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Biometric observations of upland rice (*Oryza sativa* L.) as influenced by cropping geometry and *In situ* soil moisture conservation practices

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Abstract
To study the influence of cropping geometry and *in situ* soil moisture conservation practices on biometric observations of upland rice (*Oryza sativa* L.), an experiment was conducted at college of Agriculture, Vellayani, Thiruvananthapuram, Kerala Agricultural University, Kerala, India, The treatments were laid out in randomized block design. Altered cropping geometries like normal planting (20cm x 10cm) and paired row planting (10cm x 10cm) with 40 cm between paired rows, different *in situ* soil moisture conservation practices such as live mulching of cowpea, hydrogel application and coirpith application were studied and evaluated statistically on growth parameters like plant height (30 DAS, 60 DAS and harvest), number of tillers m^{-2} (60 DAS) leaf area index (60 DAS) and dry matter production (60 DAS, harvest). Results disclosed a significant difference in biometric observations and the treatment T_9 (Paired row planting with live mulching of cowpea, hydrogel and coir pith application) showed the highest plant height (109.13 cm), the maximum number of tillers m^{-2} (349.67), leaf area index (4.34) and dry matter production (5546 kg ha^{-1}).

Keywords: Crop, geometry, live mulching, hydrogel, coirpith compost, upland rice

Introduction

Rice is one of the most important staple food and extensively grown crop providing food for majority of the world population. India is first in area under rice cultivation (43 m ha) and second in production (95 m t) which shares 40 per cent of the total food grain production (Kumar *et al*., 2017) [4]. The availability of water for agricultural sector is 83.3 per cent of the total water used and might shrink to 71.6 per cent by 2025 leading to physical water scarcity of irrigated rice (Yadav *et al*., 2001) [11]. It is necessary to increase the water productivity of rice by following upland rice cultivation. But the productivity of upland rice is low due to various factors like biotic (weeds) and abiotic (moisture) stresses. The productivity of upland rice can be improved by reducing the abiotic stresses i.e., by following *in situ* moisture conservation practices like hydrogel application, live mulching with cowpea and coirpith compost application etc. However, with the low moisture availability there is an effect of cropping geometry on yield of upland rice.

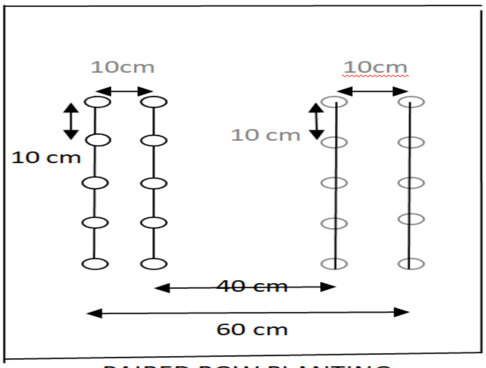
Cropping geometry is the shape of space available for the plants. In the conventional system of rice, planting is done at a spacing of 20cm x 10cm, where the scope for intercropping is less. As a result, widening of inter row spacing is important for growing intercrops (Saeed *et al.*, 1999) [8]. Live mulch with cowpea is grown as a cover crop along with main crop, which helps in weed suppression, conserves soil moisture and regulates soil temperature (Power and Koerner, 1994) [7]. It protects the soil from erosion and fixes nitrogen in soil by the process of biological nitrogen fixation.

Coirpith compost generated from coir industries can be used effectively as a mulching material in upland rice. It improves the productivity by maintaining the soil fertility, conserving moisture, improving the physical and biological properties of soil (Solaimalai *et al.*, 2001) [9].

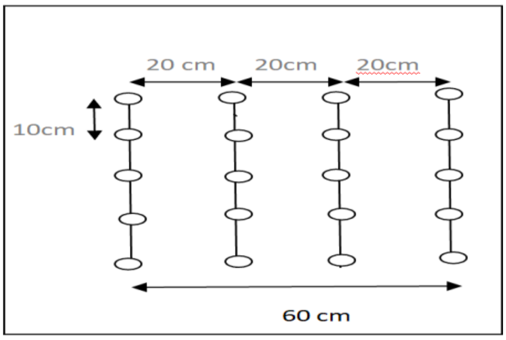
Hydrogels are polymers having high capacity to absorb water when water is available and releases absorbed water based on the need of plants over a period of time (Akhter *et al.,* 2004) [1]. The productivity of crops can be enhanced by the application of hydrogel under water stressed environmental conditions along with sustainability. The frequency of irrigation to crops can be reduced by using hydrogel, thereby reducing the time and cost of water application (Das *et al.,* 2017) [2].

