Performance of Different Varieties in Direct Seeded Rice (*Oryza sativa* L.) as Affected by Different Sowing Methods

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Abstract

Field experiments were conducted in DaikU and Maubin Townships from November, 2015 to April, 2016 with two objectives: (1) to compare the different sowing methods on performance of tested rice varieties, (2) to investigate the effect of sowing methods on yield and yield components of tested rice varieties in direct seeded rice areas (DSR) by using split-plot design with three replications. Three different rice varieties (Theehtatyin, Yeanelo 4 and Yeanelo1) were assigned in main plot and three different sowing methods (broadcasting, line sowing and drum seeder) were arranged in sub plot. Yeanelo 1 gave the highest grain yield (4.75 t ha-1) with the maximum number of spikelets panicle-1 in DaikU, whereas Theehtatyin obtained the highest grain yield (6.32 t ha-1) with the highest number of panicles m-2 and harvest index in Maubin. Although drum seeder had minimum number of panicles m-2, number of spikelets panicle-1, 1000-grain weight, panicle length and harvest index were relatively high among the sowing methods. Therefore, the results highlighted that drum seeder method gave the maximum grain yield for all tested rice varieties, especially, Yeanelo 1 for DaikU and Theehtatyin for Maubin.

Key words: DSR, rice varieties, sowing methods, grain yield

Introduction

Rice (*Oryza sativa* L.) is the most important staple food of about half of the world population. In Myanmar, actual paddy sown areas in 2015-2016 were 7.17 million hectares with the national average yield of 3.94 MT ha-1 and production reached at 28.21 million metric tons (MOALI 2016). Ayeyarwaddy and Bago regions are the most widely rice grown regions (DoA 2014). Ministry of Agriculture and Irrigation made efforts to increase production of paddy by growing high yielding varieties, including introduction of hybrid rice varieties (MOAI 2014). High Yielding Varieties (HYVs) were reported to be used for 70-80% of the monsoon crop and for virtually all the summer crop. HYVs are widely grown in the summer season because of their early maturity and the absence of flooding risk at that time of year (Denning et al. 2013). In Myanmar, most of the varieties used for summer rice were high (HYVs) and used for both transplanting and wet seeded rice (WSR) cultivation. Wet seeding was more common for the summer rice crop in Myanmar. This is because of the lower likelihood of submergence and related mortality of young seedlings. Without optimum plant population, a cultivar cannot give maximum genetic potential. Optimum plant population contributes to high yield, which relates directly to seeding density (Janoria 1989).

Wet seeded rice (WSR) areas in Myanmar constituted 30% in monsoon and 80% in summer of the concerned rice area in 2001-2002 (AED 2002). Tin Maung Bo and Hla Min (1995) expressed that there were different planting methods of WSR in Myanmar; broadcasting (WSR-B), line seeding (WSR-L) and spot seeding or hill-wise seeding (WSR-S).

The seed may be broadcasted by hand or less

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commonly using a seeder. The drum seeder was widely distributed in Myanmar through Livelihoods and Food Security Trust Fund (LIFT) and implementing partners (Barca 2012). Drum seeder offers several advantages. It reduces seeding rate to about 50-100 kg ha-1 without compromising yield (broadcast seeding rate requires 100-150 kg ha-1). Drum seeder increases yield due to better weed control, better fertilizer and sunlight distribution due to less crowded plants.

Farmers grow mostly rice-based cropping with a limited level of diversification and they are facing rising labour costs and difficulties to access labour on time, especially between the monsoon and winter seasons. The adoption of new rice varieties and alternative crop management options can advance the rice harvest, provide options for post-rice crops and lead to greater diversification for small-holder farmers in the Ayeyarwaddy Delta. Therefore, the study was carried out (1) to compare the different sowing methods on performance of tested rice varieties in DaikU and Maubin Township (2) to investigate the effect of sowing methods on yield and yield components of tested rice varieties in both locations.

