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Enhancing the quality of single cross maize hybrid (*Zea mays* L.) and soil fertility status under divers hydrogel and fertility levels in rainfed condition of North-Western Himalayan region

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Abstract
The present experiment has been conducted in *kharif* 2019 and 2020 at Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur with four level of hydrogel application (H_1: Control; H_2: 2.5 kg/ha; H_3: 5.0 kg/ha; H_4: 7.5 kg/ha) and four levels of fertility (F_1: 75 kg N + 40 kg P_2O_5 + 30 kg K_2O ha^{-1}**;** F_2**:** 90 kg N + 45 kg P_2O_5 + 35 kg K_2O ha^{-1}**;** F_3**:** 105 kg N + 50 kg P_2O_5 + 40 kg K_2O ha^{-1}; F_4**:** 120 kg N + 55 kg P_2O_5 + 45 kg K_2O ha^{-1}**)** using factorial randomized block design. Study revealed that soil application of hydrogel @ 7.5 kg/ha recorded significantly higher protein content, nutrient content, their uptake and available N, P and K of soil and WHC which remained at par on soil application of hydrogel @ 5.0 kg/ha over control. In different fertility levels, application of 120 kg N + 55 kg P_2O_5 + 45 kg K_2O ha^{-1} (F_4) recorded significantly higher protein content, nutrient content, their uptake and available N, P and K of soil which remained at par on soil application of 105 kg N + 50 kg P_2O_5 + 40 kg K_2O ha^{-1} (F_3) over control. Our result suggested that application of hydrogel @ 5.0 kg/ha with 105 kg N + 50 kg P_2O_5 + 40 kg K_2O ha^{-1} enhance grain quality and soil nutrient status.

Keywords: Hydrogel, WHC, maize hybrid, protein

Introduction
It is perhaps one of nature's most important gifts to mankind that maize (*Zea mays* L.) has evolved into such a major crop. Maize is cultivated worldwide, and each year more maize is produced than any other grain. It is the third most important cereal crop that is considered as an integral component of food security at global level. It is source for a large number of industrial products *viz.*, maize corn, corn starch, corn oil, baby corn, popcorn, as dairy feed, poultry feed, piggery, used in agro industries, and so on. In Rajasthan, the crop occupies 0.97 million ha area with an annual production of 2.70 million ton and average yield of 27.69 q ha^{-1} (Govt. of Rajasthan, 2021) [8]. The climate of the southern Rajasthan is very much favourable for maize crop wherein it is predominantly cultivated under rainfed condition during *kharif* season.

About 80 per cent of maize is cultivated during the monsoon season, mostly under rainfed conditions. During this period, no similar trend for dry spell has been noted, yet majority of maize growing areas in the state is exposed to 15 to 20 per cent probability of the occurrence of moderate drought which may be at initial stage, knee high stage or flowering and grain filling stage thus causes in severe reduction in grain yield or sometimes leading to crop failure situation. Water is an important lifesaving natural resource for all crops in particular maize. It profoundly influences photosynthesis, respiration, absorption, translocation and utilization of mineral nutrients and cell division (Kumari *et al.*, 2017) [13]. Thus rainfed situation needs sustainable use of available water in soil by absorption and desorption over long period of time in soil for the efficient use of available resources by the hybrid maize plants. It is possible to increase the productivity of agricultural crops by utilizing soil conditioners like super absorbent polymer (Hydrogel). These polymers can hold 400-1500 g of water per gram of polymer (Kumari *et al.*, 2017) [13]. Thus, the use of polymers has great importance for their role in increasing of water absorption and desorption again under partial water stress condition. Under rainfed conditions, single cross hybrid can withstand partial stress and efficiently use available recourses from soil by use of these polymers.

It also affects protein content of the grain as well as fodder (Halvin *et al.*, 2005) [9]. Similarly, potassium is another important primary nutrient as it is vital to many plant processes. It increases root growth and improves drought resistance, activates many enzymes in plant systems, maintains turgor, reduces water loss and wilting, aids in photosynthesis and reduces respiration, prevent energy losses, enhances translocation of sugars and starch, produces grain rich in starch, increases protein content of plants, promotes cellulose synthesis and reduces lodging as well as in retarding crop diseases (Pettigrew, 2008) [20]. Higher yield of single cross maize hybrid can be obtained through the judicious use of nitrogen, phosphorus and potassium (Das *et al.*, 2012 [6] and Choudhary *et al*., 2021) [1]. This study examined the performance of a single cross maize hybrid (*Zea mays* L.) under varying hydrogel and fertility levels in rainfed conditions in Southern Rajasthan in light of the above facts and the lack of research findings related to these aspects in the region.