Materials and Methods

The experimental study was conducted at College of Agriculture, Vellayani, Kerala Agricultural University, Kerala, India during kharif season of 2019. The soil of the experimental field was red sandy clay loam type with a pH 4.8, organic carbon 0.67 per cent, available nitrogen 190.15 kg ha^{-1}, available P_2O_5 35.45 kg ha^{-1} and available K_2O 248.12 kg ha^{-1}. The experiment was carried out in randomized block design comprising different treatments of planting geometries and *in situ* soil moisture conservation practices.



PAIRED ROW PLANTING



NORMAL PLANTING

The treatments followed were T_1: Normal planting of upland rice (20 cm x 10 cm); T_2: Normal planting with live mulching of cowpea; T_3: Normal planting with live mulching of cowpea and hydrogel application; T_4: Normal planting with live mulching of cowpea and coir pith application; T_5: Normal planting with live mulching of cowpea, hydrogel and coir pith application; T_6: Paired row planting with live mulching of cowpea; T_7: Paired row planting with live mulching of cowpea and hydrogel applicaton; T_8: Paired row planting with live mulching of cowpea and coir pith application; T_9: Paired row planting with live mulching of cowpea, hydrogel and coir pith application.

Before the start of experiment, farm yard manure having nutrient content of 0.5 per cent N, 0.2 per cent P_2O_5 and 0.3 per cent K_2O was applied uniformly to all the plots at the rate of 5 t ha^{-1} and mixed well with the top soil. The nutrients were applied i.e., 60 kg N in form of urea in three equal split doses (one at basal, second at active tillering stage, finally at panicle initiation stage), 30 kg P_2O_5 in form of rajphos (entire quantity as basal), 30 kg K_2O in form of muriate of potash ha^{-1} in two split doses (one as basal and other at panicle initiation stage). The growth attributes like plant height (30 DAS, 60 DAS and harvest), number of tillers m^{-2} (60 DAS) leaf area index (60 DAS) and dry matter production (60 DAS, harvest) were recorded at the respective growth stages.

Results and Discussion

The data on biometric observations like plant height, number of tillers m^{-2}, leaf area index and dry matter production were prominently influenced by the treatments (Table 1). The treatment T_9 (Paired row planting with live mulching of cowpea, hydrogel and coir pith compost application) recorded the highest plant height (109.13 cm), the maximum number of tillers m^{-2} (349.67), leaf area index (4.34) and dry matter production (5546 kg ha^{-1}) and almost all the growth attributes recorded by T_9 are on par with T_5 (Normal planting with live mulching of cowpea, hydrogel and coir pith application).

In paired row cropping geometry, two rows of rice at a spacing 0f 10cm x 10cm were sown as paired rows and the spacing between two such paired rows was 40cm where three rows of green manure cowpea was grown as intercrop. The reason for longer plants in paired row cropping geometry might be due to the sufficient interspace between paired rows for rooting and extraction of moisture which consecutively helped in better water and nutrient absorption. This was in conformity with the reports of Mahajan and Chauhan (2011) [6] in upland rice.

The leaf area index and number of tillers m^{-2}, were increased in T_9 due to the improved soil health and higher organic matter content due to insitu green manuring resulting in biological nitrogen fixation. This was in conformity with the findings of Srinivasan (2002) [10] in upland rice. The improved growth attributes such as plant height, number of functional leaves, leaf area index and number of tillers resulted in higher dry matter production in T_9. The higher water holding capacity of hydrogel and reduced evaporation and soil temperature by mulch increased the plant availability of nutrients leading to increased plant height, number of tillers and dry matter production which was in conformity with the reports of Islam *et al.* (2011) [3] in rice and Kumar *et al.* (2018) [5] in maize.

Table 1: Effect of cropping geometry and in situ soil moisture conservation practices on plant height at different growth stages, number of tillers m^{-2}, leaf are index and dry matter production

Treatments	Plant height (cm)			Number of Tillers m^{-2} (60 DAS)	Leaf Area Index (60 DAS)	Dry matter production	
	30 DAS	60 DAS	Harvest			60 DAS	Harvest
T_1	58.81	83.81	92.61	298.33	3.93	1967	4276
T_2	59.69	88.86	99.81	325.00	4.19	2124	4850
T_3	58.53	88.79	100.60	337.00	4.13	2138	4925
T_4	58.70	90.78	102.16	335.00	4.18	2220	4992
T_5	58.56	91.78	104.00	349.33	4.22	2399	5503
T_6	58.88	90.65	98.91	313.00	4.25	2143	4762
T_7	59.46	90.54	100.73	314.33	4.15	2237	5466
T_8	59.13	90.70	101.09	331.00	4.22	2242	5149
T_9	59.41	91.32	109.13	349.67	4.34	2464	5546
SEm (±)	0.67	1.04	1.29	6.88	0.07	60	174
CD (0.05)	NS	3.150	3.897	20.804	NS	182.5	525.4

