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Growth and Yield of Rice as Influenced by Seed Rates and Genotypes under Aerobic Condition

Dev Kumar Saphi[1], Dil Raj Yadav[2]

[1, 2]National Rice Research Program, Hardinath, Dhanusha, Nepal

Abstract: ***The grain yield of aerobic rice is greatly influenced by plant population and the farmers are getting low yield in aerobic situation. Hence, field experiments were conducted at the experimental block of National Rice Research Program, Hardinath, Dhanusha during 2015-16 aiming to find the optimum seed rates and suitable genotypes for higher grain of rice under aerobic conditions. The experiments were laid out in split plot design with three replications in both years. Three rice genotypes, IR833383, HUA565 and NR2157-122-1-2, were allocated to main plots and five levels of seed rates (20,30,40,50 and 60 kg/ha) as sub plots. The statistical analysis showed that the seed rate influenced grain yield and yield attributing characters significantly and grain yield of more than 3.0 t/ha was recorded in seed rates of 40 kg/ha. The variety and seed rate interaction was found non-significant for grain yield and its contributing parameters. This study showed that the seed rate of 40 kg/ha was promising for high grain yield under aerobic condition.***

Keywords: Aerobic rice, seed rate, yield and yield attributes

1. Introduction

Rice (Oryza sativa L.) is the staple food for more than half of the world's population and provides more calories per hectare than any other crop (Faisul-ur-Rasool et al., 2013). In Nepal, rice is a major cereal crop of Nepal and contributes about 22% and 7% in agricultural gross domestic product (AGDP), gross domestic product (GDP) of the country, respectively. It is grown in about 1.34 million hectares with an average productivity of 3.35 t/ha [1]. In Nepal, rice is predominantly grown by transplanting seedlings into puddle soil and kept flooded for most part of the growing season. Rice cultivation is a water intensive enterprise and its sustainability sustainability is threatened by increasing water shortages due to climate change [2]. In Asia, rice consumes more than 50% of the water used for irrigation in Asia [3]. Aerobic rice is the same as the other cereal crops like wheat, oats or maize would be planted by direct seeding. Compared with flooded low-land rice, aerobic rice requires 30-50% less water [4] and supplementary irrigation is applied in aerobic rice system of cultivation as and when required [4, 5]. The aerobic rice system of rice cultivation could be one of the options for upland mid-upland conditions. However, the grain yield levels realized by the farmers under upland situations are still lower. Of the various factors affecting grain yield under upland conditions, method of sowing, seed rate and cultivars are the major factors influence the grain yield [6]. Among the inputs required for rice cultivation, seed costs a lot thus the quantity of seed is required to be used judiciously particularly for upland conditions as the farmers of this ecosystem are generally resource poor. Information of optimum seed rates for promising rice genotypes suitable for aerobic cultivation are scanty. Therefore, the current research was carried with the objective of finding optimum seed rate for maximization of rice yield under aerobic conditions.

2. Materials and methods

Experimental site

Field experiments were carried out at the research block of National Rice Research Program, Dhanusha, Nepal in 2015 and 2016 rainy season. The experimental site is located at the latitude of 26°49' E and longitude of 86°01' N with an altitude of 93 m from mean sea level. Agro-ecologically, the area comes under sub-tropical region. The climate is warm and moist having hot and humid summer and mild winter. The maximum temperature in summer is 44°C and minimum temperature in winter is 4.8°C. The average annual rainfall is 1281 mm and maximum rainfall occurs in July and 80% of the total annual rainfall comes between June and September.

Experimental design and treatments

The experiment was laid out in a split design with three replications. A total of three rice varieties (IR833383, HUA565 and NR2157-122-1-2) and five levels of seed rates (20, 30, 40, 50 and 60 kg/ha) were included as treatments. Rice varieties were treated as main plot factors and seed rates were as sub plot factors.

Experimental details

Seeds of each three cultivars were treated with carbendazim @ 0.5 g ai/kg rice seed and sown in the first week of June in both years. Seeds were direct seeded at a soil depth of 2-3 cm. The crop was managed following the standard recommended practices for rice in Nepal. Fertilizers were applied @ 90:30:30 N:P_2O_5:K_2O kg/ha. Half dose of the N, full dose of P_2O_5 and K_2O was applied as a basal application. Remaining N was splitted into two equal parts and applied at 40 and 60 DAS as a top dress. At harvesting, five rice plant clusters were randomly selected from each treatment to collect data for plant height (cm), panicle length, number of grains/panicle. Effective tillers were recorded from 1 m^2 area for each treatment at harvesting.

Statistical analysis

Data were subjected to analysis of variance using CropStat V.07 [7]. The interaction effect of varieties with weed control methods was non-significant, therefore, combined analysis was done. Weed density data were subject analysis square root transformation before analysis. Means were

separated using Least Significant Difference (LSD) test at P ≤ 0.05. Using Least Significant Difference (LSD) test at P ≤ 0.05

3. Results

Effect on growth and yield parameters

Data on effects of seed rates and genotypes on growth and yield attributes of rice is presented in Table 1 & 2. The effect of genotypes was found non-significant for all the measured yield attributes except days to heading while the effects of seed rates were significant for most of the growth and yield attributes except days to heading and 1000-grains weight (g) in both years. The earliest heading of 92 and 93 days were observed in HUA565 in 2015 and 2016, respectively. Significantly more number of effective tillers/m^2, panicle length (cm) were recorded in seed rate @ 40 kg/ha.

