Agriculture, Forestry and Fisheries
2014; 3(3): 199-202
Published online June 30, 2014 (http://www.sciencepublishinggroup.com/j/aff)
doi: 10.11648/j.aff.20140303.19

Determination of optimum seed rate for productivity of rice (*Oryza Sativa L.*), at Woito, Southern Ethiopia

Tekle Yoseph[1, *], Wedajo Gebre

Southern Agricultural Research Institute, Jinka Agricultural Research Center, Jinka, Ethiopia

Email address:
tganta@yahoo.com (T. Yoseph)

To cite this article:
Tekle Yoseph, Wedajo Gebre. Determination of Optimum Seed Rate for Productivity of Rice (*Oryza Sativa L.*), at Woito, Southern Ethiopia. *Agriculture, Forestry and Fisheries.* Vol. 3, No. 3, 2014, pp. 199-202. doi: 10.11648/j.aff.20140303.19

Abstract: A field experiment was undertaken at Woito, to determine the effect of seed rate on productivity of rice (Oryza Sativa L.), at Woito. The experiment was conducted with five levels of seed rate (40, 60, 80, 100 and 120 kg ha^{-1}). The treatments were laid out in a randomized complete block design (RCBD) with four replications. Phenological and growth parameters such as yield and yield components, total biomass and harvest index were studied. The result showed that all the phenological and growth parameters except panicle length per plant were significantly affected by the treatments. As the seed rate increased there was a proportional increment on the number of tillers per plant. Grain yield and total biomass were significantly affected by seed rate while 1000 seeds weight and harvest index were not influenced significantly by seed rate. The grain yield obtained from the seed rate of 40 kg ha^{-1} (5.0222 t ha^{-1}) was higher by 66.81% compared to the seed rate of 80 kg ha^{-1} (1.6667 t ha^{-1}). The noted total biomass yield advantage from the seed rate of 40 kg ha^{-1} (7.2875 t ha^{-1}) was higher by 44.25% compared to the seed rate of 120 kg ha^{-1}(4.0625 t ha^{-1}). Therefore, it can be concluded from this result that the seed rate of 40 kg ha^{-1} is advisable and could be appropriate for rice production in the test area even though further testing is required to put the recommendation on a strong basis.

Keywords: Growth Parameters, Phenological Parameters, Rice, Seed Rate, Yield Components, Yield

1. Introduction

Rice (*Oryza Sativa L.*) is an annual cereal grain and it is the most important staple food for a large part the world's human population, especially in East and South Asia, the middle East, Latin America and the West India. Rice is most important food crop and a major food grain for more than a third of the world's population [1]. Rice represents 29% of the total output of grain crops worldwide [2]. It is the leading and one of the oldest cereal crops of South East Asia, which is a thickly populated region of the world. The global rice cultivation is estimated at 150 million hectare with annual production averaging 500 million metric tons [3]. Rice occupies 10% of the total land under cereal production and produces 15% of the total cereal production [4]. It is one of the most important cereal crops cultivated in sub-Saharan Africa (SSA). Currently, rice is grown in over 75% of the African countries with a total population of 800 million people. Africa has become a big player in international rice markets, accounting for 23% global imports. Rice ranked as the fourth most important crop in terms of production after sorghum (*Sorghum bicolor*), maize (*Zea mays*) and millet (*Eleusine coracana*) [4]. New rice cultivars have a potential yield of $\geq$ 10 t ha^{-1} [5]. Rice yields in Africa are generally low about 1 t ha^{-1} in uplands, 1 to 2 t ha^{-1} in rain fed lowlands and 3 to 4 t ha^{-1} in the irrigated zones and a range of factors explains this low productivity [6]. In Ethiopia, rice is a recently introduced crop and its area and production have been increasing. Though rice production is increasing in Ethiopia, there are a number of agronomic management constrains with this crop. Rice is becoming a high potential crop in Southern region in general and south omo zone in particular, but as the crop is new to the target area, there is a lack of appropriate agronomic management recommendations that could help to maximize the productivity of the cultivation techniques in the study area. Among the rice production constrains seed rate is an important in the study area. Area specific recommendation of seed rate is vital to set optimum seed rate for rice production in the study area. Therefore, this study is aimed at and initiated with the objective of determining the optimum seed rate of rice in the target area.

