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Study on N, P, K uptake influenced by the application of hydrogel and mulching on maize (*Zea mays* L.) in sandy soil

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Abstract
A research trial was conducted to Study on N, P, K uptake influenced by the application of hydrogel and mulching on maize in sandy soil by using randomised block design with two factors (hydrogel and mulching) with three levels each and one additional control. Main and interaction effects and a control were analysed statistically. Application of hydrogel @ 2.5 kg ha^{-1} recorded the highest stover, grain and total N and P uptake. The highest K uptake by grain was recorded by application of hydrogel @ 2.5 kg ha^{-1}, while maximum stover and total K uptake was recorded in hydrogel @ 3.75 kg ha^{-1}. Among types of mulch maximum stover, grain and total N, P, K uptake was recorded by the application of rice straw mulch @ 5 t ha^{-1}. Among interactions, maximum total N and P uptake was recorded in which hydrogel @ 2.5 kg ha^{-1} with rice straw mulch @ 5 t ha^{-1} and maximum total K uptake was recorded in hydrogel @ 3.75 kg ha^{-1} with rice straw mulch applied @ 5 t ha^{-1}.

Keywords: Hydrogel, mulch, nitrogen, phosphorous, pottasium

Introduction
Among the cereal crops maize is the most important crop because of its higher productivity and vide variety of uses like food for humans and cattle, raw materials for dairy products and industries etc. Low moisture retaining capability, poor fertility and high percolation losses of soil moisture resulted in low crop productivity and reduced water and nutrient use efficiency in sandy soils (Sivapalan, 2006) [11]. In present research an old technology which is mulching with locally available material and a relatively new technology which is hydrogel can be used to improve the water and nutrient use efficiency of the sandy soil.
Hydrogel was used as a moisture holding substances in agriculture because when it is amended in soil, it holds high amount of moisture (about 400 times than its weight) as well as nutrients. Under moisture stress condition this preserved moisture and nutrients slowly released to the plants as per its requirements and finally enhanced the plant growth (Yazdani *et al*., 2007) [13].
Application of hydrogel decreased the leaching of nutrients like ammonical nitrogen, calcium, magnesium and potassium due to the presence of hydrogel (Magalhaes *et al*., 1987) [6]. which reduced nitrogen losses through leaching up to 45% as compared to nitrogen fertilizer alone (Mikkelsen *et al*., 1993) [8], finally there is substantial increase in the nitrogen utilization by the maize crop (Dragicevic *et al*., 2011) [3].
Greater soil moisture in top soil and low diurnal top soil temperature deviation could be enhanced nutrient uptake, which will intensify the influence of mulching on growth and development. Sustaining residue on top soil hasn't constantly give increased yields. Yield decreases under great residue quantities, was owed partly to little N fertility (Unger, 1986) [12].
Crop residues mulch improved soil moisture reserves, enhance soil organic matter content and reutilize nutrients by decomposing it, which directly influence crop yield by providing crop nutrients and indirectly by enhancing consistency of aggregates (Celik *et al*., 2004) [1]. The accretion of N from organic mulches was far slower than the inorganic fertilizers in nutrient discharge to soil (Khan and Parvej, 2010) [5].
Mulch residue, besides regulating soil moisture and temperature, affects the changes of soil organic matter which could reduce the C: N ratio of plant residue by decomposing it (Chantigny, 2003) [2].
The straw mulch application could bring advantage to corn yield and yield components because it might be efficiently progress soil nutrient availability, improves crop development (Fang *et al*., 2011) [4]. Application of rice husk enhanced the chemical properties of soil and resulted in improved grain yield of maize by preserving the nutrients through reduced leaching losses from the root zone (Njoku *et al*., 2015) [9].

