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Performance of Rice Varieties at different Moisture Regimes under Direct Seeded condition

Guda Adilakshmi[1*], Rajan Kumar[2], Vinod Kumar[3], Vipin Kumar[4] and S. K. Singh[5]

[1]Research Scholar, Dr. Rajendra Prasad Central Agricultural University, Pusa-848125, Bihar, India.
[*]Department of Agronomy, S. V. Agricultural College (ANGRAU), Tirupati-517502, (Andhra Pradesh), India.
[2]Assistant Professor (Agronomy), Dr. Rajendra Prasad Central Agricultural University, Pusa-848125, Bihar, India.
[3]Professor (Agronomy), Dr. Rajendra Prasad Central Agricultural University, Pusa-848125, Bihar, India.
[4]Assistant Professor (Soil Science), Dr. Rajendra Prasad Central Agricultural University, Pusa-848125, Bihar, India.
[5]Professor (Plant Pathology), Dr. Rajendra Prasad Central Agricultural University, Pusa-848125, Bihar, India.

(Corresponding author: Guda Adilakshmi)*
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ABSTRACT: The current study "Performance of rice varieties at different moisture regimes under direct seeded condition" was conducted in a split plot design with three replications at Crop Research Centre-Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar during *kharif* (2018) in order to study the growth and yield of direct seeded rice at different moisture regimes. The treatments in main plot consisted of four moisture regimes *i.e.*, M_1-AWD at 3 Days (Irrigation was applied at 3 days after disappearance of ponded water), M_2-AWD at 5 Days (Irrigation was applied at 5 days after disappearance of ponded water), M_3-Saturation level till physiological maturity (Irrigation was applied at zero soil moisture potential) and M_4-10 % of moisture depletion (Irrigation was applied at 10 % moisture depletion of Field capacity) and in sub plot consisted of three varieties i.e., V_1-Rajendra Neelam, V_2-Abhishek and V_3-Rajendra Saraswati. The result revealed that plant growth and yield attributes like plant height (104.71 cm), number of tillers m^{-2} (417.59), LAI (5.10), dry matter production (1019.39 g m^{-2}), crop growth rate (15.36 g m^{-2} day^{-1}), number of panicles m^{-2} (255.85), number of grains $panicle^{-1}$ (99.68), test weight (24.82 g), grain yield (41.94 q ha^{-1}), and straw yield (60.00 q ha^{-1}) were found to be maximum with the moisture regime of AWD at 3 Days (M_1) which was significantly superior to M_2 and M_4 but was found statistically at par with M_3. With respect to varieties, growth characters and yield attributing characters like plant height (102.90 cm), number of tillers m^{-2} (399.83), LAI (5.04), dry matter production (979.21 g m^{-2}), crop growth rate (14.70 g m^{-2} day^{-1}), number of panicles m^{-2} (244.98), number of grains $panicle^{-1}$ (95.44), test weight (24.39 g), grain yield (40.16 q ha^{-1}) and straw yield (57.76 q ha^{-1}) were found to be maximum with variety Rajendra Neelam (V_1) which was significantly superior to V_2 and V_3.

Keywords: Direct seeded rice, Moisture regimes, Varieties, Growth characters, Yield.

INTRODUCTION

Rice is such an important cereal of India's food security, the adage "RICE IS LIFE" is particularly fitting. Rice (*Oryza sativa*) is a staple food for billions of people all over the world. Rice is a water-loving plant that can tolerate a wide range of climatic conditions during its life cycle.

Traditional rice cultivation is having standing water for most of the growth stages. In rice, Water use efficiency is much lesser compared to other crops. Irrigated lowland receives 24-30 % of global freshwater resources (Bouman *et al*., 2007). Conventional puddle transplanted rice cultivation consumes more than two thousand millimeter of water in many command areas of India and requires about 3000-5000 liters to produce 1 kg of grain (IRRI, 2001) and is labour, water and energy intensive which proved less profitable (Kumar and Ladha, 2011).

Puddling rice fields repeatedly destroys soil aggregates, reduces permeability in subsurface layers, and creates hard pans at shallow depths, all of which have a negative impact on soil physical qualities. Since, both surface and subterranean water supplies are depleting on a daily basis, profit margins in transplanted rice are shrinking due to rising labour costs and water demands. During the past one decade or so, there have been numerous efforts to find alternatives to the conventional practice of transplanted rice (Ladha *et al*., 2009) which can increase water productivity. Water saving irrigation technologies for rice is seen a key component in any strategy to deal with water scarcity (Li and Barker, 2004). It is necessary develop a better way of growing

rice that uses less water, while maintaining high yields (Wang *et al*., 2002). This leads to an alternative method of establishment to sustain the productivity as well as natural resources *i.e.*, direct seeded rice (DSR).

