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Productivity of Maize (*Zea mays* L.) as Influenced by Different Tillage Practices and Doses of Hydrogel under Rainfed Conditions under Maize-Mustard Cropping Sequence

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ABSTRACT

An experiment was conducted to study the effect of different tillage practices and hydrogel on yield, yield attributes and economics of maize under rainfed conditions. Experimentation was laid out in Split Block Design. There were two factors (tillage and hydrogel) with four levels each including control (without hydrogel). Different tillage practices and levels of hydrogel, their interactions were analyzed statistically. The results showed that under the rainfed climatic condition of Chhindwara, the grain yield of rainfed maize increased under zero tillage as compared to conventional and mulching/residue retention @ 4 t/ha increase yield of rainfed maize as compared to no mulching. Both zero tillage and mulching enhanced the returns over variable cost. Hydrogel @ 5 kg/ha increased yield of rainfed maize returns and benefit cost ratio over variable cost.

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INTRODUCTION

Across the world for the poor people's maize is staple food owing to its high nutritional value. The presence of abundant starch in its grain renders nutritional benefits to maize making it rich in carbohydrate. The nutritional value of maize is not only limited to humans but it is being used in a big way for feeding animals and poultry. From kernels to husk and cobs, every part of the plant is used to make divers products ranging from animal feed to starch and ethanol in petrochemical industries, due to which maize now a days has made its mark in the economy as the fastest growing cash crops. Owing to its cultivation in diverse ecologies of the country, maize is subjected to various abiotic and biotic stresses; these include moisture and temperature extremes, diseases and insect- pests. Among the indispensable resources for the proper growth and development of crop and to reach its maximum productivity water is of prime importance throughout crop life cycle. Within the plant system it profoundly influences the various metabolic activities. In India due to limited availability of water for irrigation the call of the hour is to increase irrigation efficiency along with water use efficiency. The use of soil conditioners like hydrogel has a great potential to exploit the existing water in soil for agricultural crops by increasing their produc-

Table 1. Effect of tillage methods and hydrogel doses on growth and developmental parameters of maize (Mean over the years).

Tillage practices	Hydrogel (kg/ha)	Plants (000/ha)	Plant height (cm)	Number of days taken to 50% tasseling	Number of days taken to 50% silking
Conventional tillage	Control	69.4	192.7	57.7	58.3
	Hydrogel 2.5	72.2	194.7	58.0	58.3
	Hydrogel 5.0	75.9	203.3	57.7	59.7
Conventional tillage + mulching	Control	73.6	198.3	58.0	59.0
	Hydrogel 2.5	76.8	211.0	58.7	59.0
	Hydrogel 5.0	75.9	212.7	57.7	58.7
Zero tillage	Control	78.2	204.7	58.0	59.7
	Hydrogel 2.5	74.5	205.0	57.7	59.0
	Hydrogel 5.0	74.0	205.0	57.3	60.0
Zero tillage+Residues (4 t/ha)	Control	74.5	205.7	58.3	58.7
	Hydrogel 2.5	81.0	211.3	58.3	58.7
	Hydrogel 5.0	81.4	213.0	58.0	58.7
CD (5%)	Tillage practices	2.5	12.1	NS	NS
	hydrogel	2.4	8.7	NS	NS

tion. When hydrogel is incorporated into the soil it is presumed that they retain large quantities of water and nutrients, which are released as required by the plant. Thus, plant growth could be improved with limited water supply. The incorporation of super absorbent polymer enhanced seed germination and emergence, crop growth and yield. Under rainfed conditions crop like maize can easily withstand scarcity of water when supplied with hydogel during sowing. Keeping this in view, the present study was carried out to evaluate the response of different tillage practices to super absorbent polymer in maize-mustard cropping system under rainfed conditions of Madhya Pradesh.