Material and Methods

Site description: In two consecutive years, *kharif* 2019 and 2020, the field experiment was conducted at the Instructional Farm of the Department of Agronomy, Maharana Pratap University of Agriculture and Technology, Udaipur. The soil of experimental field had pH (7.4 and 7.6), electrical conductivity (0.86 and 0.87 dSm^{-1}) and organic carbon (0.65 and 0.67%), Available N, P and K were (290.4 and 297.3, 20.5 and 20.7, 350.2 and 368.4kg/ha, respectively) in 2019 and 2020, respectively.

Treatments details and crop management

Using a factorial randomized block design with three replications, sixteen treatment combinations were examined, each consisting of two factors *viz.* soil application of hydrogel and fertility levels. In soil application of hydrogel (H_1: Control; H_2: 2.5 kg/ha; H_3: 5.0 kg/ha; H_4: 7.5 kg/ha) and fertility levels (F_1: 75 kg N + 40 kg P_2O_5 + 30 kg K_2O ha^{-1}**;** F_2**:** 90 kg N + 45 kg P_2O_5 + 35 kg K_2O ha^{-1}**;** F_3**:** 105 kg N + 50 kg P_2O_5 + 40 kg K_2O ha^{-1}; F_4**:** 120 kg N + 55 kg P_2O_5 + 45 kg K_2O ha^{-1}**)** were taken for study. As per treatment, calculated quantity of nitrogen, phosphorus and potassium were applied through urea, DAP and MOP. One third of nitrogen and full dose of phosphorus and potassium were given as basal applications at time of sowing by drilling urea, DAP and MOP fertilizer in crop rows about 4-5 cm below the seeds. The rest two third nitrogen was applied in two equal splits *viz.*, knee high stage and at 50 per cent tasseling as top dressing. As per treatments calculated quantity of hydrogel was first mixed in sand and thereafter applied at time of sowing by drilling it in crop rows about 4-5 cm below the seeds. The cropwas sown using 20 kg seed ha^{-1}. In well prepared field, furrows were opened at 60 cm apart and seeds were placed manually at 25 cm at a depth of 3-4 cm. Before sowing, seeds were treated with recommended fungicide to protect from diseases. To see the impact of hydrogel no irrigation was given during crop growth period and the crop was raised as rainfed crop.

Sample collection and analysis

During both the years, the grain and stover samples collected at harvest from produce of each experimental unit were oven dried at 65°C to a constant weight and ground in laboratory mill for estimating nutrient content. These samples were subjected to chemical analysis for determination of nutrient contents. The following standard methods were adopted for analysis.

Methods employed for plant analysis

Nitrogen	Nessler's reagent colorimetric method (Lindner, 1944) [14]
Phosphorus	Vanadomolybdate phosphoric yellow colour method (Richards, 1968)
Potassium	Flame photometer Jackson (1973) [11]

Nutrient uptake of N, P and K were computed by using the following formula:

$$\text{Nutrient uptake}\left(\text{kg ha}^{-1}\right)=\frac{\text{Nutrient content }(\%)\times\text{Yield}\left(\text{kg ha}^{-1}\right)}{100}$$

The total uptake by the crop was computed by summing up the uptake of grain and stover. Soil samples were collected from each plot up to 15 cm depth after harvest of experimental maize crop. These samples were dried, ground and passed through 2 mm sieve in order to analyse for available nitrogen, phosphorus, potassium content of soil as per standard methods (Subbiah and Asija (1956) [26], Olsen *et al.* (1954) [18] and Jackson (1973) [11], respectively). The grain samples collected at harvest from produce of each experimental unit were oven dried at 65 °C to a constant weight and ground in laboratory mill. These samples were subjected to chemical analysis for determination of protein content through Lowery protein assay method (Lowery *et al.*, 1951) [15]. At time of harvest the grain samples were collected from each experimental unit and subjected to determination of moisture content through digital moisture recorder.

