Original Research Article

Influence of hydrogel and different sowing methods on Aerobic Rice (*Oryza sativa* L.)

ABSTRACT

The field experiment was conducted during Khairf 2022 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.0), low in organic carbon (0.40 %), available N (161.48 kg/ha), available P (151.2 kg/ha) and available K (232.5 kg/ha).To evaluate the influence of different level Hydrogel (0, 2, 4 kg/ha.) and methods of sowing on growth and yield of aerobic rice. Hydrogel was broadcasting in the field before sowing and mixed well in the soil. The growth attributes which was plant height (96.20 cm), total tillers/m^2 (540.27), plant dry weight (1078.70 g/m^2), and crop growth rate (65.27 g/m^2/day) was significantly increased with increasing the level of Hydrogel (0, 2 to 4 kg/ha.) and maximum was obtained with application of 4 kg Hydrogel with Furrow sowing highest effective tillers/m^2 (238.33), number of filled grains/panicle (172.83), grain yield (4.81 t/ha), Harvest index (44.35%), gross return (INR 1,76,043/ha), net return (INR 1,31,193/ha.) and benefit cost ratio (2.93).

Keywords: Aerobic rice, Hydrogel, Methods of sowing, Growth and Yield attributes.

1 INTRODUCTION

Rice is one of the most important staple food crops as it helps to sustain two thirds of the world's population. India is an important centre of rice cultivation. It provides the bulk of daily calories for many companion animals and humans [1]. Rice is a nutritional staple food which provides instant energy as its most important component is carbohydrate (starch), it also provides 27% of dietary energy supply, 20% of dietary protein and 3% of dietary fat [2]. India cultivated the rice in 44 million hectors land. Total rice production of 130.29 million tonnes in the 2021-22 which is more 3% more in pervious year 118.87 million tones. West Bengal first rank rice in production with 14.76 million tones [3]. It is higher by 13.85 million tonnes than the last five years' average production of 116.44 million tonnes. It is the highest rice producing state in India with a yield of 2600 kilograms per hectare. **Uttar Pradesh** with 14.02 million tons of rice production, Uttar Pradesh ranks on the 2nd position in the country [4].

To maintains the soil moisture and increase the water use efficiency by adding “Pusa Hydrogel” in the soil [5]. Puss Hydrogel is an indigenous product designed and developed to enhance the crop productivity per unit available water and nutrients, particularly in moisture stress agriculture [6] New strategies have to be adopted to mitigate the ill effects of drought. Due to their three-dimensional cross linked hydrophilic polymer networks, hydrogels are subjected to swelling and retain large amount of water or de swelling to loose its moisture. Thus, they act as miniature reservoirs. The swelling enables hydrogel to act as a water reservoir for plants in the root zone for uptake during water stress studied by [7]. Recently, hydrogel polymer technology has been widely used in the agricultural sector as soil conditioner because of its multifunctional roles in excellent water absorbency and water-retaining ability [8].

In the system of aerobic rice, especially adapted aerobic rice cultivars are grown under non-flooded or aerobic soils with supplementary irrigation [9]. Growing rice aerobically saves a significant amount of water which can be used for any other purpose. Although aerobic rice has a great potential for saving water but all this is at the cost of severe reduction in yield. A less water availability at reproductive stage is found to be a reason for low yield of aerobic rice [10]. It is, therefore, obligatory to develop appropriate management strategies in order to make water available to maximize the income on sustainable basis. Aerobic rice is emerging water saving rice production system in which rice is grown like wheat or maize. However, with low available water there is a contradiction among researchers which of different sowing methods is better [11] and [12] have a view that shifting rice from flat to ridge increases the water use efficiency of rice resulting in yield improvement. While rice sowing in furrows also helps in light penetration and also reduce the humidity in the rice field. This method can reduced rice diseases and increase leaf area, tillering and weight of per thousand grains [13]. This technique reduces labour needs by more than 25% in term of working hours. The input requirements and the investment in direct seeded rice are much lower than in transplanted rice reported by [14].

