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Evaluation of Pusa Hydrogel for higher Productivity of Wheat in Bihar

RAM PAL*

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ABSTRACT

Water is considered as one of the most crucial inputs for agricultural production. Moisture stress at critical stages of growth badly hampers the yield in wheat. Pusa hydrogel (supper absorbent polymer: coated carboxymethyl cellulose) can maintain the optimum moisture level in the root zone and prevent the crop from moisture stress. A trial was conducted during Rabi 2015-16 and 2016-17 to evaluate the appropriate dose of it for getting a better yield of wheat in Bihar (Rohtas district), having three doses (0, 2.5 and 5.0 kg/ha hydrogel). The dose of 2.5 kg/ ha hydrogel recorded the highest estimates for all the traits under the studies, namely, grain yield (6120 kg/ha), biological yield (12356 kg/ha), spikes/m^2 (225.25), grains/ear (65.21), test weight (37.69 g) and harvest index (49.59 %). Spikes/ m^2 and test weight having, significantly superior scores over the control, seems to be the reasons behind the increase in grain yield due to the application of hydrogel. The economic analysis of the findings reflected that the highest B:C ratio (3.43) was recorded in T_2(2.5 kg/ha hydrogel) , followed by T_1 (0 kg/ha hydrogel) (3.39) and T_3(5 kg/ha hydrogel) (3. 04) which are about at par with each other. The high cost of the hydrogel may be a reason behind this, nullifying the benefit due to the increase in yield.

KEYWORDS

Hydrogel, wheat, moisture stress, water stress

INTRODUCTION

Wheat is one of the most significant cereal in human nutrition and is being cultivated worldwide over large areas, i.e. 226 million ha (mha), constituting 32% of total cereal cultivated land (FAO 2016). It contributes about 20% of humans' daily dietary calorie and 21% of daily dietary protein intake. Wheat is the second most important food grain of India, with an area of 30.5 mha, production of 98.4 million tonnes (mt), and average productivity of 3216 kg/ha (Anonymous, 2016).

Water is considered as one of the most crucial inputs for agricultural production. It facilitates a higher productive potential from the land, and significant response from applied agricultural inputs, viz. high-yielding varieties and fertilizer etc. (Kukal *et al.*, 2014). Water scarcity is an emerging global concern in the context of increasing population and competitive demands from agriculture, industry and urban inhabitants (Babel and Wahid, 2008). Groundwater is the main source of irrigation in the wheat-growing belt of the country where the water table is lowering by approximately a meter annually, causing an alarming situation in the region (CGWB 2014). If the present level of water consumption for wheat cultivation persists, the major wheat-producing belts may not possibly sustain their wheat production in the future (Kang *et al.*, 2002, Kukal *et al.*, 2003). It has been estimated that by the year 2025, about two-thirds of the world will experience water scarcity. India has already entered the shadow of the zone of physical and economic scarcity.

Rohtas produced 8.4 percent of total state wheat production in only 6.7 percent of the area of Bihar in the year 2014-15. Average annual grain productivity of Bihar increased by 5.65 % during the year 2010-2015. During the same time average annual growth in rice productivity was recorded as18.99 % while negative growth of 7.44% in wheat productivity was recorded (Anonymous, 2016). This negative growth might be due to several reasons but moisture stress at a different critical stage is very much responsible for lower wheat yield.

Several technologies and agronomic practices have been developed and recommended for improving water productivity of wheat. However, a holistic strategy to evolve integrated solutions for multiple problems has been elusive (Ladha *et al.*, 2009). In this context, the hydrogel has shown potential to realize higher crop yield with limited water. A significant improvement in yield and water use efficiency in most of the test crops was reported by application of hydrogel (Anupama and Parmar, 2012). It has also been reported to improve seed germination, root growth and density, and help plants withstand extended moisture. Hydrogels have great potential in areas where the opportunity for irrigation is limited and can increase water availability during crop establishment.

The hydrogels can also modify various physical properties of soil like infiltration rates, density, soil structure and compaction, etc.(El-Hady and Abo-Sedera, 2006). Various reports have suggested the beneficial impact of the hydrogel in crop growth and soil properties. Hydrogel applied at the rate of 5 kg/ ha along with farm yard manure (FYM) in an alluvial sandy loam soil significantly impacted hydrological properties of soil like the field capacity, plant available water content, relative field capacity and saturated hydraulic conductivity (Narjary and Aggarwal,2014). Grain yield, nutrient uptake and water-use efficiency improved in winter wheat when hydrogel was applied at the rate of 5 kg/ha in a sandy loam

Krishi Vigyan Kendra, Rohtas, Bikramganj, Rohtas, Bihar 802212, India
*Corresponding Author email: rampalag97@gmail.com

soil (Tyagi *et al*., 2015), while in a clay loam soil with the same dose of hydrogel application along with recommended dose of fertilizer 8.48% increase in yield was observed(Borivoj *et al*., 2006). Keeping above in mind, an On Farm Trial (OFT) was conducted to examine the effect of different dose of hydrogels on productivity and profitability of wheat cultivation in Rohtas district of Bihar.