Statistical data analysis

All the data were subjected to statistical analysis by adopting appropriate method of analysis of variance as described by Cochran and Cox (1967) [5]. Wherever, the F value was found significant at 5 per cent level of significance, the critical difference (CD) values were computed for comparing treatment means.

Result

N, P and K content and uptake by grain and stover

Hydrogel level: The maximum N, P, and K content in grain and stover was recorded under soil application of 7.5 kg hydrogel ha^{-1}irrespective of the years as well as the pooled basis, which was statistically at the same level as the N, P, and K content recorded under 5 kg hydrogel ha^{-1}, but was significantly higher than the other levels of hydrogel application (Table- 1, 2 and 3). At the same time application of 2.5 kg hydrogel ha^{-1} also significantly increased N, P and K content of grain and stover over control. Across the years as well as on pooled basis, maximum N, P and K uptake by grain and stover was recorded under soil application of 7.5 kg hydrogel ha^{-1} which was statistically at par with that of N, P and K uptake recorded under 5 kg hydrogel ha^{-1}, however, proved significantly higher over rest of the levels of hydrogel application (Table- 4, 5 and 6).Nutrient accumulation in plant depends upon dry matter accumulation and nutrients content at cellular level. The content of nutrients increases under soil application of hydrogel. The uptake of nutrients by grain, stover and total uptake increased may be attributed to significantly higher grain and stover yield and their nutrient content under soil application of hydrogel. The results are in close accordance with findings Parik *et al.* (2019) [19].

Fertility levels

Different levels of fertility significantly affected N, P and K content and N, P and K uptake. Application of fertilizers @ 120 kg N + 55 kg P_2O_5 + 45 kg K_2O ha^{-1} recorded highest, P and K content and N, P and K uptake by grain and stover and total but it was remained at par with application of fertilizers @105 kg N + 50 kg P_2O_5 + 40 kg K_2O ha^{-1} over 75 kg N + 40 kg P_2O_5 + 30 kg K_2O ha^{-1} in both the years.The significant improvement in nutrient status of maize, grain and stover could be on account of greater availability of nutrients in soil environment along with better extraction and translocation towards plant system. The externally applied nitrogen, phosphorus and potassium supported native available nutrients and increase nitrogen, phosphorus and potassium concentration in soil with increase fertility which was sufficient to meet the requirement of maize crop. The significantly increase in nitrogen, phosphorus and potassium uptake of stover at harvest seems to be account of capabilities of fodder maize plants for efficient absorption, translocation and utilization of absorbed nutrients. The results are in line of. It is an established fact that nutrient uptake depends upon dry matter and content of nutrient at cellular level. The simultaneous improvement in both of these components resulted in higher uptake of nitrogen, phosphorus and potassium with increasing fertility levels from 75 kg N + 40 kg P_2O_5 + 30 kg K_2O ha^{-1} to 120 kg N + 55 kg P_2O_5 + 45 kg K_2O ha^{-1}. The present results are in close accordance with the findings of Dhaka, (2014) [7], Rodinpuia *et al*. (2019) [22], Van *et al*. (2020) [30], Choudhary *et al*. (2021) [1] and Choudhary *et al*. (2022) [2].

Quality parameters

Hydrogel level

Across the years as well as on pooled basis, the highest protein in grain was recorded under soil application of hydrogel at 7.5 kg ha^{-1} which was significantly higher over hydrogel at 2.5 kg ha^{-1} and control, however, proved statistically at par with 5.0 kg hydrogel ha^{-1} application (Table-7). Irrespective of the years as well as on pooled basis, increasing hydrogel levels failed to record perceptible variation in moisture content of grain. It has been reported that treatment of soil application of hydrogel induced vigour of plant, improve growth due to many folds by increase of metabolic activities, enzymes α-amylase and protease activity through better availability of moisture and nutrients (Meena, 2020) [17]. Hydrogel might have up-regulated the α-amylase and protease activity in maize plant which in turn increase N, P and K content in leaves, grain and stover and protein contents in grain. The results are in close accordance with findings of Yu *et al*. (2021) [32] and Kumar *et al*. (2021).

