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Yield and water use efficiency of direct seeded rice affected under different moisture regimes and brown manuring practices

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Abstract

A field experiment was conducted during rainy (*kharif*) season of 2020 in split plot design with three replications at Centre of excellence on water management, Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar to investigate the Yield and Water Use Efficiency of direct seeded rice affected under different moisture regimes and brown manuring practices. The treatments consist of three moisture regimes i.e. I_1 – Alternate wetting and drying after 3 days, I_2 – Alternate wetting and drying after 5 days and I_3 – Alternate wetting and drying after 7 days and 4 brown manuring treatments i.e. B_1 – Control, B_2 – Rice + Dhaincha, B_3 – Rice + Moong and B_4 – Rice + Urad. The test cultivar was Rajendra Neelam. The result showed that growth and yield attributes like plant height, number of tillers/m^2, number of panicles/m^2, number of grains/panicle, grain and straw yield and Water Use Efficiency were found to be maximum with I_1 moisture regimes which are significantly superior to I_2- Alternate wetting and drying after 5 days and I_3- Alternate wetting and drying after 7 days.

Growth and yield attributes like plant height, number of tillers/m^2,number of panicles/m^2, number of grains/panicle, grain and straw yield found to be maximum with B_2 – Rice + Dhaincha treatment. Water Use Efficiency was at par with B_3 – Rice + Moong.

Keywords: Rice, RDF, moisture regimes, brown manuring

Introduction

Rice is a semi aquatic plant which cultivated in high rainfall and wide range of environmental condition during its life span. Previously rice crop cultivation was done in stagnant water for almost all growth stages. Rice crop having very less Water Use efficiency as compares to the other crops. Cultivation of rice indiscriminate use of ground water precedes to declines the water table and enhances cost of water pumping.

Direct seeded rice in India occupied 7.2 m ha area according to (Gangwar *et al.*, 2008) [2]. DSR method of rice cultivation is also followed in the tropical Asian countries like Malaysia, Myanmar and Philippines, whereas, DSR already replaced TPR techniques in many regions of South East Asian countries.

These factors prompt researchers to look for new crop establishment strategies that can boost water productivity. The sole alternative for reducing wasteful water flows is to plant direct seeded rice. Through DSR method helps to reduce water consumption. Intensity of water saving is managed by scheduling of irrigation. Improved short duration and high yielding varieties DSR secure timely sowing of succeeding crop without much disturbance of soil structure. Greater adoption of DSR is mainly because it helps in adequate irrigation, good germination rate, controlled on weed emergence and efficient WUE.

Growing *Sesbania* and other green manuring crops with rice and using 2, 4-D @ 400-500 g/ha to kill the green manure crop 30 days after seeding is known as brown manuring. We called this is knocking down effect. After killing leaf color turns green to brown this is called brown manuring. This approach causes *Sesbania* leaves to fall to the ground and cover the soil surface forming a mulch layer that inhibits weed establishment, controls moisture evaporation, and adds roughly 20-35 kg N/ha without significantly increasing cultivation costs. Brown Manuring not only increases the organic carbon content of the soil but it also gives nitrogen to the rice plant, reducing the need for external nitrogen fertilizer. Brown manuring also improves the soil physicochemical and biological qualities as well as the rhizospheric environment.

As well as in addition to reducing of weeds their enzymatic activities are get enhanced that encourages root development and crop yield.

Materials and Methods

A field experiment was conducted during *kharif* season of 2020 in split plot design with three replications at Crop Research Centre, Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar, situated in Samastipur district of North Bihar on the Southern and Western bank of the river *Burhi Gandak* at 25° 59' North latitude and 85°48´ East longitude with an altitude of 52.92 meters above mean sea level. It has sub-tropical and sub humid monsoon climate. The average rainfall of the area is 1323.6 mm out of which nearly 1026.0 mm is received during the monsoon between June to September. The treatments consisted of three irrigation management i.e. The treatments consist of three moisture regimes i.e. I_1 – Alternate wetting and drying after 3 days, I_2 – Alternate wetting and drying after 5 days and I_3 – Alternate wetting and drying after 7 days in main plot treatments and four brown manuring treatments i.e. B_1 – Control, B_2 – Rice + dhaincha, B_3 – Rice + moong and B_4 – Rice + urad. The test cultivar was Rajendra Neelam. The soil of experimental plot was sandy loam in texture, alkaline in reaction (pH-8.32), low in available N (153 kg/ha), P_2O_5 (18.21kg/ha) and K_2O (134.00 kg/ha). The crop was fertilized with 120:60:40:25 kg/ha N-P_2O_5-K_2O-$ZnSO_4$. Application of half (50%) dose of nitrogen and total phosphorus and potash and $ZnSO_4$ (25 kg/ha) were applied as basal and remaining dose of nitrogen in two equal splits (25% N at active tillering and 25% N at panicle initiation stage). Seeds of *Sesbania aculeata*, moong and urad were sown in the field alongside paddy in plots where brown manuring treatments was scheduled seed @ 40 kg/ha. They were allowed to grow for 25 days before blossoming. The field was sprayed with a post-emergence herbicide such 2,4-D at a rate of 1.25 liters per hectare. Data were statistically analyzed using analysis of variance (ANOVA).