2 MATERIALS AND METHODS

This experiment was carried out investigation entitled, “Influence of Hydrogel and methods of sowing on growth and yield of Aerobic Rice (*Oryza sativa* L.)” was laid out during zaid season of 2022 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.). The crop research farm is situated at 25.57^0N latitude, 87.19^0 E longitude and at an altitude of 98 m above mean sea level. The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.0), low in organic carbon (0.40 %), available N (161.48 kg/ha), available P (151.2 kg/ha) and

available K (232.5 kg/ha). The experiment was laid out in randomized block design comprised of levels of hydrogel and methods of sowing with ten treatments and each were replicated thrice viz. Flat sowing + No hydrogel, Ridge sowing + No hydrogel, Furrow sowing + No hydrogel, Flat sowing + 2 kg Hydrogel/ha, Ridge sowing + 2 kg Hydrogel/ha, Furrow sowing + 2 kg Hydrogel/ha, Flat sowing + 4 kg Hydrogel/ha, Ridge sowing + 4 kg Hydrogel/ha, Furrow sowing + 4 kg Hydrogel/ha, Control (RDF 85:60:65). Total annual rainfall observed in cropping period was (98.68mm) The observation was recorded for plant height, tillers/m^2, plant dry/m^2, effective tillers/m^2, no. of grains/panicle, test weight, grain yield, straw yield, Harvest index. The collected data was subjected to statistical analysis by analysis of variance method

Application of Hydrogel and different sowing methods

Sowing methods comprised flat sowing, ridge sowing and furrow sowing. Hydrogel was applied manually at the time of soil preparation at (2,4 kg/ha The material used as hydrogel was Pusa hydrogel There were two hydrogel treatments (2,4 kg)and application of Pusa hydrogel with rice variety Raja Dhan-309 was used as medium of trial with seed rate of 60 kg/ha. The rice crop was sown with a single row hand drill in lines at 20 cm spaced rows; while on ridges, seeds were planted on one side maintaining line to line distance 20 cm. In furrow sowing was done in dead furrow with the same line-to-line distance, size of the furrow 5cm × 5cm × 5cm (L×B×W) sowing was done in aerobic conditions and irrigation was applied just after the sowing of rice seed. The crop was sown on July 27, 2022.

3 Result and discussion

3.1 Plant height

At 80 DAS, Significant variation in plant height of rice was observed under different sowing methods Maximum plant height (96.21 cm) of rice was measured in application of 4 kg hydrogel/ha + furrow sowing compared to the minimum plant height (80.30 cm) in control. The higher plant density at closer crop geometry leading to more severe competition for light and higher intra and inter-row competition for nutrients and water by the plants which coupled with the optimum sowing time, suitable growth period and favorable climatic conditions especially temperature might have resulted in maximum plant height. [15] Application of hydrogel helping in maintain in moisture soil which can improve plant height and similar result reported by [16].

3.3 Numbers of tillers/m^2

At 80 DAS, Significant variation in number of tillers/m^2 of rice was observed under different sowing methods, the maximum number of tillers/m^2 obtained Hydrogel 4

kg/ha + Furrow sowing (540.27), which is significantly superior over control (536.20). Direct seeded rice in Furrow obtaining stable rice seed emergence and preventing lodging of crops in the paddy field. Results of 63-73% for seed establishment were obtained using this method, which can improve the tillers count per meter square [17] Application of 5 kg hydrogel/ha in significantly impacted plant population and tillering. The plant population per m^2 was highest in hydrogel treated treatment and similar result was obtained by [18]

3.3 Plant dry weight

At 80 DAS, Significant variation in plant dry weight of rice was observed under different sowing methods, the maximum plant dry weight obtained 4 kg hydrogel per ha. with furrow sowing (1078.70 g/m^2) as compare to control (909.43 g/m^2). Hydrogel also improves crop growth and development by increasing nutrient absorption of plant under limited moisture condition [19] In furrow sowing also provide better utilization of radiation and improve the photosynthesis. An improvement of soil hydrothermal environment, optimizes canopy structure, and ultimately obtained an increase growth of plant and same result was reported by [20]

3.4 Numbers of effective tillers/m^2

Number of effective tillers per m^2 showed significant difference according to treatment combinations. Maximum effective tillers found application of Hydrogel 4 kg/ha + Furrow sowing (238.33 $/m^2$), which was significantly superior over control (203.67 $/m^2$). Whereas Hydrogel 4 kg/ha + Ridge sowing (235.00 $/m^2$) and Hydrogel 4 kg/ha + Flat sowing (235.00 $/m^2$) found to be statistically at par with Hydrogel 4 kg/ha + Furrow sowing.