Materials and methods

A research programme was conducted at college farm, College of Agriculture, Padannakkad, Kerala Agricultural University, Thrissur, Kerala during *rabi*, 2017. Experiment was laid out in randomised block design with two factors (hydrogel and mulching) and an extra treatment (control). Both factors having three levels each. Three levels of hydrogel H_1 – 1.25 kg ha^{-1}, H_2 – 2.5 kg ha^{-1} and H_3 – 3.75 kg ha^{-1} and three types of mulch M_1 – rice straw mulch, M_2 – rice husk mulch, M_3 – Coirpith compost mulch were used in the experiment. Straw mulch and rice husk mulch were applied @ 5 t ha^{-1} and coirpith compost mulch was applied @ 2.5 t ha^{-1}. The treatment combinations were T_1 - 1.25 kg ha^{-1} hydrogel + rice straw mulch, T_2 - 1.25 kg ha^{-1} hydrogel + rice husk mulch, T_3 - 1.25 kg ha^{-1} hydrogel + Coirpith compost mulch, T_4 - 2.5 kg ha^{-1} hydrogel + rice straw mulch, T_5 - 2.5 kg ha^{-1} hydrogel + rice husk mulch, T_6 - 2.5 kg ha^{-1} hydrogel + coirpith compost mulch, T_7 - 3.75 kg ha^{-1} hydrogel + rice straw mulch, T_8 - 3.75 kg ha^{-1} hydrogel + rice husk mulch, T_9 - 3.75 kg ha^{-1} hydrogel + coirpith compost mulch, T_{10} - control (without hydrogel and mulch). Uptake of N, P and K nutrients were estimated by multiplying nutrient content of the sample with respective dry weight of plant samples and expressed in kg ha^{-1}. The recorded data was analysed statistically.

$$\text{Nutritive uptake} = \frac{\text{Percentage of nutrient X Total dry matter production (kg ha-1)}}{100}$$

Results

Uptake nitrogen by stover

Among the levels of hydrogel, maximum nitrogen uptake by stover was observed in hydrogel level @ 2.5 kg ha^{-1} (156.64 kg ha^{-1}) and was significantly superior to other two levels. Rice straw mulch @ 5 t ha^{-1} (170.21 kg ha^{-1}) recorded maximum nitrogen uptake by stover and was significantly superior to other two types of mulches. With regard to the interaction of treatments, rice straw mulch @ 5 t ha^{-1} along with hydrogel level @ 2.5 kg ha^{-1} (190.13 kg ha^{-1}) recorded the maximum value and was significantly superior to all other combinations. When compared with control, control recorded lower nitrogen uptake by stover than the other treatments.

Uptake of nitrogen by grain

Among the levels of hydrogel, maximum nitrogen uptake by grain was observed with hydrogel level @ 2.5 kg ha^{-1} (64.08 kg ha^{-1}) which was on par with hydrogel level @ 1.25 kg ha^{-1} and significantly superior to hydrogel level @ 3.75 kg ha^{-1}. Among the types of mulch, maximum nitrogen uptake by grain was obtained by rice straw mulch @ 5 t ha^{-1} (68.26 kg ha^{-1}) and was superior to all other types of mulch. With respect to interactions, H_2M_1 (75.51 kg ha^{-1}) recorded maximum nitrogen uptake by grain and was superior to all other combinations. When control was compared with other treatments, it was found that control recorded a lower uptake by grain than the other treatments.

Total nitrogen uptake

Hydrogel @ 2.5 kg ha^{-1} (220.83 kg ha^{-1}) recorded maximum nitrogen uptake which was significantly superior to other two levels. Among the types of mulch, total nitrogen uptake was maximum in rice straw mulch applied @ 5 t ha^{-1} (238.47 kg ha^{-1}) and was significantly superior to other two types of mulch. With respect to interactions, H_2M_1 (265.64 kg ha^{-1}) recorded maximum total nitrogen uptake and was significantly superior to all other combinations. Control recorded lower nitrogen uptake and was significantly lower than the other treatments.