Result and Discussion

The data presented in (Table:-1) indicated that moisture regimes had a significant impact on all growth stages of rice. Maxium plant height (112.15 cm), Number of tillers/m^2 (357.15/m^2), Number of panicles/m^2 (256.02), Number of grains/panicle (93.19) was recorded with alternate wetting and drying after 3 days which was significantly superior to alternate wetting and drying after 5 days. Thus, possible that related to favorable moisture availability sufficient supply of moisture ensured good root establishment and improved the performance of several metabolic activity that shows good nutrient mobilization and leads greater Plant height. Smallest plant height was found with alternate wetting and drying after 7 days because rice development was stunted due to moisture stress. It matched with research of (Harishankar *et al*., 2016) [4] and (Kumari *et al.*,2018) [7].

Moisture regimes had a substantial impact on grain yield of DSR. Yield and straw yield considerably higher with alternate wetting and drying after 3 days (3.96 t/ha and5.70 t/ha)) compared to alternate wetting and drying after 5 days (3.63 t/ha5.23 t/ha) and 7 days (3.06 t/ha4.43 t/ha). Moisture regimes shows a significant effect on grain yield, with the greater value obtained with alternate wetting and drying after 3 days shows significantly higher than the remaining trials and low data obtained with alternate wetting and drying after 7 days of crop phase. Due to this higher no. of tillers/m^2 increased dry matter accumulation under more favorable water conditions. The combined effect of numerous growth and development characteristics determines a crop grain yield. In the current study, increasing moisture regimes seemed to affect all developmental characters while under moisture stress condition photo accumulation process reduced due to stomata closure which found decreases CO_2 uptake and protoplasm capacity to carry out photosynthesis actively. Low translocation may hamper final products but in treatment that received adequate water continuous the developing period the opposite was true. These findings were complemented by (Kumar *et al.*, 2015) [6], (Das *et al*., 2016) [1] and (Nayak *et al.*, 2016) [9].

WUE was significantly affected by moisture availability (Table:-2). Higher value of WUE was found with alternate wetting and drying after 3 days (32.27 kg/ha-cm) which more over alternate wetting and drying after 7 days (29.23 kg/ha-cm) but at par with 5 days (31.09 kg/ha-cm). This could be attributable to increased water use efficiency; however yield did not rise in proportion to the amount of water used (Shekara *et al*., 2010) [11] and (Nayak *et al.*, 2016).[9]

Different brown manuring procedures had a substantial effect (Table:-1) on plant height at (30.61 cm) whereas Rice + dhaincha and Rice + moong was at par. Rice + dhaincha had the highest crop height (110.17 cm) at harvest which significantly higher than Rice + moong, Rice + urad and Control. This might be due to when the time comes the brown manuring crops were sprayed with 2, 4-D ethyl ester to kill them this resulted in a proper combination of organic and inorganic blending in the rice rhizo-ecosystem. Organic and Inorganic nitrogen creates a beneficial environment. The immediate release of fertilizer N in the early stages, followed by the release of organic N later ensured a regular availability favors higher plant height. This is consistent with findings of (Gill and Wallia, 2014) [3] and (Sarangi *et al*., 2016) [10].