3.5 Number of grains/panicle

Highest Number of filled grain per panicle was recorded with the application Hydrogel 4 kg/ha. + Furrow sowing (172.83) which was found significantly superior over control (168.83). Whereas Hydrogel 4 kg/ha + Flat sowing (172.53/m^2), Hydrogel 4 kg/ha + Ridge sowing (168.83) and Hydrogel 2 kg/ha + Flat sowing (168.83 $/m^2$) along with RDF found to be statistically at par with Hydrogel 4 kg/ha + Furrow sowing. The result conformity by [21]

3.6 Grain yield (t/ha)

Significantly higher grain yield of aerobic rice was recorded with application Hydrogel 4 kg/ha + Furrow sowing (4.81 t/ha). Which was found significantly superior over control (3.12 t/ha), this treatment gave 35.13% higher yield than control plot. Whereas Hydrogel 4 kg/ha + Flat sowing (4.76 t/ha), Hydrogel 4 kg/ha + Ridge sowing (4.62 t/ha), and Hydrogel 2 kg/ha + Flat sowing (4.08 t/ha), along with RDF found to be statistically at par with Hydrogel 4 kg/ha + Furrow sowing. Similar result obtained by [22]

3.7 STRAW YIELD (t/ha)

Significantly higher straw yield was recorded with application Hydrogel 4 kg/ha + Ridge sowing (6.20 t/ha).Which was found significantly superior over control (5.43 t/ha). Whereas Hydrogel 4 kg/ha + Flat sowing (6.05 t/ha.), Hydrogel 4 kg/ha + Furrow sowing (5.93 t/ha) and Hydrogel 2 kg/ha + Furrow sowing (5.78 t/ha.) found to be statistically at par with Hydrogel 4 kg/ha + Ridge sowing.

4 CONCLUSION

It is concluded that application of 4 kg/ha Hydrogel in rice with furrow sowing was found to be significantly more productive (4.81 t/ha) as well as economic (INR 1, 76,043/ha) as compare to other treatment. Since, the finding based on the research done in one season. In rice application of hydrogel along with furrow sowing which give good yield per drop of water and helping in saving water.

Table 1. influence of hydrogel and different methods of sowing on growth and yield attributes of the aerobic rice.

Treatments	Plant height in (cm)	Numbers of tillers/m^2	Plant dry weight(g/m^2)	Effective tillers/m^2	No. of grain/panicles	Seed yield (t/ha.)	Straw yield (t/ha)
T_1	82.83	477.23	983.17	207.67	151.20	3.26	5.37
T_2	84.39	482.93	987.53	204.33	152.40	3.30	5.42
T_3	85.78	487.87	974.63	208.33	158.07	3.37	5.43
T_4	88.72	490.47	986.33	210.67	156.43	3.69	5.67
T_5	90.59	497.20	985.30	212.33	158.67	3.83	5.72
T_6	90.82	508.40	1018.17	218.67	163.90	4.08	5.78
T_7	90.61	533.50	1064.10	228.00	172.53	4.76	6.05
T_8	93.65	536.20	1048.43	235.00	168.83	4.62	6.20
T_9	96.21	540.27	1078.70	238.33	172.83	4.81	5.93
T_{10}	80.3	461.93	909.43	203.67	148.77	3.12	5.43
F-Fest	S	S	S	S	S	S	S
SEm (±)	2.74	14.48	31.13	7.22	4.67	0.26	0.17
C D at 0.5%	8.13	43.03	92.49	21.44	13.88	0.77	0.51

REFERENCES

1 Ryan, E. P. 2011. Bioactive food components and health properties of rice bran. *Journal of the American veterinary Medical Association,* **238**: 593 – 600

2 Deepa, G., Singh, V. and Naidu, K. A. 2008. Nutrient composition and physicochemical properties of Indian medicinal rice – Njavara. *Food Chemistry,* 106: 165– 171.

3 Ministry of Agriculture and Farmers Welfare Department of Agriculture, Cooperation and Farmers Welfare. Directorate of economics and statistics. *First advance estimates of production of foodgrains* for 2021-22

4 Ministry of Agriculture and Farmers Welfare Department of Agriculture, Cooperation and Farmers Welfare. Directorate of economics and statistics. *First advance estimates of production of foodgrains* for 2021-22

5 Anupama, and Parmar, B. S.2012. An indigenous semi synthetic superabsorbent technology for conserving water and enhancing crop productivity. *Indian Agricultural Research Institute* (IARI).

