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Growth and Yield Performance of Rice as Influenced by Different Varieties and Fertility Levels under Aerobic Conditions

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Abstract A field experiment was undertaken during *kharif* season of 2014. The experimental soil was sandy loam in texture, slightly alkaline in reaction, low in organic carbon and nitrogen, medium in available phosphorus and potassium. The experiment was laid out in factorial RBD with four varieties viz. PR-115, DRRH-3, PAC-837 and PR-121, as one factor and four fertility levels viz. 0 : 0 : 0, 90 : 45 : 22.5, 120 : 60 : 30 and 150 : 75 : 37.5 kg N-P_2O_5 K_2O ha^{-1}, as second factor. Full dose of P and K along with one third of N were applied as basal dose at the time of sowing through inorganic sources of nutrients viz. urea, DAP and MOP, respectively and remaining two third of N was applied in two equal splits one at active tillering stage and other at panicle initiation stage. Maximum crop growth rate was observed at 60-90 DAS in all the varieties. Rice variety PAC-837 and DRRH-3 showed higher growth characteristics, yield and harvest index over PR-115 and PR-121. Application of 150 : 75 : 37.5 N-P_2O_5-K_2O kg ha^{-1} recorded highest grain (52.78 q ha^{-1}) and straw yield (73.85 q ha^{-1}). The fertility levels had non significant effect on harvest index.

Keywords Fertility level, Varieties, Aerobic rice, Crop growth rate, Leaf area index.

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Introduction

In India, rice is commonly grown by transplanting rice seedlings into puddle soils in Indo-Gangetic plains and other regions. The enormous amounts of water are generally used in rice production. The increasing water scarcity for agriculture and competition for water from non-agricultural sectors dictate to an urgent need to improve crop water productivity. Of the potential threats of rice production system over coming decades, water scarcity and increasing competition for water in irrigated rice systems are perhaps the most pressing in terms of potential impact on overall production levels. It is estimated that by 2025, approximately two million hectare of irrigated dry season rice and thirteen million hectare of wet season rice will experience water scarcity [1]. Hence, water-saving irrigation technologies for rice are seen as a key component to deal with water scarcity in the days to come. Rice production system, without constant standing water in non-puddled soils, reffered to as 'aerobic rice' is considered to be one of the most promising technologies in terms of water saving [2]. Keeping in view the apprehensions of water scarcity in coming times particularly in rice growing belt, an investigation envisaging growth and yield performance of rice as influenced by different varieties and fertility levels under aerobic conditions was conducted during *kharif* of 2014.

Materials and Methods

A field experiment was undertaken at Research Farm of Division of Agronomy, SKUAST-J, Chatha during *kharif* season of 2014. The soil samples collected from the experimental site before sowing were analyzed following standard methods. Soil pH was measured potentiometrically in a 1:2.5(w/v) soil/water ratio using combination electrode [3] and electrical conductivity (EC) was measured through R-D-26 solubridge conductivity meter. Organic carbon (OC) was estimated by the wet digestion method. Available N, P and exchangeable K were determined as per standard procedures [3]. The experimental soil was sandy loam in texture, slightly alkaline in reaction (8.15), low in organic carbon (4.6 g/kg) and nitrogen (233.27 kg ha^{-1}), medium in available phosphorus (13.42 kg ha^{-1}) and potassium (149.62 kg ha^{-1}). The experiment was laid out in factorial RBD with four varieties viz. PR-115, DRRH-3, PAC-837 and PR-121, as one factor and four fertility levels viz. 0 : 0 : 0, 90 : 45 : 22.5, 120 : 60 : 30 and 150 : 75 : 37.5 kg N-P_2O_5-K_2O ha^{-1}, as second factor. Full dose of P and K along with one third of N were applied as basal dose at the time of sowing through inorganic sources of nutrients viz. urea, DAP and MOP, respectively and remaining two third of N was applied in two equal splits one at active tillering stage and other at panicle initiation stage. The seeds were sown in furrows by *kera* method on 15th June during *kharif* season of 2014 with a seed rate of 50, 40, 50 and 60 kg ha^{-1} for PR-115, DRRH-3, PAC-837 and PR-121, respectively. Only six supplemental irrigations were applied when crop leaves started to roll and excess water was drained out on occasion of heavy rainfall. For weed management, pre-emergence herbicide pendimethalin @ 1 kg ha^{-1} and post emergence herbicides pyrazusulfuron ethyl @ 25 gat 7 DAS and bispyribac sodium @ 30 g ha^{-1} at 30 DAS were applied. All observations of crop growth and yield recorded through standard procedures.

Table 1. Crop growth rate (g m^{-2} day^{-1}) of rice between various growth stages as influenced by different varieties and fertility levels under aerobic conditions.