2. Materials and Methods

2.1. Description of the Study Area

The experiment was conducted at Woito located at 36° 59' 58" E longitude and 5° 21' 47.8" N latitude. Woito is situated in South Ethiopia at about 649 kms from the capital Addis Ababa, at an altitude of 566 meters above sea level (masl). The long term weather data of the area revealed that the mean annual rainfall of the area is 51.74 mm with a range of 32.52 to 74.23 mm. The experiment was conducted during the second cropping season (July to December, 2013) under irrigation. Furrow irrigation was used and all the plots were irrigated uniformly and accordingly per the intended irrigation schedule.

2.2. Treatments and Experimental Design

Treatments were made from five levels of seed rate (40, 60, 80, 100 and 120 kg ha^{-1}). One variety of rice namely, NERICA 4 was selected based on its yielding potential. The experiment consisted of five treatments with a total of twenty plots. The field experiment was laid out in a randomized complete block design (RCBD) with four replications. Rice was sown on July 8, 2013 in twelve rows per plot with spacing of 30 cm between rows and 15 cm between plants within a row with gross plot area of 24 m^2.

2.3. Data Collection

Phenological Parameters

Phenological parameters such as days to emergence, days to flowering and days to maturity were recorded. Days to emergence was recorded when 50% the plants per plot emerged while days to flowering was recorded by counting the number of days after emergence when 50% of the plants per plot had the first open flower. Days to maturity were recorded when 90% of heads/spikes per plot.

Growth Parameters

At mid flowering stages ten plants from each of the plots were selected randomly and uprooted carefully to determine crop growth parameters such as plant height and number of tillers.

Grain Yield, Yield Components, Total Biomass and Harvest Index

Six central rows (5 m x 1.8 m = 9 m^2) were harvested for determination of grain yield. Grain yield was adjusted to 12.5% moisture content. Ten plants were randomly selected from the six central rows to determine yield and yield components, which consisted of number of tillers per plant, number of seeds per spike and thousand seeds weight. Spike number per plant was determined by counting spikes of the ten randomly selected plants while number of seeds per spike was recorded by counting the total number of seeds in a spike from ten randomly sampled spikes taken from the ten randomly selected plants. Seed weight was determined by taking a random sample of 1000 seeds and adjusted them to 12.5% moisture content. Total biomass yield was measured from the six middle rows when the plant reached harvest maturity. Harvest index was calculated as the ratio of seed yield to total above ground biomass yield.

2.4. Statistical Analysis

Analysis of variance was performed using the GLM procedure of SAS Statistical Software Version 9.1 [7]. Effects were considered significant in all statistical calculations if the P-values were $\leq$ 0.05. Means were separated using Fisher's Least Significant Difference (LSD) test.

3. Results and Discussion

The analysis of variance exhibited that seed rate had significantly ($P< 0.01$) influenced days to flowering (Table 1). To the reverse, seed rate did not affect significantly days to flowering [8]. Days to maturity and number of tillers per plant were significantly affected by seed rate (Table 1). Plant height was significantly affected by seed rate (Table 1). On the other hand, research report revealed that seed rate had brought no significant effect on plant height of rice [8]. Seed rate did not affect significantly panicle length (Table 1). The maximum number of tillers per plant (5.7) and the minimum (2.55) were recorded from the seed rate of 40 kg ha^{-1} and 120 kg ha^{-1}, respectively (Table 2). In this result, there was a significant decreasing tendency in number of tillers per plant with the increasing seed rate. This could possibly be due to the enhanced tillering capacity of the existing plant population associated with the adequate availability of soil nutrients for the lower population resulted from the decreased seed rate.