Uptake of phosphorus by stover

Among the levels of hydrogel, maximum phosphorus uptake was recorded by hydrogel @ 2.5 kg ha^{-1}(53.70 kg ha^{-1}) which was on par with hydrogel level @ 1.25 kg ha^{-1} and was significantly superior to hydrogel @ 3.75 kg ha^{-1}. Maximum phosphorus uptake by stover was obtained in rice straw mulch @ 5 t ha^{-1} (51.51 kg ha^{-1}) which was on par with coirpith mulch @ 2.5 t ha^{-1} and was significantly superior to rice husk mulch. With respect to interactions, H_1M_3 (58.36 kg ha^{-1}) recorded maximum phosphorus uptake by stover and was on par with H_2M_1 and H_2M_2. When control was compared with other treatments, control was found to have lower phosphorus uptake by stover than the other treatments.

Uptake of phosphorus by grain

Maximum phosphorus uptake by grain was recorded by hydrogel @ 2.5 kg ha^{-1} (35.45 kg ha^{-1}) which was on par with hydrogel @ 3.75 kg ha^{-1} and was significantly superior to hydrogel @ 1.25 kg ha^{-1}. Among the types of mulch, maximum phosphorus uptake by grain was obtained in rice straw mulch @ 5 t ha^{-1} (39.15 kg ha^{-1}) and was significantly superior to other types of mulches. With respect to interactions, H_2M_1 (40.68 kg ha^{-1}) recorded maximum phosphorus uptake by grain which was on par with H_3M_1 and superior to other combinations. When compared with control, it was found that control was significantly inferior to all the treatments and its combinations.

Total phosphorus uptake

As observed in the phosphorus uptake of stover and grain, total phosphorus uptake was also significantly influenced by different treatments and their combinations (Table 1). Hydrogel @ 2.5 kg ha^{-1} (89.15 kg ha^{-1}) and rice straw mulch @ 5 t ha^{-1} (90.66 kg ha^{-1}) and its combination (97.84 kg ha^{-1}) recorded maximum P uptake and were significantly superior to other treatments.

Uptake of potassium by stover

Hydrogel @ 3.75 kg ha^{-1} (220.35 kg ha^{-1}) recorded maximum potassium uptake by stover and was significantly superior to other two levels of hydrogel. Maximum potassium uptake by stover was obtained in rice straw mulch @ 5 t ha^{-1} (241.76 kg ha^{-1}) and was significantly superior to other types of mulch. Among the interactions, H_3M_1 (269.33 kg ha^{-1}) recorded maximum potassium uptake by stover. When control was compared with other treatments, it was observed that potassium uptake by stover was significantly lower than the other treatments.

Uptake of potassium by grain

Hydrogel @ 2.5 kg ha^{-1} (16.27 kg ha^{-1}) recorded maximum potassium uptake by grain and was significantly superior to other levels of hydrogel. Maximum potassium uptake by grain was obtained in rice straw mulch @ 5 t ha^{-1} (17.59 kg ha^{-1}) and was significantly superior to other types of mulch. Among interactions, H_2M_1 (18.76 kg ha^{-1}) recorded maximum potassium uptake by grain which was on par with interaction H_3M_1 and significantly superior to other combinations. Control recorded a lower K uptake by grain and was significantly lower than other treatments.

Total potassium uptake

Total potassium uptake (Table 1) was significantly influenced by the levels of hydrogel, types of mulch, their interactions and control *versus* other treatments. Hydrogel @ 3.75 kg ha^{-1} (234.29 kg ha^{-1}) recorded maximum potassium uptake which was significantly superior to other two levels. Among the types of mulch, maximum total potassium uptake was obtained in rice straw mulch @ 5 t ha^{-1} (259.35 kg ha^{-1}) and was significantly superior to other two types of mulch. With respect to interactions, H_3M_1 (287.37 kg ha^{-1}) recorded maximum total potassium uptake and was significantly superior to all other combinations. Control recorded lower potassium uptake and was significantly lower than the other treatments.