Direct seeded rice (DSR) helps to reduce water use, and the amount of water saved is determined by irrigation timing (Prasad, 2011). One of the main reasons for farmers' interest in DSR is the rising cost of agriculture and diminishing income from traditional methods. It requires only 34% of total labour and saves 27% of the overall cost of transplantation (Mishra and Singh, 2011). Growers are inclined to favour a technique that generates a better profit despite yields that are similar or slightly lower.

An optimal variety has made a significant contribution to increasing rice yield. Using regionally adapted varieties ensures a strong crop establishment as well as a high yield with marketable grain quality. Variety must be suitable in terms of yield stability, pest or disease resistance, and adaptability to local conditions. Certain rice varieties are better adapted to certain crop setup methods and farmer management approaches. Timely planting of crops generally ensures sufficient time for root development and vegetative growth for optimal harvesting of available soil nutrients and radiant energy (Soler *et al*., 2007). Keeping the aforementioned aspects in mind, the research paper titled "Performance of rice varieties at different moisture regimes under direct seeded condition" in order to investigate the growth and yield of direct seeded rice varieties at different moisture regimes.

MATERIALS AND METHODS

During the rainy (*kharif*) season of 2018, a field experiment was conducted at the Crop Research Centre, Department of Agronomy, DRPCAU, Pusa, Bihar, which is located at 25° 59' North latitude and 85°48' East longitude with an altitude of 52.92 meters above mean sea level. The study site's climate was subtropical and humid, with an average rainfall of 1276.1 mm, nearly 80-90 percent of which fell between June and September during the south-west monsoon. With three replications, the experiment was set up in split plot design (SPD). The treatments in the main plot included of four moisture regimes i.e., M_1-AWD at 3 Days (Irrigation was applied at 3 days after disappearance of ponded water), M_2-AWD at 5 Days (Irrigation was applied at 5 days after disappearance of ponded water), M_3-Saturation level till physiological maturity (Irrigation was applied at zero soil moisture potential) and M_4-10 % of moisture depletion (Irrigation was applied at 10 % moisture depletion of Field capacity) and in sub plot consisted of three varieties i.e., V_1-Rajendra Neelam, V_2-Abhishek and V_3-Rajendra Saraswati. The experimental plot's soil was sandy loam, alkaline in response (pH 8.42), low in organic content (0.46 %), and high in free $CaCo_3$ (26.7 %). The crop was fertilized with 120-60-40-25 kg ha^{-1} N-P_2O_5-K_2O and $ZnSO_4$. Half dose (50 percent) of the nitrogen, total phosphorus, potash, and $ZnSo_4$ (25 kg ha^{-1}) doses were applied as a base, and the remaining nitrogen dose were split into two equal parts (25 percent N at active tillering and 25 percent N at panicle initiation stage). As specified in the package, the required cultural practices and plant protection measures were followed. Five plants were selected and labelled with tags for recording growth and yield attributes during the course of investigation and was statistically analyzed by following the analysis of variance procedure as suggested by Panse and Sukhatme (1985). Statistical significance was tested with F test at 5 per cent level of probability and compared the treatment means with critical difference.

RESULTS AND DISCUSSION

A. Growth characters

Moisture regimes and varieties had a substantial impact on plant growth parameters such as plant height, number of tillers m^{-2}, LAI, dry matter production (g m^{-2}) and crop growth rate (g m^{-2} day^{-1}) (Table 1).

Table 1: Growth characters as affected by different moisture regimes and rice varieties.

Treatments	Plant height (cm)	Number of tillers m^{-2}	Leaf area index	Dry matter production (g m^{-2})	Crop growth rate (g m^{-2} day^{-1})
Moisture regimes					
M_1	104.71	260.43	5.10	1019.39	15.36
M_2	95.96	214.04	4.65	846.79	12.62
M_3	101.09	245.19	4.93	963.25	14.46
M_4	90.91	187.69	4.43	739.93	11.07
SEm±	2.51	6.28	0.12	23.46	0.37
CD (P=0.05)	8.69	21.72	0.43	81.18	1.28
Rice varieties					
V_1	102.90	249.36	5.04	979.21	14.70
V_2	97.74	232.00	4.69	912.95	13.68
V_3	93.86	199.15	4.60	784.87	11.74
SEm±	1.81	4.88	0.09	18.91	0.29
CD (P=0.05)	5.43	14.64	0.27	56.68	0.86
Interaction M x V					
SEm±	**3.62**	**9.77**	**0.18**	**37.81**	**0.58**
CD (P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**

