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STUDIES ON IMPACT OF IRRIGATION AND WATER CONSERVATION PRACTICES ON THE GROWTH AND YIELD OF DIRECT SOWN RICE UNDER WATER CONSTRAINT SITUATION

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ABSTRACT

An experiment was conducted to study the agronomic practices for growth and yield maximization of direct sown rice under water constraint situation. The main plot treatments comprised of three levels of irrigation *viz.,* Conventional irrigation (M_1), tensiometer based irrigation (M_2) and deficit irrigation (M_3) respectively and were tested with different water conservation practices *viz*., soil application of water saving crystals (WSC) @ 5 kg ha^{-1} (S_1), foliar application of drought shield @ 3 liters ha^{-1}(S_2), soil application of humic granules @ 2.5 kg ha^{-1} (S_3) and soil application of FYM @ 12.5 t ha^{-1} (S_4). Interaction between different levels of irrigation and water conservation practices were significantly influenced. Tensiometer based irrigation along with soil application of humic granules @ 2.5 kg ha^{-1} (M_2S_3) recorded the higher growth and yield parameters in direct sown rice.

Keywords: Irrigation, Water conservation, direct sown rice, Growth parameters, Yield parameters.

INTRODUCTION

Rice (*Oryza sativa*) is the most important staple food for more than half of the world's population and its cultivation possess an immense importance to food security in Asia, where more than 90% of the global rice is produced and consumed (Kurrey *et al.,* 2018). From time immemorial, rice has been grown in lowland areas under flooded conditions (*i.e.*, continuous flooding). Due to increased water scarcity, efficient water management practices have to be adopted. The challenge to produce more food under increasing water scarcity has led to the notion that crop water productivity need to be increased (Kijne *et al.,* 2003). For deficit rainfall areas direct sown rice is an ideal option, which deliberately avoids three basic operations namely nursery preparation, transplanting and maintaining a standing column of water. In order to mitigate water scarcity, application of new generation water saving chemicals and organic products has to be used to conserve water under field condition. Tensiometer is a simple device that measures the amount of energy required by the plant to pull soil water at the current moisture level and it guides the farmers about the scheduling of irrigation in crops (Kamal *et al.,* 2018). Hydrogel acts as a reservoir to store and release water and nutrients which plants need to grow. From the crystal bead of hydrogel, plant roots are able to absorb water (Rehman *et al.,* 2011). Application of humic substance in paddy resulted in increased plant growth and yield characteristics remarkably (Perumal *et al.,* 2015). Drought shield protects plants from heat, water loss, drying winds, sunburn and make them stable under drought prone condition.

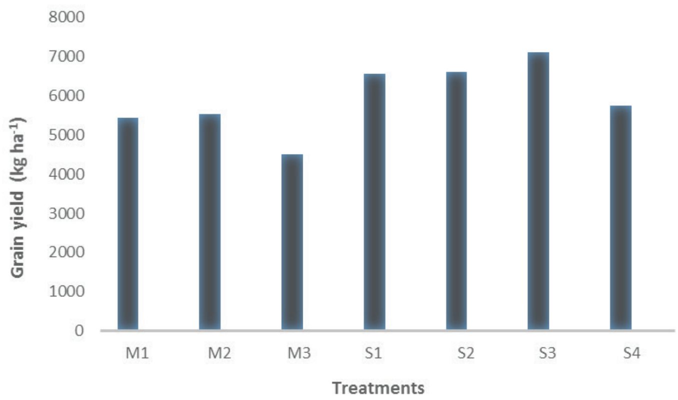
MATERIALS AND METHODS

The experiment was carried out at the Experimental farm, Department of Agronomy, Annamalai University, Annamalai Nagar to study the impact of agronomic practices on the growth and yield of direct sown rice under water constraint situation during February to May 2018 ("Sornavari" season). Rice variety CO-51 was chosen for the study and the adopted spacing was 15 x 10 cm. Recommended dose of NPK for rice variety 120:40:40 kg ha^{-1} was adopted in crop management practices.