Fertility levels

Irrespective of years as well as on pooled basis, application of 105 kg N + 50 kg P_2O_5 + 40 kg K_2O ha^{-1} significantly increased protein content in grain over 90 kg N + 45 kg P_2O_5 + 35 kg K_2O ha^{-1} and 75 kg N + 40 kg P_2O_5 + 30 kg K_2O ha^{-1}. At the same time further increase in fertility level from 105 kg N + 50 kg P_2O_5 + 40 kg K_2O ha^{-1} to 120 kg N + 55 kg P_2O_5 + 45 kg K_2O ha^{-1} though increased protein, however, failed to record significant variation in this respect during both the years as well as on pooled basis.

Soil nutrient status

Hydrogel level: Different levels of hydrogel application significantly affected available N, P and K content in soil (Table-8). Application of hydrogel up to 7.5 kg ha^{-1} recorded highest N, P and K content in soil but it was remained at par with application of hydrogel up to 5 kg ha^{-1} over control in both the years.

Fertility levels: Different levels of fertility significantly affected N, P and K content in soil (Table-8). Application of fertilizers @ 120 kg N + 55 kg P_2O_5 + 45 kg K_2O ha^{-1} recorded highest N, P and K content in soil but it was remained at par with application of fertilizers @105 kg N + 50 kg P_2O_5 + 40 kg K_2O ha^{-1} over 75 kg N + 40 kg P_2O_5 + 30 kg K_2O ha^{-1} in both the years. The increase in available nitrogen, phosphorus and potassium content of soil under application of highest fertility level could be ascribed that added nutrients are used for maintaining their higher concentration, which could be used for better growth and development of plant and thereafter for sustaining higher yields on one hand, and assured higher restoration of soil nutrient status on other hand (Meena *et al.*, 2017) [16] and Parik *et al.* (2019) [19]. After fulfilling required nitrogen, phosphorus and potassium for plants, the additional nutrients as well as other nutrients on account of their mineralization from native source in soil caused increased nutrient status in soil under increasing fertility levels. The results of present investigation are in line conformity with results of Totawat *et al.* (2010) [28], Snehlata *et al.* (2016) [25], Choudhary *et al*. (2021) [1] and Choudhary *et al*. (2022) [2].

Water holding capacity

Hydrogel level

Irrespective of years as well as on pooled basis maximum WHC at 15 and 30 cm depth was recorded under soil application of 7.5 kg hydrogel ha^{-1}followed by soil application of 5.0 kg hydrogel ha^{-1}which was significantly higher over rest of the treatments (Table-8). The polymers with high molecular weight and high negative charge absorb a significant amount of water, up to 400–2000 g water g^{-1} (Yang *et al.*, 2014) [31]. When the hydrogel-amended soil dries, the absorbed water by hydrogel particles (about 90–95% of the retained water) could gradually be released to the plants (Han *et al.*, 2013) [10]. These polymers can hold 400-1500 g of water per gram of polymer (Kumari *et al.*, 2017) [13]. Thus, the use of polymers has great importance for their role in increasing of water absorption and desorption again under partial water stress condition. The hydrogel application might increase not only WHC but also AWC of soils and reduce water loss by deep percolation and fertilizer leaching (Yu *et al.*, 2017) [33].

Fertility levels

Irrespective of the years as well as on pooled basis, increasing fertility levels failed to record perceptible variation in soil WHC at 15 and 30 cm depth.

Table 1: Effect of hydrogel levels and fertility levels on nitrogen content of grain andstover at harvest single cross hybrid maize

Treatments	Nitrogen content (%)					
	Grain			Stover		
	2019	2020	Pooled	2019	2020	Pooled
Hydrogel levels (kg ha^{-1})						
Control	1.470	1.550	1.510	0.657	0.771	0.714
2.5	1.725	1.808	1.766	0.776	0.823	0.799
5.0	1.770	1.858	1.814	0.808	0.863	0.835
7.5	1.785	1.874	1.829	0.812	0.868	0.840
SEm±	0.013	0.009	0.007	0.005	0.007	0.002
C.D. (P = 0.05%)	0.038	0.027	0.019	0.014	0.020	0.007
Fertility levels (kg ha^{-1})						
75 kg N + 40 kg P_2O_5 + 30 kg K_2O	1.513	1.572	1.543	0.678	0.779	0.728
90 kg N + 45 kg P_2O_5 + 35 kg K_2O	1.702	1.809	1.755	0.769	0.823	0.796
105 kg N + 50 kg P_2O_5 + 40 kg K_2O	1.756	1.852	1.804	0.800	0.852	0.826
120 kg N + 55 kg P_2O_5 + 45 kg K_2O	1.779	1.857	1.818	0.805	0.870	0.837
SEm±	0.013	0.009	0.007	0.005	0.007	0.002
C.D. (P = 0.05%)	0.038	0.027	0.019	0.014	0.020	0.007