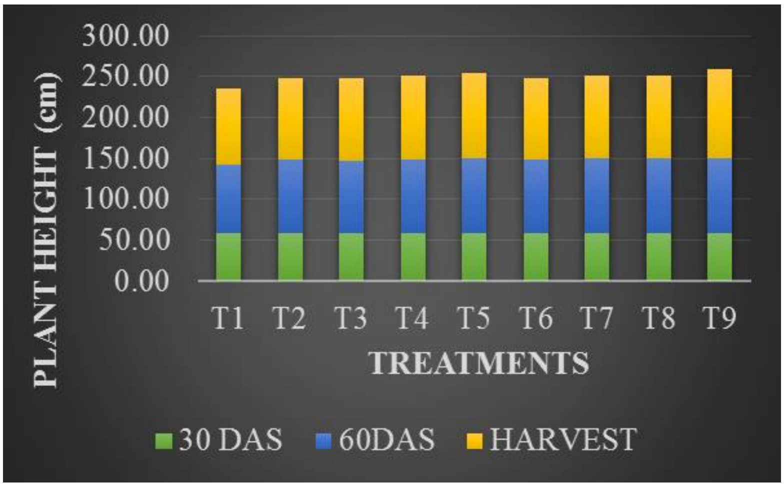


Fig 1: Effect of cropping geometry and in situ soil moisture conservation practices on plant height at different growth stages, cm

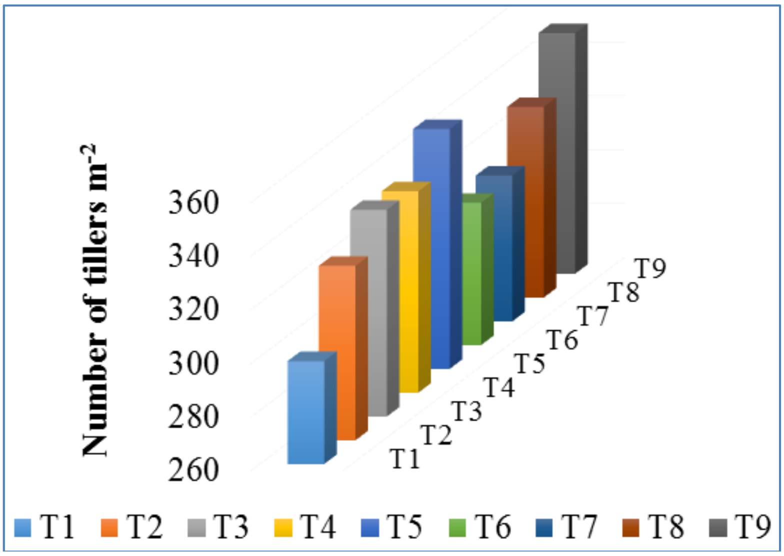


Fig 2: Effect of cropping geometry and in situ soil moisture conservation practices on number of tillers m^{-2}

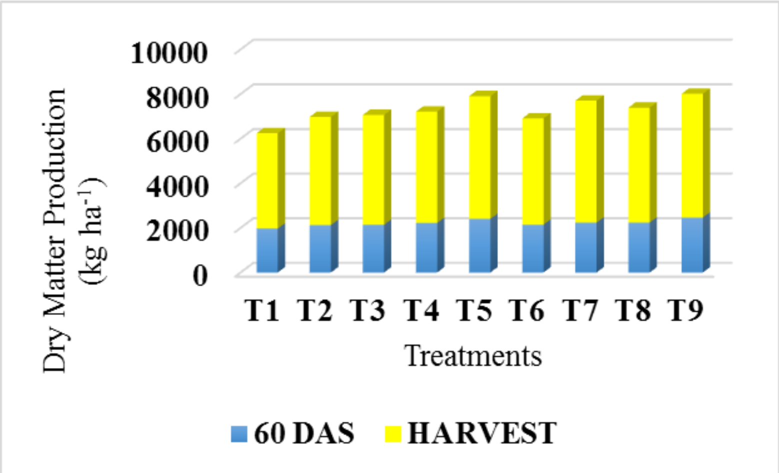


Fig 3: Effect of cropping geometry and in situ soil moisture conservation practices on Dry Matter Production (DMP) (60 DAS, Harvest)

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