The experiment was carried out in split plot design with three replications. The main plot treatments comprised of three levels of irrigation *viz.,* Conventional irrigation (M_1), tensiometer based irrigation (M_2) and deficit irrigation (M_3) and the sub-plot treatments comprised of different water conservation practices *viz*., soil application of water saving crystals (WSC) @ 5 kg ha^{-1} (S_1), foliar application of drought shield @ 3 litres ha^{-1} (S_2), soil application of humic granules @ 2.5 kg ha^{-1} (S_3) and soil application of FYM @ 12.5 t ha^{-1} (S_4). In this region the water requirement for direct sown rice is 920 mm. Under conventional irrigation, the crop was irrigated with 5 cm of water each time 3 days after disappearance of applied water throughout the crop duration. In tensiometer based irrigation, the crop was irrigated up to the field capacity (tensiometer value of 0.7) and in deficit irrigation, the crop was irrigated to a medium level of A.S.M. (tensiometer value of 0.5). Irrigation was scheduled at vegetative phase, reproductive phase, ripening phase and the total number of irrigations given under the main plots were scheduled as follows: conventional irrigation (23), tensiometer based irrigation (17) and deficit irrigation (12) respectively. Observations on plant height, leaf area index, no of tillers hill^{-1}, DMP

Table 1: Effects of different levels of irrigation and water conservation practices on growth parameters and yield of direct sown rice

Treatments	Plant height (cm)	No. of tillers plant-1	LAI (flowering)	DMP (kg ha-1)	CGR (30-60 DAS)
M_1 – Conventional irrigation	90.54	5.48	4.51	13411	9.72
M_2 – Tensiometer based irrigation	90.78	5.48	4.55	13631	9.83
M^3 – Deficit irrigation	80.13	4.56	3.85	11303	8.41
S. Ed	0.65	0.03	0.03	94.79	0.06
C.D (p=0.05)	1.82	0.10	0.08	263.21	0.18
S_1 – Soil application of water saving crystals (WSC) @ 5 kg ha^{-1}	87.84	5.22	4.33	12826	9.37
S_2 – Foliar application of drought shield@ 3 litres ha^{-1}	88.20	5.27	4.36	13057	9.44
S_3 – Soil application of humic granules @ 2.5 kg ha^{-1}	93.93	5.73	4.75	14229	10.25
S_3 – Soil application of FYM @ 12.5 t ha^{-1}	78.62	4.48	3.77	11016	8.23
S. Ed	1.01	0.06	0.05	156.76	0.11
C.D (p=0.05)	2.14	0.13	0.11	329.36	0.23



Figuere 1: Effects of different levels of irrigation and water conservation practices on grain yield (kg ha-1) of direct sown rice

and yield were recorded.

RESULTS AND DISCUSSION

Effects of different levels of irrigation and water conservation practices on growth parameters

Plant height

The data pertaining to plant height at harvest stages are presented in Table 1. Interaction effect influenced the plant height of direct sown rice significantly. The maximum plant height of 98.69 cm at harvest stage is recorded in the treatment combination M_2S_3 (Tensiometer based irrigation applied with soil application of humic granules @ 2.5 kg ha^{-1}). This was followed by M_1S_3 (Conventional irrigation along with soil application of humic granules @ 2.5 kg ha^{-1}). The treatment combination M_3S_4 (Deficit irrigation applied with FYM @ 12.5 t ha^{-1}) recorded the minimum plant height of 73.25 cm at harvest stage. Improved plant growth was due to proper irrigation scheduling of direct sown rice based on soil water tension, which might have increased the irrigation water productivity by avoiding water deficit stress and over-irrigation and resulted in increased plant height, LAI, number of tillers plant^{-1} and DMP. Similar results was observed by Khalilzadeh *et al.,* (2012) and Abeer Meganid *et al.,* (2015).

