Jurnal Lahan Suboptimal
ISSN: 2252-6188 (Print), ISSN: 2302-3015 (Online)
Vol. 1, No.2: 107-115, Oktober 2012

In-situ Evaluation of Growth Rate and Yield Components of Several Non-tidal Swamp Rice Accessions in South Sumatera

Evaluasi In-situ terhadap Kecepatan Pertumbuhan dan Komponen Produksi beberapa Aksesi Padi Rawa Lebak Sumatera Selatan

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ABSTRAK

Konversi lahan pertanian mendorong masyarakat untuk menggunakan lahan rawa lebak sebagai lahan untuk budidaya tanam padi lebih intensif. Penelitian ini bertujuan untuk mengidentifikasi laju pertumbuhan dan komponen hasil beberapa aksesi padi rawa lebak Sumatera Selatan. Penelitian menggunakan sembilan aksesi padi lebak yang ditanam di daerah rawa lebak. Lahan dipersiapkan sesuai kebiasaan petani lokal dan dibagi i 27 petak berukuran 280 cm x 80 cm dengan pola Rancangan Acak Kelompok. Aksesi tersebut dapat dikelompokkan menjadi tiga, yaitu yang memiliki kecepatan pertumbuhan yang lambat, sedang, dan cepat yang disebut sebagai LGRA, IGRA, dan HGRA. Kelompok ini, masing-masing memiliki kecepatan pertumbuhan yang bersesuaian dengan peningkatan tinggi permukaan air di lahan rawa lebak, yaitu sebesar < 5 cm, 5-6 cm, dan > 6 cm per minggu. Kelompok LGRA meliputi aksesi Petek (A5) Senia (A6); kelompok IGRA meliputi aksesi Bone (A1), Pelita Rampak (A2), serta Sawo Rimbo (A7); dan kelompok HGRA meliputi aksesi Kuning (A3), Siam (A4), Sawah Beling (A8) dan Putih Olak (A9). Sejumlah komponen produksi pada aksesi cenderung menurun, seiring dengan meningkatnya kecepatan pertumbuhan, dan beberapa lainnya bervariasi tergantung pada aksesi. Untuk efektifitas dan efesiensi budidaya padi rawa lebak, perlu mempertimbangkan faktor kecepatan pertumbuhan, dan potensi produksi dalam memilih aksesi yang akan ditanam.

Kata kunci: In-situ, evaluasi, padi, rawa, lebak

ABSTRACT

Rapid increase of agricultural land conversion has led to the intensified utilization of non-tidal swamp**.** The objective of this research was to identify growth rate and yield components of several rice accessions of non-tidal lowland swamp of South Sumatera. This research incorporated the cultivation of nine rice accessions in non-tidal swamp area. Research plots were prepared by local farmers to include 27 plots of 280 cm x 80 cm following the Complete Randomized Block Design. Research indicated that rice accessions might be classified into 3 groups of Low Growth Rate (LGRA), Intermediate Growth Rate (IGRA), and High Growth Rate (HGRA) accessions. Each group has different growth rate according to the field water level during flooding season of < 5 cm, 5 to 6 cm, and >6 cm per week, respectively. The LGRA group consisted of Petek (A5) and Senia (A6), the IGRA group consisted of Bone (A1), Pelita Rampak (A2), and Sawo

Rimbo (A7) and the HGRA group consisted of Kuning (A3), Siam (A4), Sawah Beling (A8) and Putih Olak (A9). Some yield components tended to decrease as the growth rate increased, and some varied depending on the accessions. For effective and efficient cultivation, farmers should apparently consider growth rate and yield potential to decide which rice accessions to grow.

Keywords: In-situ, evaluation, rice, non-tidal swamp

INTRODUCTION

The role of non-tidal lowland swamp become more important in rice production in Indonesia, as the farm-land conversion problem increase. Ecological condition of non-tidal lowland swamp is wet and capable to hold water in certain period. Although experiencing many difficulties and limitation, this condition, certainty, encourages farmers to cultivate rice plant in the area.

Rice cultivation in non-tidal lowland swamp has been practiced by generations of farmers in Indonesia, including in South Sumatera (Ar-Rhiza *et al*. 2012). In Indonesia, potential development of rice cultivation in such area is very large, with cover area of more than 13 millions ha (Widjaya-Adhi *et al*. 1992). In South Sumatera, there is more than 3 million ha of such area, concentrated in 5 districs of Ogan Komering Ilir, Ogan Komering Ulu Timur, Musi Banyuasin, Banyuasin, dan Musirawas (Dinas Pertanian Tanaman Pangan Sumsel, 1998).

For the purpose of cultivation, non-tidal lowland swamp area in Indonesia is classified into 3 different types of Levee Swamp, Floodplain Swamp, and Back Swamp. Hydrological characters of these 3 types of area is quite different (Table 1).

With respect to hydrological characters, Pasaribu (2007) mentioned 9 critical efforts to cultivate rice in the of non-tidal lowland swamp area, which included water management system, combined with the use of appropriate rice varieties that are able to keep up with water-flooding rate and period. Such rice varieties, should perform certain growth rate that correspond to the water level in certain period of flooding. This research, was carried out in-situ, in natural area of non-tidal lowland swamp area, without addition of fertilizer and pesticides. The objective of this research was to identify growth rate and yield components of several rice accessions of non-tidal lowland swamp of South Sumatera. Result of this research is useful for the farmers to decide which variety to cultivate, and become important information for the researchers to identify new accessions to be incorporated in their breeding program.