Discussion

Increased N uptake was higher when hydrogel applied @ 2.5 than when it was applied @ 3.75 kg ha^{-1}. It may be due to the moisture availability at 2.5 hydrogel application was optimum for nitrification process. Further increased in soil moisture content, as in case of hydrogel application @ 3.75 kg ha^{-1}, may be the ammonium was not converted to nitrate because this process is aerobic. Maximum P uptake @ 2.5 kg ha^{-1} hydrogel application was may be due to higher plant growth along with the high root growth. Maximum K uptake was recorded when hydrogel applied @ 3.75 kg ha^{-1}. It may be due to K release patterns in soil depends on equilibrium concentration in its pools. With increased in water content in soil there is better release of K in to saturated zone that resulted in higher uptake of K when hydrogel applied @ 3.75 kg ha^{-1} than other two levels of hydrogel application. Increased nutrient uptake by hydrogel application was also observed by Mandal *et al*. (2015) [7] in maize and Shahid *et al*. (2016) [10] in wheat.

Among types of mulches the maximum nutrient uptake was recorded when rice straw mulch applied @ 5 t ha^{-1}. It may be due to complete covering of rice straw mulch than the other mulches, which leads to the decreased evaporation along with maintenance of optimum soil temperature resulted in better moisture holding capacity of soil. Optimum soil moisture leads to more nutrients to be absorbed by the maize crop resulted in higher uptake of nutrients.

As mulch indicates to cover the soil surface. In case of rice straw mulch, it covered the soil well than both rice husk mulch and coir pith compost mulch. These two mulches were mixed well with the sandy soil and undergoes decomposition. Because of high C:N ratio of these two mulches, most of the nutrients were used in the decomposition process for microorganisms growth. That caused the low nutrients available to the crop leads to lower uptake in case of these two mulch application.

Table 1: Effect of hydrogel and mulching on stover, grain and total nutrient uptake

Treatment	Stover uptake (Kg ha^{-1})			Grain uptake (Kg ha^{-1})			Total uptake (Kg ha^{-1})		
Levels of hydrogel	**N**	**P**	**K**	**N**	**P**	**K**	**N**	**P**	**K**
H_1	140.39	53.04	210.33	63.18	30.66	12.52	203.57	83.70	222.84
H_2	156.64	53.70	212.12	64.08	35.45	16.27	220.83	89.15	228.37
H_3	145.38	42.32	220.35	62.95	34.99	13.95	208.33	77.32	234.29
SEm (±)	2.260	1.124	1.952	0.434	0.539	0.414	2.944	1.363	2.605
CD (0.05)	4.749	2.361	4.100	0.912	1.132	0.870	6.185	2.865	5.473
Types of mulch									
M_1	170.21	51.51	241.76	68.26	39.15	17.59	238.47	90.66	259.35
M_2	143.90	48.25	205.65	61.87	33.21	14.27	205.88	81.46	219.87
M_3	128.31	49.30	195.39	60.07	28.75	10.87	188.37	78.04	206.28
SEm (±)	2.260	1.124	1.952	0.434	0.539	0.414	2.944	1.363	2.605
CD (0.05)	4.749	2.361	4.100	0.912	1.132	0.870	6.185	2.865	5.473
Interactions									
H_1M_1	149.85	49.09	223.64	68.35	37.72	15.93	218.20	86.81	239.60
H_1M_2	135.61	51.66	204.25	47.53	30.31	13.48	183.15	81.97	217.67
H_1M_3	135.70	58.36	203.08	73.66	23.96	8.16	209.36	82.32	211.24
H_2M_1	190.13	57.16	232.32	75.51	40.68	18.76	265.64	97.84	251.09
H_2M_2	155.79	54.29	207.83	64.63	33.88	13.87	220.75	88.18	221.60
H_2M_3	124.01	49.65	196.22	52.09	31.79	16.17	176.09	81.44	212.41
H_3M_1	170.63	48.28	269.33	60.94	39.06	18.08	231.57	87.34	287.37
H_3M_2	140.30	38.81	204.86	73.45	35.43	15.46	213.74	74.24	220.32
H_3M_3	125.21	39.88	186.87	54.45	30.50	8.29	179.66	70.37	195.18
SEm (±)	3.915	1.946	3.380	0.752	0.933	0.717	5.098	2.362	4.512
CD (0.05)	8.226	4.089	7.102	1.580	1.960	1.506	10.712	4.962	9.480
Control *vs* other treatments									
Control	90.81	34.39	148.71	36.29	23.24	11.01	127.10	57.63	159.73
SEm (±)	2.918	1.451	2.520	0.560	0.695	0.534	3.800	1.760	3.363
CD (0.05)	6.131	3.048	5.294	1.177	1.461	1.123	7.984	3.698	7.066