Treatments	Days after sowing 0 to 30	30 to 60	60 to 90	90 to 120
Varieties				
V_1: PR-115	3.69	8.57	16.74	2.22
V_2: DRRH-3	3.85	8.63	17.20	2.38
V_3: PAC-837	4.02	8.83	17.38	2.25
V_4: PR-121	3.54	6.74	12.04	3.52
SEm±	0.08	0.26	0.65	0.08
CD (0.05)	0.24	0.74	1.88	0.23
Fertility levels (N-P_2O_5-K_2O kg ha^{-1})				
F_1: $N_0P_0K_0$	2.59	5.54	5.63	2.34
F_2: $N_{90}P_{45}K_{22.5}$	3.63	8.17	14.72	2.58
F_3: $N_{120}P_{60}K_{30}$	4.33	9.32	20.68	2.72
F_4: $N_{150}P_{75}K_{37.5}$	4.55	9.75	22.32	2.74
SEm ±	0.08	0.26	0.65	0.08
CD (0.05)	0.24	0.74	1.88	0.23
Interaction	NS	NS	NS	NS

Results and Discussion

The crop growth rate (CGR) in general, increased with advancement of crop age up to 90 DAS thereafter it showed a declining trend (Table 1). Maximum crop growth rate was observed at 60-90 DAS in all the varieties. Rice variety PAC-837 showed highest CGR at 0-30 DAS, 30- 60 DAS, 60-90 DAS and 90-120 DAS due to more vegetative growth period as influenced by differential genetic makeup of varieties, which was statistically at par with variety DRRH-3 and PR-115 but, at 90-120 DAS, the highest value of CGR was observed in rice variety PR-121. Increase in LAI was recorded up to 90 DAS in all varieties, beyond this stage LAI declined (Table 2). High-

Table 2. Leaf area index of rice at various growth stages as influenced by different varieties and fertility levels under aerobic conditions.

Treatments	Days after sowing 30 DAS	60 DAS	90 DAS	120 DAS
Varieties				
V_1: PR-115	0.87	2.79	3.33	2.77
V_2: DRRH-3	1.05	3.21	3.87	3.23
V_3: PAC-837	1.13	3.68	4.04	3.49
V_4: PR-121	0.65	2.23	3.07	2.63
SEm±	0.03	0.08	0.10	0.11
CD (0.05)	0.08	0.22	0.28	0.31
Fertility levels ($N-P_2O_5-K_2O$ kg ha)				
F_1: $N_0P_0K_0$	0.54	2.00	2.11	1.60
F_2: $N_{90}P_{45}K_{22.5}$	0.96	2.96	3.55	2.92
F_3: $N_{120}P_{60}K_{30}$	1.09	3.43	4.23	3.72
F_4: $N_{150}P_{75}K_{37.5}$	1.11	3.53	4.42	3.88
SEm±	0.03	0.08	0.10	0.11
CD (0.05)	0.08	0.22	0.28	0.31
Interaction	NS	NS	NS	NS

Table 3. Response of different rice varieties and fertility levels on grain yield, straw yield and harvest index.

Treatments	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest index (%)
Varieties			
V_1: PR-115	41.06	59.50	40.17
V_2: DRRH-3	43.37	58.65	42.44
V_3: PAC-837	45.65	59.98	43.12
V_4: PR-121	32.99	51.42	39.36
SEm±	0.68	1.04	0.69
CD (0.05)	1.96	3.01	1.99
Fertility levels ($N-P_2O_5-K_2O$ kg ha^{-1})			
F_1: $N_0P_0K_0$	20.86	31.33	40.15
F_2: $N_{90}P_{45}K_{22.5}$	39.22	54.85	41.57
F_3: $N_{120}P_{60}K_{30}$	50.21	69.53	41.82
F_4: $N_{150}P_{75}K_{37.5}$	52.78	73.85	41.56
SEm±	0.68	1.04	0.69
CD (0.05)	1.96	3.01	NS
Interaction	S	S	NS

est value of LAI was recorded in PAC-837 variety which was statistically at par with DRRH-3. Significant differences in plant growth characteristics of rice as influenced by various genotypes were also reported by various researchers [4,5].

The data presented in Table 3 revealed that grain yield and straw yield were higher in hybrids, PAC-837 and DRRH-3 over PR-115 and PR-121. This might be due to higher nutrient uptake, greater vegetative growth and better light interception due to higher leaf area index and higher dry matter partitioning towards economic part. Yield variability among rice cultivars also attributed to genetic characters and environmental effects. Phenotypic expressions are largely dependent upon genotype's ability and environmental effect [5]. The difference among the varieties in relation to straw yield was also reported in various literatures [6]. Increased harvest index in hybrids (DRRH-3 and PAC-837) was due to faster mobilization of dry matter towards grains under aerobic conditions [7].

Fertility levels had significant influence on CGR and LAI at all periodic time intervals (Tables 1 and 2). CGR and LAI increased up to 90 DAS in all fertility levels thereafter declining trendwere observed. Increased level of fertilizers had great response in increasing CGR and LAI in decrimental trend up to 120 : 60 : 30 $N-P_2O_5-K_2O$ kg ha^{-1} at all stages. Highest CGR and LAI were recorded in 150 : 75 : 37.5 $N-P_2O_5-K_2O$ kg ha^{-1} which remained statistically at par with 120 : 60 : 30 $N-P_2O_5-K_2O$ kg ha^{-1} at all stages. The lowest value of CGR and LAI were observed in control at all growth stages. NPK fertilization leads to increase inleaf area index at all growth stages. Higher leaf area index helps in better utilization of solar radiations and available nutrient which are essential for higher growth rate. Similar results were reported in other literature also [8].

Under aerobic conditions, increasing fertility levels increased grain and straw yield significantly. Application of 150 : 75 : 37.5 $N-P_2O_5-K_2O$ kg ha^{-1} recorded highest grain (52.78 q ha^{-1}) and straw yeild (73.85 q ha^{-1}). The increased in yield with increasing fertility levels may be due to increased NPK uptake and utilization by crop that led to enhanced growth and yield attributes which occurred due to increased photo synthetic efficiency of crop which in turn caused greater dry matter production and translocation to sink. Positive correlation was reported among yield and nitrogen levels by NPK levels [4].The fertility levels had non significant effect on harvest index.

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