The rice crop grown with moisture regime of M_1-AWD at 3 Days has recorded the highest value of plant height (104.71 cm) which was significantly superior over M_2-AWD at 5 Days and M_4-10 % of moisture depletion but moisture regime of Saturation level till physiological maturity (M_3) was found statistically at par. This could be attributed to a sufficient supply of moisture, which aided in the mobilisation and absorption of nutrients by the crop, resulting in lush vegetative growth. This is confirmed with the results of Das *et al*., (2016) and Kumari *et al*., (2018). The variety V_1-Rajendra Neelam had the highest plant height (102.90 cm) in the subplot, which was much higher than V_2-Abhishek and V_3-Rajendra Saraswati. The result could be attributable to the variety's genetic makeup as well as the crop's response to nutrients, which aided in the plant's vegetative growth. The experimental findings are supporting with Gautam *et al*., (2008) and Mahajan *et al*., (2012).

Maximum number of tillers m^{-2} were achieved with M_1-AWD at 3 Days (417.59) which was significantly superior to moisture regime of M_2-AWD at 5 Days and M_4- 10 % of moisture depletion whereas moisture regime of M_3-Saturation level till physiological maturity was found statistically at par with M_1. This might be due to the adequate supply of moisture had helped in increased number of tillers and also its survival. These results are evidenced with the findings of Kumari *et al*., (2018) and Kumari *et al*., (2019). Number of tillers m^{-2} was greatly varied by different varieties. Number of tillers m^{-2} with the variety V_1-Rajendra Neelam (399.83) had shown significantly superior to V_2-Abhishek and V_3-Rajendra Saraswati. This is due to the genetical character of the variety which has high tillering capacity. The conclusions of the study are supported by the findings of Sarawgi *et al*., (2006) and Baghel *et al*., (2013).

Maximum Leaf Area Index (LAI) was calculated with the moisture regime of M_1-AWD at 3 Days (5.10) which was significantly superior to other moisture regimes except M_3-Saturation level till physiological maturity which was found statistically at par. Findings might be due to increase in leaf size when there was a sufficient amount of moisture, helped in proper mobilization of the nutrient and absorption of the nutrient by the plant which helped to increase in size of the leaf. The output is in agreement with Kumar *et al*., (2015) and Das *et al*., (2016). Maximum leaf area index was recorded with variety V_1-Rajendra Neelam (5.04) which was significantly superior to V_2-Abhishek and V_3-Rajendra Saraswati. This could be attributable to the variety's genetic makeup as well as its nutritional responsiveness. The results are supporting with Swain *et al*., (2006) and Veeresh *et al*., (2011).

M_1-AWD at 3 Days (1019.39 g m^{-2}) & (15.36 g m^{-2} day^{-1}) considerably outperformed M_2-AWD at 5 Days and M_4-10 % of moisture depletion in terms of dry matter production and crop growth rate but the moisture regime of M_3-Saturation level till physiological maturity was found statistically at par with M_1. This was attributable to an increase in dry matter production due to increased plant height, number of tillers, LAI, and number of panicles. This is confirmed with the results of Kumar (2002) and Harishankar *et al*., (2016). Maximum dry matter production and crop growth rate were obtained with variety V_1- Rajendra Neelam (979.21 g m^{-2}) & (14.70 g m^{-2} day^{-1}) which were significantly superior to V_2-Abhishek and V_3-Rajendra Saraswati. This could be owing to the variety's genetic character in terms of growth and yield contributing factors. The findings are consistent with those of Pradhan *et al*., (2014) and Chandrika *et al*., (2017).

B. Yield attributes and yield

Different moisture regimes and varieties had a substantial impact on yield attributing parameters including number of panicles m^{-2}, number of grains $panicle^{-1}$, and test weight (Table 2).

Table 2: Yield attributes and yield as affected by different moisture regimes and rice varieties.