Table 2: Effect of hydrogel levels and fertility levels on phosphorous content of grain and stover at harvest in single cross hybrid maize

Treatments	Phosphorous content (%)					
	Grain			Stover		
	2019	2020	Pooled	2019	2020	Pooled
Hydrogel levels (kg ha^{-1})						
Control	0.308	0.319	0.313	0.161	0.175	0.168
2.5	0.377	0.399	0.388	0.165	0.178	0.172
5.0	0.390	0.414	0.402	0.174	0.184	0.179
7.5	0.396	0.417	0.406	0.175	0.188	0.182
SEm±	0.004	0.004	0.002	0.002	0.002	0.001
C.D. (P = 0.05%)	0.010	0.011	0.005	0.007	0.006	0.003
Fertility levels (kg ha^{-1})						
75 kg N + 40 kg P_2O_5 + 30 kg K_2O	0.309	0.320	0.315	0.161	0.173	0.167
90 kg N + 45 kg P_2O_5 + 35 kg K_2O	0.377	0.396	0.387	0.166	0.180	0.173
105 kg N + 50 kg P_2O_5 + 40 kg K_2O	0.390	0.414	0.402	0.173	0.185	0.179
120 kg N + 55 kg P_2O_5 + 45 kg K_2O	0.394	0.417	0.406	0.176	0.188	0.182
SEm±	0.004	0.004	0.002	0.002	0.002	0.001
C.D. (P = 0.05%)	0.010	0.011	0.005	0.007	0.006	0.003

Table 3: Effect of hydrogel levels and fertility levels on potassium content of grain and stover at harvest in single cross hybrid maize

Treatments	Potassium content (%)					
	Grain			Stover		
	2019	2020	Pooled	2019	2020	Pooled
Hydrogel levels (kg ha^{-1})						
Control	0.424	0.439	0.432	1.261	1.292	1.277
2.5	0.444	0.463	0.453	1.305	1.321	1.313
5.0	0.454	0.476	0.465	1.330	1.347	1.338
7.5	0.466	0.482	0.474	1.349	1.353	1.351
SEm±	0.003	0.003	0.001	0.007	0.008	0.004
C.D. (P = 0.05%)	0.007	0.010	0.004	0.020	0.022	0.010
Fertility levels (kg ha^{-1})						
75 kg N + 40 kg P_2O_5 + 30 kg K_2O	0.434	0.449	0.442	1.277	1.299	1.288
90 kg N + 45 kg P_2O_5 + 35 kg K_2O	0.444	0.460	0.452	1.303	1.320	1.312
105 kg N + 50 kg P_2O_5 + 40 kg K_2O	0.453	0.474	0.463	1.329	1.345	1.337
120 kg N + 55 kg P_2O_5 + 45 kg K_2O	0.457	0.477	0.467	1.336	1.350	1.343
SEm±	0.003	0.003	0.001	0.007	0.008	0.004
C.D. (P = 0.05%)	0.007	0.010	0.004	0.020	0.022	0.010

Table 4: Effect of hydrogel levels and fertility levels on nitrogen uptakeby grain, stover and total uptake by single cross hybrid maize

Treatments	Nitrogen uptake (kg ha^{-1})								
	Grains			Stover			Total		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
Hydrogel levels (kg ha^{-1})									
Control	53.55	61.46	57.50	39.80	50.40	45.10	93.35	111.85	102.60
2.5	67.72	78.51	73.11	50.31	56.87	53.59	118.03	135.38	126.70
5.0	74.68	87.43	81.05	56.43	66.55	61.49	131.11	153.98	142.54

