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Effect of Tillage Practices and Hydrogel Applications on Yield and Yield Attributing Traits of Maize (*Zea mays* L.) over the Years

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This study investigated the effects of different tillage practices and hydrogel applications on maize yield in sandy loam soils at the Agricultural Research Station, Karimnagar, PJTSAU, Telangana state over a period of four years (2015-2018) during the Kharif season. The experiment was designed as a split plot with four main treatments *i.e*., Conventional tillage (CT), Conventional tillage with residue mulching (4 t/ha), Zero tillage (ZT) and Zero tillage with residue mulching (4 t/ha). These were combined with three sub-treatments involving hydrogel application *i.e*., Control (no hydrogel), Hydrogel at 2.5 kg/ha and Hydrogel at 5.0 kg/ha. The study was replicated three times to

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ensure reliability of the results. The combination of zero tillage with residue mulching yielded the highest maize grain yield (4435 kg/ha). This suggests that this practice is more effective in retaining soil moisture, which is critical under rainfed conditions. The addition of hydrogel, regardless of the rate (2.5 kg/ha or 5.0 kg/ha), did not lead to any significant improvement in maize yield. The use of zero tillage combined with residue mulching is beneficial for maize production in sandy loam soils under rainfed conditions, primarily due to enhanced moisture retention. However, hydrogel application did not provide any additional yield benefits in this context.

Keywords: Maize; tillage; hydrogel; mulching; conventional tillage; zero tillage.

1. INTRODUCTION

"Maize (*Zea mays* L.) is one of the most versatile emerging crop showing wider adaptability under varied agro-climatic conditions. Globally, maize is known as queen of cereals because it has the highest genetic yield potential among the cereals. In India, maize is the third most important food crops after rice and wheat. Maize in India, contributes nearly 9 % in the national food basket and its production was 24.26 M.T. from 9.06 M.ha with a productivity of 2.68 t/ha" [1]. "Projected demand for maize production by 2050 in India is around 121 M.T. Maize is predominantly grown as a rainfed crop in India. Currently rainfed yields (1.9 tonnes/ha) are much lower than irrigated yields (3.5 tonne/ha) in India. This indicates huge untapped yield potential in rainfed maize production system. Maize is cultivated around 4.2- 4.5 lakh hectares in rainfed situations in Telangana state" [2]. "Conservation agriculture is on priority to sustain the productivity of cropping system in India. The interest in conservation tillage systems has increased in response to the need to limit erosion, promote water conservation and reduce weed seed bank. The yields on the zero tillage plots approached those of the conventional tilled plots when N was added. Had a higher level of N fertilizer been applied it is possible that the yields on zero tillage plots would have equaled or exceeded those of the conventional tilled plots. The net mineralization rate was greater with conventional tillage than the zero tillage. Soil temperature at 5 and 10 cm depths was less on zero tillage than on conventional tillage plots. Water content in soil was greater on zero tillage compared to conventional tillage plots. The drought had a considerable effect on socio-economic, agricultural and environmental aspects" [3]. "Mulching has been proved to be useful material in conserving moisture and enhancing the productivity of maize. Leaf mulch also provides benefit regarding increasing infiltration rate, lowers the soil temperature and improves fertilizer availability and increase crop yield" [4]. "The hydrogel used in agriculture is mainly poly acryl amides with acrylic acid as basic units" [5]. Recently, hydrogels have included cellulose [6] protein Kong et al., [7], and starch Mahmoodi-Babolan et al., [8] in their structures. "The hydrogel gradually releases up to 95% of its stored water when its surroundings begin to dry out. But, when comes in contact with water again, it gets replenished. This process can last up to 2-5 years, by which time biodegradable hydrogel decomposes to CO2, water and ammonia and potassium ions, without any residue, thus, environment friendly" [9]. "And also improve the crop growth by increasing water holding capacity in soil and delay the wilting point in drought stress" [10]. In this context, the present study was undertaken to study the effect of conservation tillage and hydrogel in maize yield performance under rainfed conditions.