Table 1: Effect of seed rates and genotypes on growth and yield attributes of rice under aerobic conditions in 2015 at NRRP, Dhanusha, Nepal

Treatments	Growth and yield attributes				
	Days to heading	Plant Height (cm)	Effective tillers/m^2	Panicle Length (cm)	1000-grains weight (g)
Genotypes					
IR833383	102	77.7	369	23.8	24.6
HUA565	93	94.4	373	24.4	24.4
NR2157-122-1-2	102	98.8	436	25.3	26.2
SEM (±)	0.41	1.9	28.99	0.28	0.49
F-test (5%)	**	**	ns	ns	ns
LSD (5%)	1.15	5.29	-	-	-
Seed rates (kg/ha)					
20	99	86.3	381	24.8	25.8
30	99	90.2	399	24.8	24.6
40	99	91.8	413	24.9	25.3
50	99	92.0	397	23.8	25.2
60	99	91.1	374	24.2	24.4
Grand Mean	**99**	**90.3**	**393**	**24.5**	**25.1**
SEM (±)	0.54	2.4	21.34	0.44	0.65
F-test (5%)	ns	*	*	*	ns
LSD (5%)	1.13	5.022	44.05	0.9	-
CV%	1.2	5.7	11.5	3.8	4.2

* and ** = Significant at 1 and 5%, respectively, CV = Coefficient of variation

Table 2: Effect of seed rates and genotypes on growth and yield attributes of rice under aerobic conditions in 2016 at NRRP, Dhanusha, Nepal

Treatments	Growth and yield attributes				
	Days to heading	Plant height (cm)	Effective tiller/m^2	Panicle length (cm)	1000 grains weight (g)
Genotpes					
IR833383	102	111.3	254	22.3	25.3
HUA565	92	97.8	246	24.0	23.9
NR2157-122-1-2	98	100.1	279	25.2	26.3
SEM (±)	0.45	2.0	8.3	1.3	0.79
F-test (5%)	**	**	ns	ns	ns
LSD (5%)	2.24	5.7	-	-	-
Seed rates (kg/ha)					
20	98	102.2	244	24.2	25.3
30	97	103.1	252	24.0	26.1
40	97	103.2	278	24.4	23.9
50	97	103.1	268	22.6	25.1
60	97	103.7	258	23.8	25.3
Grand Mean	97	103.1	260	23.8	25.2
SEM (±)	0.76	1.7	18.34	0.94	0.86
F-test (5%)	ns	*	*	*	ns
LSD (5%)	0.92	5.1	22.04	1.38	-
CV%	1.5	3.6	8.9	5.8	8.3

* and ** = Significant at 1 and 5%, respectively, CV = Coefficient of variation

Effect on grain yield

The statistical analysis showed that the effect of genotype was non-significant for grain yield while the seed rates were significantly different for grain yield in both years (Table 3). The genotypes did not differ significantly for grain yield (t/ha). However, the highest grain yield was recorded in NR2157-122-1-2 in both years and the average yield of this genotype found 3.1 t/ha. Highest grain yield of 3.2 t/ha was recorded in seed rate @ 40 kg/ha in aerobic condition in pooled analysis and similar trend was obtained in both years. The yield decreased when the seed rate increased in seed rate 50 kg/ha.

Table 3: Effect of seed rates and genotypes on grain yield of rice under aerobic conditions in 2016 at NRRP, Dhanusha, Nepal

Treatments	*2015*	*2016*	*Average*
	Grain yield (t/ha)		
Genotypes			
IR833383	3.1	2.9	3.0
HUA565	3.1	2.8	3.0
NR2157-122-1-2	3.2	3.1	3.1
SEM (±)	0.56	0.76	0.79
F-test (5%)	ns	ns	ns
LSD (5%)	-	-	-
Seed rates (kg/ha)			
20	2.8	2.7	2.7
30	3.1	2.9	3.0
40	3.4	3.2	3.3
50	3.3	3.1	3.2
60	3.0	2.9	2.9
Grand Mean	**3.1**	**2.9**	3.0
SEM (±)	0.079	0.95	0.514
F-test (5%)	**	**	**
LSD (5%)	0.16	0.19	0.15
CV%	9.4	10.3	9.7

* and ** = Significant at 1 and 5%, respectively, CV = Coefficient of variation

4. Discussion

In the present study, we found remarkable differences in respect to yield and yield contributing traits of aerobic rice due to seed rate. Similar findings were reported by [8, 9]. Our results showed that increasing trend of effective tillers/m^2, panicle length (cm) and grain yield as the seed rates increased up to 40 kg/ha. Our results are in conformity with the findings of Monica et al. [10, 11, 12] who reported that better yield attributing traits and higher grain yield per unit area might be due to optimum plant density with 40 kg/ha seed rate. The yield decreased when the seed rate increased in seed rate 50 kg/ha and above and this might be due to higher population per unit area. Decreased in grain yield might be due increase in competition among rice plants for growth limiting factors like water, nutrients, light and

space etc. which resulted in weaker plants and ultimately produced lower grain yields. Seeding rate is an important factor for higher yield in aerobic conditions. Moreover, high seeding rate helps to suppress weeds; however, yield does not always increase with high seeding rate and there are some risks associated with this such as crop lodging and insect pest infestation. On the lower seeding rate reduces seed cost. However, there are also some risks associated with the use of low seeding rate such losses due to weed infestation and poor rice seedling establishment [13]. The results of our study indicate that farmers can use a seeding rate of 40 kg/ha for successful cultivation of aerobic rice.

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6. Contribution

Authors contributed equally to this work

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