Materials and methods

The experiments were conducted at A Lann village, Maubin Township, upper delta area under Ayeyarwaddy Region and Ka Tote Phayar Gyi village, DaikU Township, Bago (East) Region during the dry season 2016. A split plot design with three replications was assigned. The three varieties (Theehtatyin, Yeanelo 4 and Yeanelo 1) were laid down in main plot while three sowing methods (broadcasting, line sowing and drum seeder) were laid down as sub plot. Individual plot size was 5 m × 4 m consisting 24 rows with spacing of 20 cm in line sowing and drum seeder plots. The whole experimental plot size was 864.5 m2. According to the soil analysis results, the soil textures were loam soil in DaikU and silty clay loam soil in Maubin (Table 1).

The land was thoroughly prepared and leveled before direct seeding. The seeds were soaked for 24 hours and incubated for another 36 hours. The incubated seeds were air-dried in the shade for about 15 minutes before sowing to facilitate singling or separating of seeds. The incubated seeds were sown on the leveled field directly by three sowing methods with the seed rate of 150 kg ha-1 for broadcasting, 100 kg ha-1 for line sowing and 50 kg ha-1 for drum seeder. In DaikU Towhship, systemic selected herbicide (M PAWN 30% EC) (Partilachlor 30% EC) was applied at the rate of 500 cc ha-1 at 3 DAS. Irrigation was done 2 times per week from 7 DAS to maximum tillering stage. In Maubin Township, systemic selected herbicide (M PAWN 30% EC) (Partilachlor 30% EC) was applied at the rate of 500 cc ha-1 at 3 DAS and systemic selected herbicide (M Paung Shin 32%WP) (Bensulfuron-methyl 14 % + Quinclorac 28 %) was supplement applied at the rate of 988 g ha-1 at 10 DAS for serious infestation of grass weeds. Hand weeding was done at 40 DAS.

Table 1. Physicochemical properties of soil analysis before experiments

Characteristics	Unit	DaikU		Maubin	
		Result	Rating	Result	Rating
pH		5.2	Moderately acid	5.5	Moderately acid
Available N	mg kg-1	1.60	Medium	1.55	Medium
Available $P_2 O_5$	mg kg-1	1	Low	7	Low
Available K_2O	mg kg-1	98	Low	524	High
Organic matter	%	0.47	Low	1.48	Medium
Textural type			Loam		Silty clay loam
Sand	%	1.9		45.0	
Silt	%	68.1		35.0	
Clay	%	30.0		20.0	

Irrigation was done one time per week from 7 DAS to maximum tillering stage. In both experiments of panicle initiation stage, a thin layer (2-3 cm) of water was kept on the plots. Water was removed from the plots during ripening stage. Compound fertilizer (15:15:15) 100 kg ha^{-1} was applied at 14 DAS. Compound fertilizer (15:15:15) 100 kg ha^{-1} and urea 25 kg ha^{-1} were applied at 28 DAS. Urea 50 kg ha^{-1} was applied at 42 DAS as the recommendation of Soil Science Section, Soil Science, Water Utilization and Agricultural Engineering Division, Department of Agricultural Research (DAR).

The crops were harvested from the harvested area of 5 m^2 at maturity and, then threshed, cleaned, dried and weight. Grain yield were adjusted at 14 % moisture and converted to t ha^{-1}. Number of panicles $hill^{-1}$, number of spikelets $panicle^{-1}$, filled grain percentage, 1000-grain weight and total dry matter were separately analyzed from sampling area per plot. Harvest index was calculated as the ratio of economic yield (seed weight) to biological yield (total dry matter weight) (Yoshida 1981). Seedlings emergence were counted from the two sampling areas (1 m^2 each) for broadcasting and line sowing per plot. The numbers of productive tillers were counted from the two sampling areas of each treatment at 14 DAS to heading stage. Plant height was measured from twelve sample plants per plot at two weeks interval from 14 days after seeding to heading stage. Panicle length was measured from 10 panicles in each plot at harvest as a linear distance from the neck-node of the panicle to the tip of the spikelet.

The collected data were analyzed by using Statistix (version-8) software and treatment mean comparison was performed by using Least Significant Difference (LSD) at 5% level (Gomez and Gomez 1984).