Number of tillers/m^2 demonstrated that brown manuring has a substantial impact on the number of tillers/m^2 at all growth phases. Maximum number of tiller/m^2 recorded at 60 DAS brown manuring practices with Rice + dhaincha (353.14/m^2) which was significantly superior over Control, Rice + moong, and Rice + Urad. Different brown manuring procedures had a substantial effect on panicles/m^2 at all growth phases according to a careful review of data on panicles/m^2. Rice + dhaincha had a substantially higher panicles/m^2 (251.72) , maximum grains/panicle (91.62) than the rest of the treatments. Average value of test weight not shown any significant difference on brown manuring practices. More test weight was found with Rice + dhaincha (22.93 g) and minimum with control (22.28 g). A critical analysis of grain yield observed that different brown manuring practices shows significant response on crop grain yield among treatments significantly higher grain and straw yield (3.89 t/ha5.62 t/ha) found with Rice + dhaincha, Rice + moong (3.57 t/ha), Rice + urad (3.50 t/ha) and control (3.23 t/ha). This might be due to brown manuring effect on crop output is determined by their nutrient quality with lower C: N and C:P ratios are usually more effective in increasing crop productivity. The action of organic acids generated during the breakdown process of these brown manuring crops had a solubilizing impact on the adsorbed and fixed nutrients in the soil, and lack of different nutrients in the soil can be alleviated by the mineralization of critical nutrients. Furthermore, brown manuring crops boost the soil organic carbon content. The chelation of micronutrients is facilitated by increased organic matter, which increases their availability to plants and it decreases of losses, such as nitrogen volatilization and leaching. Superior grain yields may be due to better availability of all important nutrient requirements in the brown manured plot. The results are supporting with (Maity and Mukherjee 2009) [8] and (Sraw *et al*., 2017) [12].

Brown manuring has a significant effect on WUE (Table:-2) Higher WUE (33.86 kg/ha-cm) was found with Rice + dhaincha over Rice + moong (31.06 kg/ha-cm), Rice + urad (30.39 kg/ha-cm) and control (28.15 kg/ha-cm). This could be because WUE is directly related to economic yield, before knock down brown manure plants act as live mulch and after spray of 2, 4-D ester it was act as dead mulch that helps to prevent evaporation losses from the soil and it helps to increase WUE. Similar citation found by (Iliger *et al.*, 2017) [5].

Table 1: Growth and Yield attributing characters affected under different moisture regimes and brown manuring practices.

Treatments	Plant height at harvest	Number of panicles/m^2	Number of grains/panicle	Test weight (g)
Moisture Regimes				
I_1 - Alternate wetting and drying after 3 days	112.15	256.02	93.19	22.99
I_2 - Alternate wetting and drying after 5 days	100.75	234.57	85.38	22.52
I_3 - Alternate wetting and drying after 7 days	92.03	197.83	72.01	22.25
S.Em±	2.30	5.26	1.92	0.15
CD (P=0.05)	9.05	20.66	7.52	NS
Brown manuring				
B_1 - Control (Rice alone)	92.83	208.96	76.06	22.28
B_2 - Rice + Dhaincha	110.17	251.72	91.62	22.93
B_3 - Rice + Moong	101.17	230.96	84.07	22.65
B_4 - Rice + Urad	99.11	226.25	82.36	22.49
S.Em±	2.95	6.73	2.45	0.27
CD (P=0.05)	8.76	19.99	7.52	NS
Interaction I × B				
S.Em±	5.11	11.66	4.24	0.46
CD (P=0.05)	NS	NS	NS	NS

Table 2: Grain, Straw Yield and Water Use Efficiency affected under different moisture regimes and brown manuring practices.

Treatments	Grain yield (t/ha)	Straw yield (t/ha)	WUE (Kg/ha- cm)
Moisture Regimes			
I_1 - Alternate wetting and drying after 3 days	3.96	5.70	32.27
I_2 - Alternate wetting and drying after 5 days	3.63	5.23	31.09
I_3 - Alternate wetting and drying after 7 days	3.06	4.43	29.23
S.Em±	0.08	0.12	0.63
CD (P=0.05)	0.32	0.39	1.85
Brown manuring			
B_1 - Control (Rice alone)	3.23	4.63	28.15
B_2 - Rice + Dhaincha	3.89	5.62	33.86
B_3 - Rice + Moong	3.57	5.16	31.06
B_4 - Rice + Urad	3.50	5.08	30.39
S.Em±	0.10	0.13	0.93
CD (P=0.05)	0.31	0.41	2.75
Interaction I × B			
S.Em±	0.18	0.27	1.60
CD (P=0.05)	NS	NS	NS

Conclusion

Alternate wetting and drying after 3 days compare to all of the treatments and brown manuring Rice + Dhaincha recorded significantly superior. Alternate wetting and drying after 3 days recorded the highest Water Use Efficiency compare to alternate wetting and drying after 7 days which was at par with alternate wetting and drying after 5 days. Where as in brown manuring Rice + dhaincha recorded maximum WUE which was significantly higher than others.

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