2. MATERIALS AND METHODS

A field experiment was conducted during two *Kharif* seasons of 2015 to 2018 at Agricultural Research station, Karimnagar PJTSAU, Telangana state under rainfed conditions. The soils are red sandy loam with medium in organic carbon (0.65 %), available N (213.1 kg ha^{-1}), available P (42.4 kg ha^{-1}) and available K (415 kg ha^{-1}). This experiment was laid out in split plot design with 4 main plots *i.e*., M1-Conventional till, M2- Conventional till + residue mulching (4 t/ha), M3- Zero tillage, M4- Zero tillage + residue mulching (4 t/ha) and three sub plot *i.e*., S1-Control (no hydrogel), S2- Hydrogel 2.5 kg/ha, S3-Hydrogel 5.0 kg/ha in three replications. Proper management practices like nutrient management (200:60:50 NPK Kg/ha) weed management by herbicides and pest management by pesticides were. Biometric observations like length of cobs, grains row per cob, number of grains per row, test weight, grain and Stover yield were recorded after harvesting of crop. Economics of each treatment was calculated on the based on the nearest market prices of inputs and outputs.

Table 1. Effect of hydrogel and tillage on yield of rainfed maize

	Grain yield (kg/ha)					Net returns (Rs./ha)					B : C Ratio				
	2015	**2016**	**2017**	**2018**	**Pooled**	**2015**	**2016**	**2017**	**2018**	**Pooled**	**2015**	**2016**	**2017**	**2018**	**Pooled**
Tillage practices															
Conventional till	2148	3930	4555	1981	3154	-17800	45127	15311	-14821	6954	0.6	1.9	1.4	0.7	1.15
Conventional till + Mulching	1460	4798	5046	2506	3453	-28839	52988	23352	-7103	10100	0.4	2.1	1.5	0.9	1.23
Zero till	1429	7663	4806	2010	3977	-21641	63572	20088	-7903	13529	0.5	2.5	1.5	0.8	1.33
Zero till + Mulching	2195	7616	5298	2632	4435	-11905	49257	24230	1465	15762	0.7	2.1	1.6	1.0	1.35
C.D. (5%)	449	824	361	132	442	6421	NS	4732	2249	NS	0.2	0.3	0.4	0.04	NS
Hydrogel application															
Control	1826	5953	4877	2260	3729	-18201	51020	21773	-8457	11533	0.6	2.1	1.5	0.8	1.25
Hydrogel (2.5 kg/ha)	1765	6096	5038	2326	3806	-20578	49631	21880	-6262	11168	0.6	2.1	1.5	0.9	1.28
Hydrogel (5.0 kg/ha)	1833	5956	4939	2501	3807	-20360	57557	18584	-4051	12933	0.6	2.3	1.4	0.9	1.30
C.D. (5%)	NS	NS	NS	NS	NS	NS	NS	NS	5519	NS	NS	NS	NS	NS	NS
Interaction effect															
C.D. (5%)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2. Effect of hydrogel and tillage on cob length, girth and kernel rows of rainfed maize

	Cob length (cm)					Cob girth (cm)					Kernel rows				
	2015	**2016**	**2017**	**2018**	**Pooled**	**2015**	**2016**	**2017**	**2018**	**Pooled**	**2015**	**2016**	**2017**	**2018**	**Pooled**
Tillage practices															
Conventional till	16.8	16.1	13.7	15.2	15.5	15.0	15.6	12.9	16.1	14.9	14.4	14.1	15.0	13.9	14.4
Conventional till + Mulching	15.7	16.6	15.5	16.2	16.0	14.2	15.4	13.5	17.1	15.1	14.2	14.0	15.8	13.7	14.4
Zero till	15.0	18.3	13.9	14.9	15.5	13.6	15.7	13.2	16.1	14.7	14.2	14.3	14.8	13.2	14.1
Zero till + Mulching	17.9	18.4	15.6	15.7	16.9	15.0	15.1	13.8	16.6	15.1	14.4	14.4	16.0	14.2	14.8
C.D (0.05)	0.4	1.2	2.0	0.5	1.0	0.3	NS	NS	NS	0.3	NS	NS	NS	NS	NS
Hydrogel application															
Control (No hydrogel)	16.3	17.4	14.7	15.0	15.9	14.3	15.3	13.1	16.3	14.8	14.2	14.1	15.7	13.4	14.4
Hydrogel (2.5Kg/ha)	16.3	17.3	14.3	15.7	15.9	14.6	15.4	13.1	16.5	14.9	14.3	14.2	15.7	14.0	14.6
Hydrogel (5Kg/ha)	16.5	17.3	15.1	15.7	16.2	14.5	15.6	13.5	16.7	15.1	14.3	14.3	15.6	13.9	14.5
C.D (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction effect															
C.D (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 3. Effect of hydrogel and tillage on kernel number per row and 100 grain weight (g) of rainfed maize