Note: H_1 - hydrogel @ 1.25 kg ha^{-1}, H_2 - hydrogel @ 2.5 kg ha^{-1}, H_3 - hydrogel @ 3.75 kg ha^{-1}, M_1 - rice straw mulch @ 5 t ha^{-1}, M_2 - rice husk mulch @ 5 t ha^{-1}, M_3 - coirpith compost mulch @ 2.5 t ha^{-1}.

References

1. Celik I, Ortas I, Killic S. Effects of compost, mycorrhiza, manure and fertilizer on some physical properties of a Chromoxerert soil. Soil Tillage Res. 2004; 78:59-67.
2. Chantigny MH. Dissolved and water-extractable organic matter in soils: a review on the influence of land use and management practices. Geoderma. 2003; 113:357-380.
3. Dragicevic V, Simic M, Sredojevic S, Kresovic B, Saponjic B, Jovanovic Z. The effect of super-hydro-grow polymer on soil moisture, nitrogen status and maize

growth. Fresenius Environ. Bull. 2011; 20(4a):1013-1019.
4. Fang SZ, Xie BD, Liu D, Liu JJ. Effects of mulching materials on nitrogen mineralization, nitrogen availability and poplar growth on degraded agricultural soil. New Far. 2011; 41:147-162.
5. Khan MAH, Parvej MR. Impact of conservation tillage under organic mulches on the reproductive efficacy and yield of Quality Protein Maize. J Agric. Sci. 2010; 5(2):52-63.
6. Magalhaes JR, Wilcox GE, Rodriguez FC, Silva FLIM, Ferreira RAN. Plant growth and nutrient uptake in hydrophilic gel treated soil. Commun. Soil Sci. Plant Anal. 1987; 18:1469-1478.
7. Mandal UK, Sharma KL, Venkanna K, Korwar GR, Reddy KS, Pushpanjali NN *et al*. Evaluating hydrogel application on soil water availability and crop productivity in semiarid tropical red soil. Indian J. Dryland Agric. Res. Dev. 2015; 30(2):01-10.
8. Mikkelsen RL, Behel AD, Williams HM. Addition of gel forming hydrophilic polymers to nitrogen fertilizer solutions. Fertil. Res. 1993; 36:55-61.
9. Njoku C, Uguru BN, Mbah CN. Effect of rice husk dust on selected soil chemical properties and maize grain yield in Abakaliki, South Eastern Nigeria. Appl. Sci. Rep. 2015; 12(3):143-149.
10. Shahid BD, Ram H. Grain yield, nutrient uptake and water-use efficiency of wheat (*Triticum aestivum*) under different moisture regimes, nutrient and hydrogel levels. Indian J Agron. 2016; 61(1):101-104.
11. Sivapalan S. Benefits of treating a sandy soil with a cross linked type polyacrylamide. Aust. J Exp. Agric. 2006; 46:579-584.
12. Unger PW. Wheat residue management effects on soil water storage and corn production. Soil Sci. Soc. Am. J. 1986; 50:764-770.
13. Yazdani F, Allahdadi I, Akbari GA. Impact of superabsorbent polymer on yield and growth analysis of soybean (*Glycine max* L.) under drought stress condition. Pakist. J Biol. Sci. 2007; 10:4190-4196.