6 Dar, S.B.,Mishra, D., Zahida, R. and Afshana, B. 2017 To Enhance Crop Productivity Per Unit Available Water Under Moisture Stress Agriculture. *Bulletin in Environment, Pharmacology and Life Sciences*, **6**(9):129–135.Bedi, K. J. and Sohrab, F. 2004.Evaluation of super absorbent polymer application on water holding capacity and potential in three soil type. *Journal of Science and polymer Technology*, **3**:163–173, 2004.

7 Ahmed, E.M. 2015. Hydrogel: Preparation, characterization, and applications: *Journal of advance research*, **6**:105-121.

8 Bedi, K. J. and Sohrab, F. 2004.Evaluation of super absorbent polymer application on water holding capacity and potential in three soil type. *Journal of Science and polymer Technology*, **3**:163–173, 2004.

9 Bouman, B.A.M., Hengsdijk H., Hardy B., Bindraban P.S., Tuong T.P., Ladha J.K. 2002. Water-wise rice production. Proceedings of the International Workshop on Water-wise Rice Production, 8–11. Los Baños, Philippines. *International Rice Research Institute,* Los Baños, Philippines.

10 Bouman, B.A.M., Peng S., Castaneda, A.R., Visperas, R.M. 2005. Yield and water use of irrigated tropical aerobic rice systems. Agricultural Water Management, *74*: 87–105.

11 Tong-Chao W., Li W., Yan W., Jun-Zhong W. 2007. Influence of bed-planting and strew mulching system on soil water and crop using of farmland. *Journal of Soil and Water Conservation*, *2*: 25–29.

12 Jin, H., Hongwen L., Kuhn, N.J., Xuemin, Z., Wenying, L. 2007. Soil loosening on permanent raised-beds in arid northwest China. *Soil and Tillage Research*, ***97***: 172–183.

13 Dhaliwal, K. L., Kaur,S., and Kaur, S. 2019. Effect of microclimatic modification and weather on brown leaf spot of rice. *Agriculture Research Journal,* **56**(2): 267-273.

14 Chaudhary, A., Mishra, k. A., Sharma, S. 2022. Agronomic and environmental determinants of direct seeded rice in south Asia. *Circular economy and Sustainability*, **3**:2251-2262
15 Karki, S., Adviento-Borbe, M.A.A., Massey, J.H., Reba, M.L. 2021.Assessing Seasonal Methane and Nitrous Oxide Emissions from Furrow-Irrigated Rice with Cover Crops. *Agriculture*, 11, 261.
16 Rudzinski W E, Dave A M , Vaishnav U H, Kumbar S G, Kulkarni A R and Aminabhavi T M. 2002. Hydrogels as controlled release devices in agriculture. *Designed Monomers and Polymers,* **5**(1): 39–65.
17 Kaur, S. and Singh, S.2015. impact of crop establishment method and weed controls on weeds, insect pest and diseases infestation in rice in north-western Indo-Ganetic plains. *International journal of agriculture sciences,***7**(4):487-497.
18 Roy, T., Kumar, S., Sharma, S. K., Kumar, R. and Mallik, A. 2019. Impact of Pusa hydrogel application on yield and productivity of rainfed wheat in North West Himalayan region*. ICAR-Indian Institute of Soil and Water Conservation*, 248-195.
19 Rahimi, S., Shahi, S., Kazemi, S., Ebrahimi, H. and Ahmadi M. 2014. The influence of superabsorbent polymer the reduction in irrigation and increase the productivity of crops. *Journal of Applied Science and Agriculture,* **9**(18): 26–28.
20 Liu, P. 2022 Ridge and furrow configuration optimized soil hydrothermal environment, Maize Canopy Traits and Improved Grain Yield in Northwest China. *Research Square,* **2**(11) 251-260.
21 Neelima S., and Kumar, A. K. 2011. Performance of Different Rice (Oryza sativa L.) Cultivars under Aerobic Conditions. *Plant Resource Management,* **2**(2): 215-217.
22 Pinheiro, L. V., Stone, F., José, A. and Nascente, S. 2016. Grain yield and termite damage in rice by compaction on the furrow and seed treatment**.** *Journals of crop science*, **51**(11): 1813-1820.