	Kernels / row of cob					100 grain weight (g)				
	2015	**2016**	**2017**	**2018**	**Pooled**	**2015**	**2016**	**2017**	**2018**	**Pooled**
Tillage practices										
Conventional till	30.8	28.5	30.2	22.7	28.1	19.4	33.2	23.1	31.0	26.7
Conventional till + Mulching	26.5	27.2	34.4	25.1	28.3	17.9	33.0	23.2	31.8	26.5
Zero till	25.0	32.7	31.5	22.5	27.9	16.9	33.0	21.0	30.6	25.4
Zero till + Mulching	33.0	32.3	38.4	25.0	32.2	20.0	32.0	23.2	31.2	26.6
C.D (0.05)	3.3	2.9	4.2	1.9	3.1	1.5	NS	NS	NS	NS
Hydrogel application										
Control (No hydrogel)	29.0	29.3	28.7	23.0	27.5	18.6	33.1	23.1	30.3	26.3
Hydrogel (2.5Kg/ha)	28.0	30.3	28.0	24.1	27.6	18.4	33.1	22.2	31.9	26.4
Hydrogel (5Kg/ha)	28.8	30.9	29.2	24.4	28.3	18.7	32.2	22.6	31.3	26.2
C.D (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction effect										
C.D (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

3. RESULTS AND DISCUSSION

First year: The grain yield resulted significantly higher under zero tillage + mulching (2195 kg/ha) on par with conventional tillage (2148 kg/ha). Due to low yields, the returns are negative. The yield attributes, cob length & girth, kernel rows & no. & 100-grain weight were also higher with zero tillage + mulching. The hydrogel application did not show significant difference on grain yield and yield attributes.

Second year: The grain yield and BC ratio resulted significantly higher under zero tillage (7663 kg/ha) on par with zero tillage + mulching (7616 kg/ha). The yield attributes cob length, kernel no. were also higher with zero tillage & zero tillage + mulching. The hydrogel application did not show significant difference on grain yield and yield attributes.

Third year: Grain yield and BC ratio resulted significantly higher under conventional tillage + mulching (5046 kg/ha) on par with zero tillage + mulching (5298 kg/ha). The hydrogel application did not show significant difference on grain yield and yield attributes.

Forth year: Significantly higher grain yield and BC ratio resulted under zero tillage + mulching (2632 kg/ha) on par with conventional tillage + mulching (2506 kg/ha). The hydrogel application did not show significant difference on grain yield and yield attributes.

Pooled data: Higher maize grain yield (4435 kg/ha) and BC ratio resulted under zero tillage + mulching when compared to without mulching in conventional tillage and Zero tillage tillage (3977 kg/ha) under rainfed conditions. Significantly lowest grain yield was observed with Conventional tillage (3154 kg/ha). The hydrogel application (@ 2.5 or 5 kg/ha) did not show significant difference on grain yield and yield attributes. Similar results were obtained with findings of Khadem et al*.,* [11], Gunes et al*.,* [12], Kumar et al*.,* [13], Kumar et al*.,* [14] and Shubham et al*.,* [15] in terms of yield and yield attributes of maize and other crops.

4. CONCLUSION

The zero tillage + mulching recorded higher maize grain yield when compared to conventional or zero tillage without mulch and conventional with mulch under rainfed conditions due to long term availability of moisture in the soil. To overcome from prolonged dry spells in rainfed situation mulching is useful.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

I am hereby declaring that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.,) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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