Table 1. *Mean Square Values for Crop Phenology and Growth Parameters of Rice at Woito, in 2013.*

Source	DF	Days to flowering	Days to maturity	Tiller number $plant^{-1}$	Plant height (cm)	Panicle Length (cm)
Replication (R)	3	88.1833**	176.050***	1.421*	25.693^{ns}	.0.095ns
Treatment (Trt)	4	30.2500*	38.7000*	5.615***	88.637**	4.504ns
Error	12	9.1833	7.8000	0.285	9.207	2.074

*, ** and *** indicate significance at $P< 0.05$, $P< 0.01$ and $P< 0.001$, respectively and 'ns' indicate non significant

Table 2. *Crop Phenology and Growth Parameters of Rice as Affected By Seed Rate at Woito, in 2013*

Treatments	Days to flowering	Days to maturity	Tiller number plant^{-1}	Plant height (cm)	Panicle Length (cm)
Seed Rate (kg ha^{-1})					
40	102.500b	132.00b	5.70a	49.90a	16.365ab
60	101.750b	132.25b	4.35b	43.85b	15.950ab
80	107.50a	139.50a	3.85bc	38.45c	14.900b
100	100.50b	133.00b	3.30cd	49.55a	17.750a
120	101.50b	135.00b	2.55d	46.20ab	15.600ab
LSD 0.05	**4.67**	**4.30**	**0.82**	**4.68**	**2.22**
CV (%)	**2.95**	**2.08**	**13.53**	**6.65**	**8.93**

Note: Means with the same letters within the columns are not significantly different at P < 0.05.

The analysis of variance for mean squares revealed that seed rate had significantly (P < 0.01) affected grain yield (Table 3). Similarly seeding rate significantly influenced rice grain yield [9]. Total biomass weight was significantly (P < 0.001) affected by seed rate; whereas, 1000 seeds weight was not significantly influenced due to seed rate (Table 3). The maximum (24.5 gm) and the minimum (22.38 gm) 1000 seeds weight were noted from the seed rates of 40 kg ha^{-1} and 120 kg ha^{-1}, respectively (Table 4). The highest (5.0222 t ha^{-1}) and the least (1.6667 t ha^{-1}) grain yields were recorded from the seed rates of 40 kg ha^{-1} and 80 kg ha^{-1}, respectively (Table 4). From the above result it could be suggested that as seeding rate increased there was no significant and proportional yield increment observed. Likewise, grain yield of rice, was significantly affected at low seed rates but further increase in seed rate did not increase the yield [10]. In line with this, similar report also depicted that the grain yield obtained from the seed rate of 25 kg ha^{-1} is superior to 50 kg ha^{-1} and 75 kg ha^{-1} [8]. The highest grain yield (5.0222 t ha^{-1}) obtained under the seed rate of 40 kg ha^{-1} might be due to the highest number of tillers produced as a result of less competition for available soil moisture and nutrients. From this study, it was noted that the grain yield advantage of 66.81% was obtained from the seed rate of 40 kg ha^{-1} as compared with that of 80 kg ha^{-1}. The maximum biomass yield of (7.2875 t ha^{-1}) and minimum biomass yield (4.0625 t ha^{-1}) were noted from the seed rate of 40 kg ha^{-1} and 120 kg ha^{-1}, respectively (Table 4). There was also biomass yield advantage of 44.25% was obtained from the seed rate of 40 kg ha^{-1} as compared to 120 kg ha^{-1}, respectively. The result revealed that as the seeding rate increased proportionally, the yield and yield attributing factors were decreased proportionally. In line with this, subsequently increasing seeding rates above 30.62 kg ha^{-1} failed to increased grain yield of rice [9].

Table 3. *Mean Square Values for Yield and Yield Components and Total Biomass in Rice at Woito, in 2013*

Source	DF	Grain Yield (t ha^{-1})	1000 Seeds Wt (gm)	Total Biomass (t ha^{-1})	Harvest Index
Replication (R)	3	1.3385ns	0.41667^{ns}	0.8511ns	0.234ns
Treatment (Trt)	4	5.73471**	2.66875ns	10.7760***	0.207ns
Error	12	0.9581	1.34375	0.5658	0.1114

*, ** and *** indicate significance at P< 0.05, P< 0.01 and P< 0.001, respectively and 'ns' indicate non significant

Table 4. *Yield and Yield Components of Rice as Affected By Seed Rate at Woito, in 2013.*