MATERIALS AND METHODS

Pusa Hydrogel was used for the study. It 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). The OFT was conducted in Rabi 2016-17 and Rabi 2017-18 at farmers field at seven sites in each year. The treatment details are given in Table 1. Most of the soil of the district is old alluvium (43.9 % reddish and brown and 35.3 % is grey and brown) and rest is new alluvium. About 86 % ofthe cultivable area is under canal irrigation. Rice wheat is the major production system. Long duration MTU 7029 and medium duration BPT 5204 are leading rice varieties of the district. Average annual rainfall is 746.6 mm and maximum and minimum temperature is 15 ^{0}C and 46^{0}C, respectively (Anonymous, 2017)

Table 1: Treatments details of on farm trails

Treatment	Descriptions
T_1	No use of hydrogel (Farmers' Practice)
T_2	Application of 2.5 kg/ ha hydrogel mixed with NPK(12:32:16)
T_3	Application of 5.0 kg/ha hydrogel mixed with NPK(12:32:16)

Hydrogel was mixed with fertilizer and put into the fertilizer box of zero-till machine for wheat sowing so as it couldbe placed just below the seed as recommended by IARI-2012. Wheat variety HD 2967 was used for trails. Fertilizer dose was kept same (N:P:K and urea 200 kg/ha + 20 kg/ha murate of potash)for all treatments. A complete dose of phosphate was applied through N:P:K (12:32:16) asa basal dose. Urea was applied in two equal split doses (26 DAS and booting stage). Murate of potash was applied along with the last dose of urea. Wheat seed rate was kept 100 kg/ha. All treatments were executed in 1000 m^{2}plots and number of farmers was taken as the number of replications. Three irrigations were applied to all plots including control. Yield and yield attributing characters were recorded in each year from three different locations using meter quadrant. Analysis of Data was done by MS-Excel package of MS- Office.

RESULTS AND DISCUSSIONS

Perusal of data presented in Table 2, displays estimates of various traits of the studies, recorded under the different treatments/ doses of hydrogel in wheat during *Rabi*-2015-16 and 2016-17. The studies indicated that all the attributes were affected by the different treatments, having the highest scores under treatment T_2 (2.5 kg/ha hydrogel). T_2 recorded the highest estimates for grain yield during both the seasons (6044 kg/ha in *Rabi* 2015-16 and 6149 kg/ha in *Rabi* 2016-17), significantly surpassing by 8.86 and 7.23 percent over the control, respectively during *Rabi*-2015-16 and 2016-17. The similar patterns were also followed by spikes/m^2 and test weight. T_2 had 237.43 (*Rabi* 2015-16) and 213.07 (Rabi 2016-17) spikes/m^2 surpassing by 34.08 (*Rabi* 2015-16) and 15.17(*Rabi* 2016-17) per cent and 38.46 (*Rabi* 2015-16) and 36.92 (Rabi 2016-17) g test weight, having an increase by 11.28 (*Rabi* 2015-16) and 5.93 (*Rabi* 2016-17) percent over the control. These findings indicate that the traits, mainly attributing in the increase of grain yield under the studies are spikes/m^2 and test weight. Similar to the present findings were reported by Tyagi *et al*., 2015; Kumar *et al*., 2019; and Anupama and Parmar, 2012. The overall mean of both the seasons indicates that 6120 kg/ha grain yield may be obtained by applying 2.5 kg/ha hydrogel, which are 8.03 percent higher than control.

Table 2: Effects of different treatments on estimates of grain and other traits in wheat.

Parameters	T1			T2			T3			CD	
	2015-16	2016-17	Mean	2015-16	2016-17	Mean	2015-16	2016-17	Mean	2015-16	2016-17
Grain yield (kg/ha)	5552	5778	5665	**6044***	**6196***	**6120**	5689	5864	5781	193.52	111.08
Biological yield (kg/ha)	12355	11499	11927	12753	11960	**12356**	12496	11661	12078	620.05	642.79
Spikes/m^2	203.93	185.0	194.46	**237.43***	**213.07***	**225.25**	235.57	191.07	213.32	21.44	13.56
Grains/ear	63.14	58.71	60.93	66.14	64.28	**65.21**	65.71	59.01	62.36	9.43	9.41
Test weight (g)	34.56	34.85	34.71	**38.46***	**36.92***	**37.69**	36.90*	35.33	36.12	2.87	1.74
Harvest index (%)	44.93	50.24	47.59	47.39	51.80	**49.59**	45.52	48.74	47.13	-	-

The economic analysis of the findings (Table 3) reflected that the highest B:C ratio (3.43) was recorded in T_2, followed by T_1 (3.39) and T_3 (3. 04) which are about at par with each other. The high cost of the hydrogel may be a reason behind this, nullifying the benefit due to the increase in yield. This is also substantiated by the lowest estimate of B:C ratio in T_3. Therefore, the cost of the hydrogel is required to be reduced to get the proper benefit of the studies. Before the recommendation of the findings, an economical gain of hydrogel application should be compared with that of the cost of additional irrigation applied.

Table 3: Economical analysis of wheat yield

Treatment	Average yield, kg/ha	Cost of cultivation (Rs)	Gross return (Rs)	Net return (Rs)	B:C ratio
T_1 (C)	5665	28920	98288	69368	3.39
T_2	6120	30920	106182	75262	3.43
T_3	5781	32920	100214	67294	3.04

(Labour cost was not added in the cost of cultivation, MSP was taken as Rs.1735/ qt.)

CONCLUSIONS

Results of this OFT clearly indicate that hydrogel at the rate of 2.5 kg ha gave better results in both the year. A higher dose (5kg/ha) neither gave higher yield nor B:C ratio and the higher dose was detrimental for crop establishment as germination at higher moisture content was failed at few sites. Rohtas has enough irrigation water at a cheaper rate and farmers have open choice to provide extra irrigation in the same expenditure which they incurred for purchasing of the hydrogel. Therefore, before making a final recommendation for the use of hydrogel, more experiments with different doses of hydrogel and the number of irrigation should be conducted. Outcome of these trails would not only be helpful in increasing wheat yield but also promote mechanization of rice harvesting and wheat sowing (rice is harvested by combine harvester when soil becomes dry enough to withstand the load of it and after this wheat is being sown by zero till lower moisture hampers the seed germination) at time of in the district.

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