MATERIALS AND METHODS

The study was conducted under rainfed conditions at Zonal Agricultural Research Station, Jawaharlal Nehru Krishi Vishwa Vidhyalaya, Chhindwara Madhya Pradesh for three consecutive years during *kharif* season of 2017-18 to 2019-2020. The experimental site is situated at a height of 682 m above mean sea level with a latitude range of 21°28′ N and longitude range of 78°10′ E. It receives an average rainfall of 1084 mm, consecutively during the three years of experimentation, the rains were normal. The soil of the experimental site was sandy clay loam with pH 7.9 and EC 0.20 ds/m. The soil contained 189 kg available nitrogen, 20.2 kg available P_2O_5 and 282 kg available K_2O per hectare with 0.46% organic carbon. During all the years of study the site was fixed. The experiment was laid out in split block design keeping with twelve treatments. The main plot treatments included tillage viz. : T_1= Conventional Tillage, T_2= Conventional Tillage + Mulching, T_3= Zero tillage and T_4= Zero tillage + Residue (4t/ha) whereas sub plot treatment includes application of hydrogel to crops viz. : G_1= control, G_2= Hydrogel @ 2.5 kg/ha gel and G_3= Hydrogel @ 5.0 kg/ha. The crop was raised as per the recommended agronomic practices. The treatments were allocated in plots of size 11m × 6 m and replicated four times in Randomized Block Design. The crop was sown in 1st week of July in all the years whereas Indian mustard (Pusa Tarak) in November just after harvesting of maize. Out of recommended fertilizer dosages of NPK half N and full dose of P and K in the form of Urea, single super phosphate and muriate of potash respectively were applied at the time of sowing. Remaining nitrogen was top dressed in two equal splits. The growth and yield attributes were measured from ten randomly selected tagged plants in each plot. The net plot area was harvested manually at the maturity and the Grain yield (q/ha) were recorded. Prevailing market prices were used for computing net income (Rs/ha) and B: C ratio.

Table 2. Effect of tillage methods and hydrogel doses on yield attributes of maize (Mean over the years).

Tillage practices	Hydrogel (kg/ha)	Number of Cobs (000/ha)	Cob length (cm)	Cob girth (cm)	Number of grains row/cob	Number of grains/ row
Conventional tillage	Control	58.35	14	14	14	36
	Hydrogel 2.5	67.33	16	14	15	37
	Hydrogel 5.0	69.05	17	15	16	40
Conventional tillage + mulching	Control	68.78	15	14	14	36
	Hydrogel 2.5	73.45	17	15	15	37
	Hydrogel 5.0	74.62	18	15	16	40
Zero tillage	Control	69.45	14	14	14	36
	Hydrogel 2.5	69.21	17	15	16	37
	Hydrogel 5.0	73.75	17	15	16	40
Zero tillage + residues (4t/ha)	Control	73.35	15	14	15	36
	Hydrogel 2.5	75.25	17	15	15	37
	Hydrogel 5.0	76.12	18	15	16	41
CD (5%)	Tillage practices	3.4	1.27	NS	NS	NS
	hydrogel	3.1	1.38	NS	1.28	3.12

RESULTS AND DISCUSSION

Growth and developmental parameters

The results from the present experiment clearly indicate that different tillage practices and doses of hydrogel had a significant effect on growth and development parameters of crop during the period of study (Table 1).

Application of Zero tillage + Residues (4t/ha) along with hydrogel @ 5 kg/ha resulted in significantly higher plant population/ha at harvest. Application of same treatment resulted in more plant height (cm) in plants over farmer's practice of conventional tillage and no hydrogel application. Application of hydogel along with residue created conducive conditions for plant growth and under rainfed condition helped in storing more moisture for longer duration which helped the crop for attaining luxuriant growth, similar findings has been reported by Rajasekar *et al*. (2019). The development characters like the number of days taken to 50% tasseling and to 50% silking were not significantly marked by the tillage practices and hydrogel application.

Yield attributes and yield

Significantly higher number of Cobs (000/ha) were observed with the application of Zero tillage + Residues (4t/ha) along with hydrogel @ 5 kg/ha. As the same treatment amassed highest number of healthy plants resulting in more number of cobs. Hydrogels are having high capability to absorb water when water is available and make that absorbed water available to plants over the period of time (Akhter *et al.* 2004).

Different tillage practices and hydrogel dosages had a significant effect on cob length (cm). Whereas, cob girth (cm) was not effected significantly. In all the treatment combinations, no hydrogel application recorded lower length and girth of the cob than the remaining treatments. This may be because of easy accessibility of moisture and nutrients specifically to plants in Zero tillage + Residues (4 t/ha) along with hydrogel @ 5 kg/ha applied treatments and generally under hydrogel application, resulted in better root and shoot growth, which finally reflected on the yield components and yield than the control. The similar results were also observed by Khan and Parvej (2010) and Zhang *et al.* (2015).