Results and Discussion

Yield and yield components

The mean effect of varieties and sowing methods on yield component and agronomic characters of rice in DaikU Township, 2016 dry season is shown in Table 2. Among the tested varieties, Thee-

Table 2. Mean effect of varieties and sowing methods on yield and yield components and agronomic characters of rice in DaikU Township

Treatment	Grain yield (t ha-1)	Panicles m-2 (no.)	Spikelets panicle-1 (no.)	Filled grain (%)	1000-grain weight (g)	Panicle length (cm)	Harvest index
Varieties							
Theehtatyin	3.97 b	597.11 a	45.44 b	58.79 b	20.61 c	17.37 b	0.48 a
Yeanelo 4	4.27 ab	388.00 b	48.38 ab	78.27 a	25.12 a	21.53 a	0.44 b
Yeanelo 1	4.75 a	418.22 b	61.09 a	70.43 ab	23.64 b	20.67 a	0.46 ab
$LSD_{0.05}$	**0.53**	**155.97**	**14.13**	**14.66**	**1.18**	**1.72**	**0.03**
Methods							
Broadcasting	4.37	623.78 a	42.17 b	70.34	23.14 ab	19.29 b	0.44 c
Line sowing	4.17	388.22 b	54.59 a	67.68	22. 84 b	19.84 ab	0.46 b
Drum seeder	4.45	373.33 b	58.17 a	69.47	23.39 a	20.44 a	0.49 a
$LSD_{0.05}$	**0.59**	**70.79**	**6.09**	**3.79**	**0.54**	**0.77**	**0.02**
Pr>F							
Variety	0.04	0.05	0.07	0.05	<0.001	0.005	0.04
Method	0.57	<0.001	0.002	0.33	0.13	0.02	<0.001
Var * Method	0.98	0.67	0.38	0.32	0.69	0.45	0.01
CV_a (%)	**9.26**	**25.81**	**20.90**	**16.19**	**3.89**	**6.64**	**4.63**
CV_b (%)	**13.28**	**14.92**	**11.47**	**5.33**	**2.26**	**3.76**	**3.52**

htatyin showed the minimum grain yield (3.97 t ha^{-1}) in comparison with the maximum grain yield of Yeanelo 1 (4.75 t ha^{-1}). Because water stress at any growth stage may reduce yield and the rice plant is most sensitive to water deficit from the reduction division stage to heading (Yoshida 1981). The maximum number of spikelets panicle^{-1} and filled grain percentage were also observed from Yeanelo 1 and it was inversely related to the number of panicles m^{-2}. This variation in the number of panicles m^{-2} was due to genetic make-up of varieties. Mahmud et al. (2012) showed that rice varieties differed significantly in all growth characters especially tillers number. Among the sowing methods, the relatively higher grain yield (4.45 t ha^{-1}) was observed from drum seeder. It was due to lower seed rate of drum seeder and the maximum number of spikelets panicle^{-1} (Figure 1). Because of greater availability of photosynthats due to less intra-plant competition, which resulted in better panicle development causing more appropriation and more number of spikelets panicle^{-1}. Aslam et al. (2002) reported maximum number of the spikelets panicle^{-1} at the lower seeding densities.

In Maubin Township, the mean effect of varieties and sowing methods on yield component and agronomic characters of rice, 2016 dry season is shown in Table 3. The maximum grain yield (6.32 t ha^{-1}) in Theehtatyin variety might be attributed to the production of maximum effective tillers m^{-2}. Uddin et al. (2010), Ali et al. (2014) and Shiyam et al. (2014) reported that the varieties which produced higher number of effective tillers hill^{-1} and higher number of grains panicle-1showed higher grain yield ha^{-1}. Regarding the sowing methods, drum seeder method produced the highest average yield (6.02 t ha^{-1}) because of the sowing distance ensure air circulation, water and light which are basic factors necessary for photosynthesis (Baloch et al. 2002) and it was due to the maximum number of spikelets panicle^{-1} (Figure 2).