Number of tillers plant^{-1}

The data pertaining to number of tillers plant^{-1} are presented in Table 1. The maximum number of tillers plant^{-1} (6.23) at active tillering stage was recorded in the treatment combination M_2S_3 (Tensiometer based irrigation along with soil application of humic granules @ 2.5 kg ha^{-1}). Application of humic acid in wheat resulted in increased growth parameters thereby the yield (Shabana Ehsan *et al.,* (2016). The treatment combination M_3S_4 (Deficit irrigation applied with FYM @ 12.5 t ha^{-1}) recorded the minimum number of tillers plant^{-1} (4.01) at active tillering stage.

Dry matter production

The data pertaining to dry matter production at harvest stages are presented in Table 1. The maximum DMP of 15546 kg ha^{-1} at harvest stage was recorded in the treatment combination M_2S_3 (Tensiometer based irrigation along with soil application of humic granules @ 2.5 kg ha^{-1}). Studies of Perumal *et al.,* (2015) stated that application of humic substance in rice significantly increased the total dry matter, nutrient uptake and nutrient recovery. The treatment combination M_3S_4 (Deficit irrigation applied with FYM @ 12.5 t ha^{-1}) recorded the minimum DMP of 9976 kg ha^{-1} at harvest stages respectively.

LAI

Tensiometer based irrigation along with soil application of humic granules @ 2.5 kg ha^{-1} (M_2S_3) has significant effect on LAI. The treatment combination of M_3S_4 (Deficit irrigation along with FYM @ 12.5 t ha^{-1}) recorded the minimum leaf area index. The result indicated that the water stress free plants increased the leaf area due to its higher turgor potential, which act as driving force for cell division and cell elongation. A similar result of increase in leaf area due to timely irrigation was revealed by Ali *et al.,* (2011) in various crops.

Crop growth rate

The data pertaining to crop growth rate at 30 to 60 DAS are presented in Table 1. The higher crop growth rate at 30 to 60 DAS of 11.11 g $m^{-2}d^{-1}$ was recorded in the treatment combination M_2S_3 (Tensiometer based irrigation along with soil application of humic granules @ 2.5 kg ha^{-1}). This was followed by the treatment M_1S_3 (Conventional irrigation along with soil application of humic granules @ 2.5 kg ha^{-1}). The treatment combination M_3S_4 (Deficit irrigation applied with FYM @ 12.5 t ha^{-1}) recorded the minimum crop growth rate at 30 to 60 DAS of 7.52 g $m^{-2}d^{-1}$. Reduced CGR was due to photosynthesis inhibition even when the stomatal influence got eliminated, suggesting that factors other than low CO_2 availability affect photosynthesis under drought conditions. Similar results of decrease in photosynthetic rate due to drought, ultimately resulted in poor crop growth rate was reported in chickpea (Krouma, 2010).

Effect of different levels of irrigation and water conservation practices on yield parameters

Grain yield

The data pertaining to grain yield are presented in Table 1. The maximum grain yield of 6352 kg ha^{-1} was recorded in the treatment combination M_2S_3 (Tensiometer based irrigation applied with soil application of humic granules @ 2.5 kg ha^{-1}). The increased yield might be due to the availability of adequate amount of nutrients and soil moisture during the physiological growth stages thereby providing favourable condition for the crop to express its yield potentiality. According to Dandge *et al.,* (2016), application of humic acid in soybean was an intelligent practice as it recorded increased grain and straw yield. Mitali *et al.,* (2017) stated that grain yield obtained from tensiometer based irrigation were the highest. The treatment combination M_3S_4 (Deficit irrigation applied with FYM @ 12.5 t ha^{-1}) recorded the minimum grain yield of 3940 kg ha^{-1}.

CONCLUSION

Based on the results of the experiment carried out at Annamalai University, Experimental Farm, it may be concluded that tensiometer based irrigation along with soil application of humic granules @ 2.5 kg ha^{-1} holds promise as an agronomically efficient and economically viable practice for achieving higher yields in direct sown rice and also paved way for achieving sustainability in agriculture.

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