7.5	77.08	89.71	83.40	57.16	69.46	63.31	134.25	159.17	146.71
SEm±	1.40	1.71	0.72	1.05	1.35	0.54	1.96	2.20	1.00
C.D. (P = 0.05%)	4.05	4.95	2.03	3.02	3.89	1.52	5.67	6.35	2.83
Fertility levels (kg ha^{-1})									
75 kg N + 40 kg P_2O_5 + 30 kg K_2O	56.60	61.89	59.24	41.80	51.46	46.63	98.40	113.35	105.87
90 kg N + 45 kg P_2O_5 + 35 kg K_2O	67.64	78.98	73.31	50.24	59.78	55.01	117.88	138.76	128.32
105 kg N + 50 kg P_2O_5 + 40 kg K_2O	73.78	87.70	80.74	55.91	65.12	60.51	129.68	152.82	141.25
120 kg N + 55 kg P_2O_5 + 45 kg K_2O	75.01	88.54	81.77	55.76	66.92	61.34	130.77	155.46	143.11
SEm±	1.40	1.71	0.72	1.05	1.35	0.54	1.96	2.20	1.00
C.D. (P = 0.05%)	4.05	4.95	2.03	3.02	3.89	1.52	5.67	6.35	2.83

Table 5: Effect of hydrogel levels and fertility levels on phosphorous uptakeby grain, stover and total uptake by single cross hybrid maize

Treatments	Phosphorous uptake (kg ha^{-1})								
	Grains			Stover			Total		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
Hydrogel levels (kg ha^{-1})									
Control	11.22	12.70	11.96	9.61	11.32	10.47	20.83	24.03	22.43
2.5	14.80	17.32	16.06	10.71	12.32	11.52	25.51	29.64	27.58
5.0	16.50	19.54	18.02	12.16	14.26	13.21	28.67	33.80	31.23
7.5	17.11	19.98	18.55	12.34	15.15	13.74	29.45	35.13	32.29
SEm±	0.34	0.38	0.18	0.26	0.26	0.13	0.48	0.41	0.24
C.D. (P = 0.05%)	0.99	1.09	0.50	0.74	0.75	0.37	1.39	1.18	0.69
Fertility levels (kg ha^{-1})									
75 kg N + 40 kg P_2O_5 + 30 kg K_2O	11.59	12.65	12.12	9.74	11.35	10.54	21.33	24.01	22.67
90 kg N + 45 kg P_2O_5 + 35 kg K_2O	15.00	17.36	16.18	10.83	13.08	11.95	25.83	30.43	28.13
105 kg N + 50 kg P_2O_5 + 40 kg K_2O	16.41	19.63	18.02	12.05	14.13	13.09	28.46	33.76	31.11
120 kg N + 55 kg P_2O_5 + 45 kg K_2O	16.64	19.90	18.27	12.20	14.50	13.35	28.84	34.41	31.63
SEm±	0.34	0.38	0.18	0.26	0.26	0.13	0.48	0.41	0.24
C.D. (P = 0.05%)	0.99	1.09	0.50	0.74	0.75	0.37	1.39	1.18	0.69

Table 6: Effect of hydrogel levels and fertility levels on potassium uptakeby grain, stover and total uptake by single cross hybrid maize

Treatments	Potassium uptake (kg ha^{-1})								
	Grains			Stover			Total		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
Hydrogel levels (kg ha^{-1})									
Control	15.42	17.35	16.39	75.16	83.64	79.40	90.58	101.00	95.79
2.5	17.36	20.02	18.69	84.54	91.17	87.85	101.90	111.19	106.55
5.0	19.12	22.36	20.74	92.95	104.21	98.58	112.07	126.57	119.32
7.5	20.09	23.03	21.56	95.17	108.75	101.96	115.26	131.78	123.52
SEm±	0.34	0.50	0.18	1.67	1.47	0.85	1.81	1.52	0.92
C.D. (P = 0.05%)	0.98	1.44	0.50	4.83	4.25	2.40	5.23	4.39	2.59
Fertility levels (kg ha^{-1})									
75 kg N + 40 kg P_2O_5 + 30 kg K_2O	16.17	17.62	16.90	77.20	84.98	81.09	93.37	102.60	97.98
90 kg N + 45 kg P_2O_5 + 35 kg K_2O	17.58	20.03	18.80	85.12	95.74	90.43	102.70	115.77	109.24
105 kg N + 50 kg P_2O_5 + 40 kg K_2O	19.01	22.37	20.69	92.75	102.76	97.76	111.76	125.14	118.45
120 kg N + 55 kg P_2O_5 + 45 kg K_2O	19.23	22.74	20.98	92.74	104.29	98.52	111.98	127.03	119.50
SEm±	0.34	0.50	0.18	1.67	1.47	0.85	1.81	1.52	0.92
C.D. (P = 0.05%)	0.98	1.44	0.50	4.83	4.25	2.40	5.23	4.39	2.59