Plant growth characteristics

In DaikU Township, line sowing gave the maximum plant height among the tested varieties except Theehtatyin. Similar results were found in Maubin Township. It means that line sowing had optimum line spacing which resulted less competition for limited resource among the plants. Besides, it was due to reduce seed rate which was leading to reduce competition among the plants. Nwokwu et al (2016) who expressed that the taller plants were produced by sowing rice at seed rate of 40 kg ha^{-1} than 80 and 120 kg ha^{-1}. However, the highest plant height for Theehtatyin was resulted from broadcasting. It was due to competition for space which

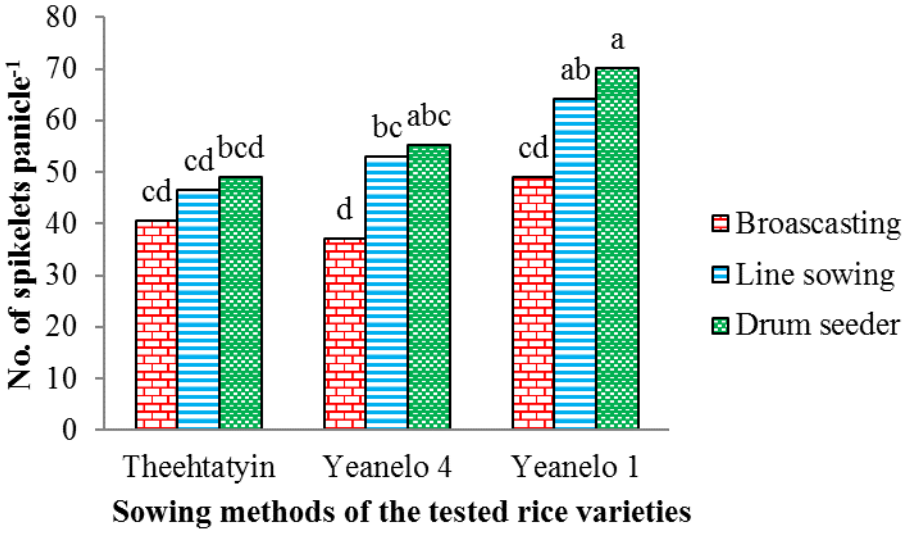

Figure 1. Mean comparison of the number of spikelets panicle -1 as affected by the tested rice varieties and sowing methods in DaikU

Table 3. Mean effect of varieties and sowing methods on yield and yield components and agronomic characters of rice in Maubin Township

Treatment	Grain yield (t ha-1)	Panicles m-2 (no.)	Spikelets panicle-1 (no.)	Filled grain (%)	1000-grain weight (g)	Panicle length (cm)	Harvest index
Varieties							
Theehtatyin	6.32 a	595.33 a	68.14	62.61 b	20.70 c	18.33 c	0.49 a
Yeanelo 4	5.23 b	424.67 b	79.15	70.82 ab	23.79 a	22.39 a	0.47 a
Yeanelo 1	5.42 b	441.56 b	78.29	79.16 a	23.03 b	20.68 b	0.47 a
$LSD_{0.05}$	**0.70**	**98.16**	**14.95**	**8.76**	**0.51**	**1.20**	**0.03**
Methods							
Broadcasting	5.52	730.44 a	54.32 c	70.83	22.41	19.87 b	0.45 b
Line sowing	5.44	427.11 b	76.54 b	71.21	22.54	20.56 ab	0.49 a
Drum seeder	6.02	304.00 c	94.72 a	70.55	22.58	20.97 a	0.50 a
$LSD_{0.05}$	**0.61**	**49.43**	**6.78**	**1.80**	**0.46**	**0.71**	**0.02**
Pr>F							
Variety	0.03	0.02	0.19	0.02	<0.001	<0.001	0.19
Method	0.12	<0.001	<0.001	0.73	0.69	0.02	<0.001
Var * Method	0.44	0.01	0.24	0.31	0.08	0.85	0.26
CV_a (%)	**9.50**	**15.39**	**15.20**	**9.45**	**1.74**	**4.5**	**4.36**
CV_b (%)	**10.47**	**9.88**	**8.76**	**2.48**	**1.97**	**3.36**	**3.18**