Treatments	Number of panicles m^{-2}	Number of grains $panicle^{-1}$	Test weight (g)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
Moisture regimes					
M_1	255.85	99.68	24.82	41.94	60.00
M_2	210.28	81.93	22.74	34.47	50.21
M_3	240.88	93.85	23.96	39.49	56.84
M_4	184.39	71.84	21.55	30.23	43.76
SEm±	6.17	2.40	0.49	1.01	1.34
CD (P=0.05)	21.34	8.31	1.68	3.50	4.65
Rice varieties					
V_1	244.98	95.44	24.39	40.16	57.76
V_2	227.92	88.80	23.17	37.36	53.93
V_3	195.65	76.23	22.24	32.07	46.41
SEm±	4.80	1.87	0.27	0.79	1.12
CD (P=0.05)	14.38	5.60	0.81	2.36	3.34
Interaction M x V					
SEm±	**9.59**	**3.74**	**0.54**	**1.57**	**2.23**
CD (P=0.05)	**NS**	**NS**	**NS**	**NS**	**NS**

Maximum number of panicles m^{-2} was recorded with moisture regime of M_1-AWD at 3 Days (255.85) this was noticeably better than M_2-AWD at 5 Days and M_4-10 % of moisture depletion but there was statistical parity with moisture regime of M_3-Saturation level till physiological maturity. This could be owing to a higher number of productive tillers, which resulted in the development of more panicles were possible with the presence of sufficient moisture in the soil. Minimum values were obtained with moisture regime of M_4-10 % of moisture depletion. This could be due to a lack of water, resulting in a decrease in the number of productive tillers and, as a result, a decrease in the number of panicles. The results are in accordance with the Sarkar *et al*., (2003) and Kumari *et al*., (2018). The largest number of panicles m^{-2} was found in the subplot with variety V_1- Rajendra Neelam (244.98) which was significantly superior to V_2-Abhishek and V_3-Rajendra Saraswati. This could be owing to the variety's genetic makeup in terms of tillers and panicles. The conclusions of the study are supported by the findings of Singh *et al*., (2004) and Yadav and Meena (2014).

The highest number of grains per panicle and the test weight were recorded with moisture regime of M_1-AWD at 3 Days (99.68) and (24.82 g) which were significantly superior to M_2-AWD at 5 Days and M_4-10 % of moisture depletion but M_3-Saturation level till physiological maturity did not vary significantly. The results were attributable to an adequate supply of moisture, which caused photosynthates to be translocated from source to sink. The results are correlated with Das *et al*., (2016) and Kumari *et al*., (2018). Maximum number of grains panicle^{-1} and test weight were recorded with variety V_1-Rajendra Neelam (95.44 g) and (24.39 g) which was significantly superior to V_2-Abhishek and V_3-Rajendra Saraswati. This could be attributable to the variety's genetic makeup. The outcomes are encouraging with Singh *et al*., (2004) and Hussain *et al*., (2008).

Different moisture regimes and varieties have a substantial impact on grain and straw yield. The highest grain production was reported with the M_1-AWD moisture regime at 3 Days (41.94 q ha^{-1}), which was much higher than M_2-AWD at 5 Days and M_4-10 % of moisture depletion but was statistically at par with M_3-Saturation level till physiological maturity. This could be attributed to the availability of appropriate moisture, which led to an increase in yield attributing features such as number of panicles, test weight, and number of grains per panicle, as well as photosynthate translocation from source to sink, which increased grain yield. The findings are in agreement with the result of Hussain *et al*., (2008) and Das *et al*., (2016). Maximum grain yield was recorded with variety V_1-Rajendra Neelam (40.16 q ha^{-1}) which was significantly superior to Abhishek (V_2) and Rajendra Saraswati (V_3). This could be attributable to the variety's genetic makeup, which includes the number of tillers, panicles, grains, and test weight. The grain yield is supporting with the results of Mahapatra *et al*., (2004).

Maximum straw yield was recorded with moisture regime of M_1-AWD at 3 Days (60.00 q ha^{-1}) which was significantly superior over M_2-AWD at 5 Days and M_4-10 % of moisture depletion but was statistically at par with M_3-Saturation level till physiological maturity. This could be owing to a sufficient supply of moisture, which led to an increase in plant height, number of tillers, and LAI, all of which contributed to increased straw yield. The results are correlated with Das *et al*., (2016) and Kumari *et al*., (2018). Maximum straw yield was recorded in sub plot with variety V_1-Rajendra Neelam (57.76 q ha^{-1}) which was significantly superior to variety V_2-Abhishek and V_3-Rajendra Saraswati. This could be attributable to the variety's genetic makeup. The findings are consistent with the findings of Sharma *et al*., (2014).

CONCLUSION

Based on the findings of this study, it can be stated that the growth characteristics, yield attributes, and yield of rice grown under direct seeding revealed that significantly higher values were obtained with the moisture regime of M_1-AWD at 3 days but was found statistically at par with M_3-Saturation level till physiological maturity. Among different varieties, variety Rajendra Neelam (V_1) was recorded significantly superior value.

FUTURE LINE OF WORK

Response of aerobic rice to different irrigation regimes need to be studied. Performance of different varieties under aerobic rice cultivation under various irrigation regimes need to be studied.

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