Table 7: Effect of hydrogel levels and fertility levels on nutrient status of soil after harvest of crop

Treatments	Nutrient status of soil after harvest of crop (kg ha^{-1})								
	Nitrogen			Phosphorus			Potassium		
	2019	2020	Pooled	2019	2020	Pooled	2019	2020	Pooled
Hydrogel levels (kg ha^{-1})									
Control	287.8	293.6	290.7	19.8	20.4	20.1	347.4	366.7	357.1
2.5	291.1	298.9	295.0	19.9	20.7	20.3	352.2	368.3	360.3
5.0	293.1	300.0	296.6	20.3	21.2	20.7	356.2	369.3	362.7
7.5	294.2	304.0	299.1	20.3	21.3	20.8	357.4	371.0	364.2
SEm±	5.04	5.07	2.56	0.28	0.36	0.14	5.23	5.41	2.66
C.D. (P = 0.05%)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Fertility levels (kg ha^{-1})									
75 kg N + 40 kg P_2O_5 + 30 kg K_2O	271.7	279.1	275.4	16.9	17.8	17.3	350.4	367.9	359.1
90 kg N + 45 kg P_2O_5 + 35 kg K_2O	295.9	303.3	299.6	19.5	20.3	19.9	352.2	368.4	360.3
105 kg N + 50 kg P_2O_5 + 40 kg K_2O	299.0	306.8	302.9	21.5	22.6	22.0	353.5	368.3	360.9
120 kg N + 55 kg P_2O_5 + 45 kg K_2O	299.5	307.2	303.3	22.4	23.0	22.7	357.1	370.6	363.9

SEm±	5.04	5.07	2.56	0.28	0.36	0.14	5.23	5.41	2.66
C.D. (P = 0.05%)	14.56	14.63	7.25	0.81	1.05	0.41	4.7	3.8	4.1

Table 8: Effect of hydrogel levels and fertility levels on WHC of soil and protein content in grain of single cross hybrid maize

Treatments	WHC (%)				Protein content (%)		
	2019		2020		2019	2020	Pooled
	15 cm depth	30 cm depth	15 cm depth	30 cm depth			
Hydrogel levels (kg ha^{-1})							
Control	38.94	39.99	40.38	41.44	9.19	9.69	9.44
2.5	40.13	41.19	41.48	42.56	10.78	11.3	11.04
5	42.06	43.14	43.47	44.57	11.06	11.62	11.34
7.5	44.29	45.39	45.65	46.77	11.16	11.71	11.43
SEm±	0.38	0.39	0.35	0.36	0.08	0.06	0.04
C.D. (P = 0.05%)	1.11	1.12	1.02	1.03	0.24	0.17	0.12
Fertility levels (kg ha^{-1})							
75 kg N + 40 kg P_2O_5 + 30 kg K_2O	41.06	42.13	42.61	43.7	9.46	9.83	9.64
90 kg N + 45 kg P_2O_5 + 35 kg K_2O	41.19	42.26	42.65	43.73	10.64	11.3	10.97
105 kg N + 50 kg P_2O_5 + 40 kg K_2O	41.56	42.64	42.86	43.95	10.98	11.58	11.28
120 kg N + 55 kg P_2O_5 + 45 kg K_2O	41.6	42.68	42.87	43.96	11.12	11.61	11.36
SEm±	0.38	0.39	0.35	0.36	0.08	0.06	0.04
C.D. (P = 0.05%)	NS	NS	NS	NS	0.24	0.17	0.12

Conclusion

From the present two year experimentation, our result suggested that application of hydrogel @ 5.0 kg/ha with 105 kg N + 50 kg P_2O_5 + 40 kg K_2O ha^{-1} enhance grain quality and soil nutrient status.

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