irrigated at IW-CPE ratio of 0.50 which was found at par with application of irrigation at IW-CPE ratio of 0.40 and both these ratio significantly increased total potassium uptake by crop over irrigation at IW-CPE ratio of 0.30 and 0.20.
On pooled basis, the extent of improvement in total potassium uptake with the application of irrigation at IW-CPE ratio of 0.40 was 8.68 and 17.10 kg ha^{-1} over irrigation at IW-CPE ratio of 0.30 and 0.20, respectively. While the magnitude of increase in total potassium under the application of irrigation at IW-CPE ratio of 0.50 was 10.12 and 18.54 kg ha^{-1}, respectively.

Hydrogel levels: Data (Table 1) indicate that application of hydrogel at varying level caused significant influence on total potassium uptake as compared to control. Application of hydrogel at 7.5 kg ha^{-1} accumulated highest quantum of total potassium which remained at par with application of hydrogel at 5.0 kg ha^{-1} and both these levels significantly increased total potassium uptake over application of hydrogel at 2.5 kg ha^{-1} and control.
On pooled basis, application of 5.0 kg hydrogel ha^{-1} significantly increased total potassium uptake by 5.22 and 10.43 kg ha^{-1} over application of 2.5 kg hydrogel ha^{-1} and control, respectively. The corresponding increase in total potassium uptake due to application of 7.5 kg hydrogel ha^{-1} was to the tune of 5.68 and 10.89 kg ha^{-1}.

Effects of irrigation schedule on Nutrient uptake and total uptake

The plant analysis revealed that successive increase in irrigation level up to IW-CPE ratio of 0.40 brought about significant improvement in nitrogen, phosphorus and potassium content in seed and straw over irrigation at IW-CPE ratio of 0.30 and 0.20. Further crop irrigated at IW-CPE ratio of 0.40 showed significance increase in nitrogen, phosphorus and potassium uptake by seed and straw thereby total uptake over IW-CPE ratio of 0.30 and 0.20 but it was at par with IW-CPE ratio of 0.50. The marked improvement in nitrogen, phosphorus and potassium content of both plant parts with higher irrigation levels seems to be due to increase availability in the root zone on account of increased moisture supply. Secondarily it can be attributed to the efficient extraction/translocation due to increase in root ramification/activities as irrigation plays vital role in maintaining physico-chemical and biological properties of

soil. This might have promoted growth of roots as well as their functional activity leading to higher extraction of nutrients from soils to plant parts. Since phosphorus and potash are less mobile in soil environment, their availability to the roots in governed by extent of root penetration and availability of soil moisture (Campbell *et al.*, 1977) [3]. Thus, at higher irrigation level, adequate moisture supply might have increased availability of these nutrients for their absorption by the roots and translocation to the plants by virtue of increased transpiration ultimately enhancing status of these nutrients in plant parts. It is well established fact that uptake of nutrient by the crop is primarily governed by total biomass production and secondarily on nutrient status at cellular level. Thus, improvement in both these under irrigation regime IW-CPE ratio of 0.40 resulted in higher uptake of added nutrients. The results of the present investigation are in close agreement with the findings of Bhunia *et al.* (2006) [2], Jat (2013) [5], Kumawat *et al.* (2013) [7], Wanjari *et al.* (2017) [12] and Dalal (2018) [4].

Effects of Hydrogel levels on Nutrient uptake and total uptake

Application of increasing rate of hydrogel up to 5.0 kg ha^{-1} significantly improved nitrogen, phosphorus and potassium status of seed and straw over application of 2.5 kg hydrogel ha^{-1} and control. Similarly the uptake of nutrients by these plant parts and total uptake by crop showed increasing trend up to highest level of hydrogel application. The positive influence of hydrogel application on nutrient status of seed and straw seems to be due to their increased availability in the root zone. Further adequate moisture availability in the root zone of rhizosphere increased the movement of nutrient in soil solution and finally their absorption by growing plant. Moreover increase in shoot growth as evident from higher accumulation of dry matter under the influence of 5.0 kg hydrogel ha^{-1}, further reveals that there was adequate supply of photosynthates from shoot to root. This might have promoted growth of roots as well as their functional activity leading to higher extraction of nutrients from soil to plant parts. Since most of nutrients (N, P, K) in seed is relocated from their reserves in vegetative parts, better nutritional conditions of seed with hydrogel application seems to be on account of their higher concentration in plants. The results are in close agreement with findings of several researchers (Tyagi *et al.*, 2015, Singh *et al.*, 2017 and Rakshit *et al.*, 2018) [11, 10, 8]. They also ascribed marked improvement in nutritional status of plant under hydrogel application due to their increase availability in the root zone and higher extraction due to better growth of roots.