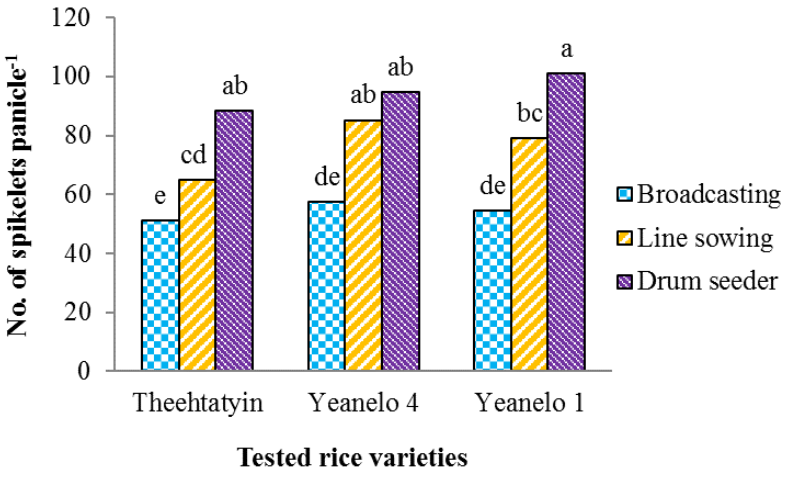

Figure 2. Mean comparison of number of spikelets panicle-1 as affected by the tested rice varieties and sowing methods in Maubin

might contribute elongating of stems in the densely populated plants. Mirza et al. (2009) reported that the plant tended to be taller for getting the light in closed place.

Similar results were found in the maximum number of productive tillers m^{-2} in both locations. The maximum number of productive tillers was obtained at 56 DAS under different sowing methods for all tested rice varieties. Theehtatyin produced the maximum number of productive tillers m^{-2} (1506) in DaikU and (1520) in Maubin at 56 days after sowing due to genetic character of variety. Regarding the sowing methods, broadcasting showed the highest number of productive tillers m^{-2} (1636.40) in DaikU and (1521.50) in Maubin at 56 days after sowing among the other sowing methods due to initial seeding density of the varieties. Phuong et al. (2005) and Chauhan et al. (2011) mentioned that increase in number of productive tillers was due to increase in seed rate.

The maximum number of panicle length was observed in drum seeder for both locations due to less competition and more appropriate between the panicles for resource utilization. Dingkuhn et al. (1991) indicated that cultural practices, particularly on sowing methods effect on the growth dynamics and partitioning patterns of rice. Although drum seeder produced the maximum number of harvest index, which was not significantly different from other sowing methods in both locations. Variations in harvest index within a crop are mainly attributed to differences in crop management (Peltonen-Sainio et al. 2008).

Conclusion

Yeanelo 1 variety gave the highest grain yield and number of spikelets $panicle^{-1}$ among the tested rice varieties in DaikU Township. Although Yeanelo 1 variety did not produced the maximum number of panicles m^{-2}, other important yield component characters such as filled grain percentage and 1000 grain weight, they were not in the lowest level. However, Theehtatyin variety gave the maximum grain yield by producing the highest number of panicles m^{-2} than that of other rice varieties in Maubin Township. By comparing the sowing methods, drum seeder gave relatively higher grain yield than that of line sowing and broadcasting in both townships. Although drum seeder had minimum number of panicles m^{-2}, other characters, especially, number of spikelets $panicle^{-1}$, 1000-grain weight and panicle length were superior than the other sowing methods in both locations. The results indicated that drum seeder was efficient for rice production under the irrigated lowland direct seeding rice cultivated areas. Moreover, the low seed rate could be used in drum seeder method without affecting the yield. Therefore, it can be concluded that Yeanelo 1 variety for DaikU Township and Theehtatyin variety for Maubin Township should be recommended for the maximum grain yield and better performance of rice with drum seeder sowing methods.

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