Treatments	Grain Yield (t ha^{-1})	1000 Seeds Weight (gm)	Total Biomass Weight (t ha^{-1})	Harvest Index
Seed Rate (kg ha^{-1})				
40	5.0222a	24.50a	7.2875a	0.6904ab
60	3.6444ab	23.25ab	6.3875ab	0.5720ab
80	1.6667c	23.75ab	4.0750c	0.4126b
100	3.5111ab	22.88ab	5.2500b	0.7418a
120	3.2333b	22.38b	4.0625c	0.796a
LSD 0.05	**1.5081**	**1.785**	**1.1589**	**0.5144**
CV (%)	**28.65**	**4.96**	**14.32**	**6..96**

Note: Means with the same letters within the columns are not significantly different at P <0.05.

4. Summary and Conclusion

Growing rice by using optimum seed rate could make an important contribution to increase agricultural production and productivity in areas like Woito where there is low practice of using improved agronomic practices such as optimum seed rate. To this end, applying optimum seed rate could be one of the alternatives to improve productivity by small farmers. However, the agronomic management regarding seed rate is not yet studied in the area. Thus, this research work is initiated to investigate the impact of seed rate on the performance of rice.

Study on seed rate was conducted at Woito under irrigation in 2013. The objective of the study was to determine the optimums seed rate that will improve rice production. The experiment was carried out using the randomized complete block design (RCBD) with four replications at Woito in 2013. The treatments involved were five levels of seed rate (40, 60, 80, 100 and 120 kg ha^{-1}). According to the results of analysis of variance, all the phenological and growth parameters except spike length per plant were significantly affected by seed rate. The maximum number of tillers per plant and the highest plant height were noted from the seed rate of 40 kg $ha^{-1.}$ Grain yield and total biomass weight were significantly affected by seed rate whereas; seed rate had brought no significant effect on the yield components such as 1000 seeds weight and number of tillers per plant. The highest grain yield of (5.0222 t ha^{-1}) and the maximum total biomass weight of (7.2875 t ha^{-1}) were obtained from the seed rate of 40 kg ha^{-1}. Therefore, it can be concluded that the seed rate of 40 kg ha^{-1} is advisable and could be appropriate for rice production in the test area even though further testing is required to put the recommendation on a strong basis.

References

[1] Zhao L, Wu L, Wu M and LiY, 2011.Nutrient uptake and water use efficiency as affected by modified rice cultivation methods with irrigation. Paddy Water environ 9: 25-32.

[2] Xu Kuangdi And Shen Guofang. 2003. Promoting Chinese Rice Production through Innovative Science and Technology. *In:* Mew T.W. Et al(eds) Proceedings of The International Rice Research Conference, 16-19 September, 2002, Beijing, China, Pp 11-18

[3] Tsuboi. 2004. Hand Book of Tropical Rice Cultivation. Association for International cooperation of Agricultural and Forestry, 19, Ichibancho,Chiyoda-Ku, Tokyo, Japan

[4] FAOSTAT, 2006. http://faostat.fao.org/

[5] Dustin L. H. and Sterling B. B. 2005. Rice yield components as affected by cultivar and seeding rate. 2009. Vol. 97. No. 6,. 1622-1625.

[6] Africa Rice Center (Africarice). 2010. Improving Access to Rice Seed and Building a Rice Data System for Sub‐Saharan Africa (Japan Emergency Project). Final Report of the Japan Emergency Project, Cotonou, Benin

[7] SAS (2007) Statistical Analysis Systems SAS/STAT user's guide Version 9.1 Cary NC: SAS Institute Inc. USA

[8] Rao, P.U. 2012. Optimal Seed Rate for Planting One Hectare of Rice. Nuziveedu Seeds Private Limited (NSPL), Hyderabad

[9] Richards A.L., J.L. Hill, J.W. Branson, and S.K. Runsick.2005. Influence of Row Spacing and Seeding Rate on Rice Grain Yield. *In:* B.R. Wells Rice Research Studies

[10] Sharam, A.R. and Ghosh, A. 1998. Optimum seed rate and nitrogen fertilizer requirement of rice under semi-deepwater ecosystem. Journal of agronomy and crop science, 181: 167-172.