Table 1: Effect of irrigation scheduling and hydrogel levels on nutrient uptake and total (kg ha^{-1}) of isabgol (Data pooled over two years)

Treatments	Nitrogen			Phosphorus			Potassium		
	Seed	Straw	Total	Seed	Straw	Total	Seed	Straw	Total
IW-CPE ratio									
0.20	15.01	14.86	29.86	4.75	7.10	11.85	4.53	73.61	78.14
0.30	17.19	16.83	34.02	5.28	7.88	13.17	5.16	81.40	86.56
0.40	19.75	19.50	39.24	5.85	8.78	14.63	6.13	89.11	95.24
0.50	20.29	19.86	40.14	5.99	8.97	14.96	6.28	90.40	96.68
S.Em.±	0.22	0.19	0.30	0.06	0.08	0.11	0.07	0.83	0.84
C.D. (P=0.05)	0.64	0.57	0.90	0.19	0.25	0.32	0.22	2.48	2.51
Hydrogel levels (kg ha^{-1})									
Control	15.67	16.31	31.98	4.73	7.55	12.28	4.72	77.80	82.52
2.5	17.34	17.46	34.79	5.27	8.06	13.33	5.26	82.47	87.73
5.0	19.54	18.54	38.08	5.91	8.52	14.44	6.02	86.92	92.95
7.5	19.68	18.73	38.42	5.97	8.59	14.57	6.09	87.32	93.41
S.Em.±	0.10	0.12	0.17	0.03	0.05	0.07	0.03	0.48	0.49
C.D. (P=0.05)	0.27	0.34	0.47	0.09	0.14	0.20	0.09	1.35	1.37

Table 2: Interaction effect of irrigation scheduling and hydrogel levels on nitrogen uptake (kg ha^{-1}) in seed of isabgol (Data pooled over two years)

Hydrogel levels (kg ha^{-1})	IW-CPE ratio			
	0.20	0.30	0.40	0.50
		Pooled		
Control	13.41	15.35	16.42	17.50
2.5	14.95	16.68	18.64	19.07
5.0	15.84	18.11	22.19	22.01
7.5	15.84	18.61	21.73	22.56
S.Em.±	0.41			
CD at 5%	1.17			
IInd S.Em.±	0.41			
CD at 5%	1.17			

Table 3: Interaction effect of irrigation scheduling and hydrogel levels on total nitrogen uptake (kg ha^{-1}) by isabgol crop (Data pooled over two years)

Hydrogel levels (kg ha^{-1})	IW-CPE ratio			
	0.20	0.30	0.40	0.50
		Pooled		
Control	27.49	31.09	33.52	35.83
2.5	29.70	33.08	37.91	38.48
5.0	31.16	35.76	42.90	42.48
7.5	31.11	36.14	42.65	43.78
S.Em.±	0.62			
CD at 5%	1.76			
IInd S.Em.±	0.62			
CD at 5%	1.76			

Table 4: Interaction effect of irrigation scheduling and hydrogel levels on phosphorus uptake (kg ha^{-1}) in seed of isabgol (Data pooled over two years)

Hydrogel levels (kg ha^{-1})	IW-CPE ratio			
	0.20	0.30	0.40	0.50
		Pooled		
Control	4.20	4.66	4.85	5.23
2.5	4.74	5.11	5.53	5.68
5.0	5.05	5.59	6.58	6.43
7.5	5.03	5.77	6.45	6.63
S.Em.±	0.12			
CD at 5%	0.35			
IInd S.Em.±	0.13			
CD at 5%	0.36			

Table 5: Interaction effect of irrigation scheduling and hydrogel levels on total phosphorus uptake (kg ha^{-1}) by isabgol crop (Data pooled over two years)

Hydrogel levels (kg ha^{-1})	IW-CPE ratio			
	0.20	0.30	0.40	0.50
		Pooled		
Control	10.97	12.08	12.60	13.49
2.5	11.79	12.85	14.19	14.49
5.0	12.36	13.76	15.92	15.70
7.5	12.30	13.98	15.82	16.17
S.Em.±	0.24			
CD at 5%	0.68			
IInd S.Em.±	0.24			
CD at 5%	0.68			

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