The yield attributing characters like number of grains row /cob and number of grains/ row were not affected by different tillage practices but application of hydrogel had a marked influence on them. Application of hydrogel @ 5 kg/ha was found superior over

Table 3. Effect of tillage methods and hydrogel doses on yield, system yield and economics (Mean over the years).

Tillage practices	Hydrogel (kg/ha)	Grain yield (q/ha)	Stover yield (q/ha)	Mustard grain yield (kg/ha)	Maize equivalent yield (q/ha)	Net return (Rs/ha)	B:C
Conventional tillage	Control	45	78	7.45	25	52602	2.5
	Hydrogel 2.5	47	81	8.50	27	53823	2.6
	Hydrogel 5.0	52	89	9.55	30	61886	2.8
Conventional tillage + mulching	Control	48	87	7.75	27	55418	2.4
	Hydrogel 2.5	60	108	8.79	33	73718	3.1
	Hydrogel 5.0	61	111	9.45	34	74571	3.0
Zero tillage	Control	51	89	8.05	28	64513	3.7
	Hydrogel 2.5	56	103	9.13	31	72333	3.9
	Hydrogel 5.0	57	104	9.56	32	73408	3.7
Zero tillage + residues (4 t/ha)	Control	59	104	8.95	32	77289	4.3
	Hydrogel 2.5	65	113	9.77	36	85929	4.4
	Hydrogel 5.0	67	114	10.90	38	87809	4.5
CD (5%)	Tillage practices	2.10	10.98	0.34	1.20	-	-
	hydrogel	1.67	6.22	0.26	0.89	-	-

control in amassing both higher number of grains row /cob and number of grains/ row. In dry spell, hydrogel may have improved the availability of water to the crop, which indirectly improved the translocation of water, nutrients and photo assimilates leading to the higher plant growth and yield. Corroborative findings have also been reported by Shivakumar *et al.* (2019).

Several factors such as environmental conditions above and below the soil coupled with reactions both physical and biological occurring within plant or its environment is responsible for determination of yield of any crop.

The grain and stover yield of rainfed maize were significantly affected by tillage practices and hydrogel application. Among the different treatment combinations, application of Zero tillage + Residues (4t/ha) along with hydrogel @ 5 kg/ha resulted in highest grain yield (67 q/ha) as well as stover yield (114 q/ha) as compared to the maize crop sown after conventional tillage and no hydrogel application (45 and 78 q/ha, respectively) (Table 2). The above effect attributes to more number of plants at harvest and higher values of yield attributing characters under same set of treatments and can also be ascribed to higher water availability to crop plants in zero tillage, essentially through soil water capture and root uptake capacity and increase total nitrogen and microbial biomass (Karki and Shrestha 2014).

The grain yield of succeeding mustard as well as maize equivalent yield in *rabi* season was influenced markedly by the tillage practices and hydrogel application in maize (Table 3). However, the system maize equivalent yield was higher (38 q/ha) under zero tillage sowing of maize as compared to its conventional sowing (25 q/ha). Higher soil moisture availability and conducive soil temperature under residue applied tillage practices during winter resulted in higher plant stand and seed yield (Kumar *et al.* 2015).

Economics

In the present study Zero tillage + Residues (4t/ha) along with hydrogel @ 5 kg/ha fetched the higher net returns (Rs 87809/ha) as a result higher benefit cost ratio (4.5) as compared to conventional till sown maize without hydrogel application (Rs 52602/ha and 2.5, respectively) (Table 3). Better returns under zero tillage were due to higher yields and lower input cost as compared to conventional tillage. Govardhanrao and Ramana (2017) also reported that zero tillage

in maize fetched higher net returns as compared to conventional tillage grown maize.

CONCLUSION

Under the rainfed climatic condition of Chhindwara, the grain yield of rainfed maize increased under zero tillage as compared to conventional and mulching/ residue retention @ 4 t/ha increase yield of rainfed maize as compared to no mulching. Both zero tillage and mulching enhanced the returns over variable cost. Hydrogel @ 5 kg/ha increased yield of rainfed maize returns and benefit cost ratio over variable cost.

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