MATERIALS AND METHODS

Research was done in-situ, at natural non-tidal lowland swamp area at Keramasan, Kertapati Palembang on July to September 2011. The land was prepared by local farmer as usual, using manual-hand clearing, and hoeing, for about a month before planting. The land was devided into 27 research plots with plot size of 280 cm x 80 cm. No fertilizer was applied to the plots. During research period, the site was inundated about 30-40 cm for the last three weeks.

Seeds of nine rice accessions (Table 2) used in this research were local varieties that were collected from several areas of non-tidal lowland swamp in South Sumatera in 2010. The seeds were soaked for a day, and then germinated on wet paper towel for 3-4 days, before they were planted in the multi-stage seeding-bed system (sistem persemaian bertingkat), in every 14 days period. The rice seedling was transplanted into designated plot in 20 cm x 20 cm by using a dibble to make hole with 5 cm deep. Each plot consisted of 75 holes,

in which, 2 rice seedling was planted in each hole.

During period of research, manual practice of hand-weeding was done at 14, 35, and 55 days after planting. No herbicide, no pesticide were applied to the plants. Harvesting was done as usual, when the grains were hard and the husk turned yellow in color.

Research was design as Randomized Complete Block (RCB), with 3 replications as a block. This research utilized 27 plots of experimental unit which consisted of 75 plants per plot. Each block was separated in 100 cm distance, while each plot in a block was separated in 50 cm distance. Measurement on certain research variables were taken by using sample of 10 plants per plot as follows:

a. Plant growth rate calculated as additional plant height per week for 16 weeks period. The measurements were done using the highest plant in each clump of the sample (cm per week)
b. Maximum number of tiller per clump. This is number of shoots that grow in eah clump of the sample (tiller per clump)
c. Productive tiller per clump. This is number of tillers that produce floret, measure at the sample. (tiller per clump)
d. Flowering time measured when more than 50% plants in entire plots of accession begin to bear flower (days)
e. Harvesting time, measured when entire plants in the accession were ready to harvest (days)
f. Average number of rice grain formation per floret measured at the sample (grain per floret)
g. Average number of productive grain per floret. This is referred to number of grain that filled out by the seed, measured at the sample (grain per floret)
h. Average weight of 1000 seeds measured at the sample (g).
i. Average yield per clumps, measured on the sample (gram per clump).

Table 1. Hydrological characters of 3 type of non-tidal lowland swam in Indonesia

No.	Type of Swamp	Hydrological characters
1	Levee Swamp	Shallow non-tidal swamp, usually located near the river. In rainy season, water flooding surface reach less 50 cm high with flooding period of less than 3 months.
2.	Floodplain Swamp	Intermediate non-tidal swamp, usually located a little bit far from the river. In rainy season, water flooding surface may reach 50 to 100 cm high, with flooding period of 3 to 6 months .
3	Back Swamp	Deep non-tidal swamp, usually located far a form the river. In rainy season, water flooding surface may reach more that 100 cm high with flooding period of more that 6 months.

Source: Badan Penelitian dan Pengembangan Pertanian (2007)

Table 2. Local rice accessions of non-tidal lowland swamp of South Sumatera used in the research

No.	Accession symbol	Local Name
1.	A1	Bone
2.	A2	Pelita Rampak
3.	A3	Kuning
4.	A4	Siam
5.	A5	Patek
6.	A6	Senia
7.	A7	Sawo Rimbo
8.	A8	Sawah Beling
9.	A9	Putih Olak

Data were analyzed by using statistical methods of Analysis of Variance (ANOVA), followed by Least Significant Difference (LSD). Significant differences were counted at α=0.05 (Petersen, 1995).

RESULTS

Results of Anova Analysis on the data is shown on Table 3. Based on the F-values indicated the growth rate and most yield components were significant at α=0.05. The F-values ranged from 1.98 to 80.07 with Coefficient of variations (CV) ranged from 2.75 to 25.51. Statistical analysis was not performed on maximum number of tillers, number of productive tiller, flowering and harvesting time, due to the lack of statistical assumption on the data.

Furthermore, results of LSD analysis on the data is shown on Table 4. The growth rate was significant with value range from 4.68 cm per week on accession of Petek (A5) to 6.99 cm per week on accession of Siam (A4). In general, the growth rate might be grouped into group with value of < 5 cm per week for accessions of Petek (A5) and Siam (A6); group with value of 5-6 cm per week that included accessions of Bone (A1), Pelita Rampak (A2), and Sawo Rimbo (A7), and group with value of > 6 cm per week that consisted of accessions of Kuning (A3), Siam (A4), Sawah Beling (A8), and Putih Olak (A9).

The yield components measured on the research (Table 4), were varied depending on accessions. The maximum number of tillers per clump ranged from 8 to 12 tillers with number of productive tillers range from 7 to 11 tillers. Accession of Petek (A5) has the highest number of maximum tillers per clump of 12 tillers with number productive tiller of 11 tillers (91.7%). While accessions of Sawo Rimbo (A7) has the lowest number of maximum tillers per clump of 8 tillers with number of productive tillers of 7 tillers (87.5%). The highest average number of grain formation per floret (1745 seeds) with average number of productive grain per clump (1416 grains) or 81.15% was attained by accession of Petek (A5). The highest average yield per clump as well, was attained by accession of Petek (A5) with value of 35.12 g per clumps. On the other hand, the highest value of average weight of 1000 seeds was attained by accessions of Pelita Rampak (A2). Flowering time of the accessions were range from 107 to 123 days, while their harvesting time range from 170 to 195 days.

DISCUSSION

In-situevaluation means that evaluation was done at natural condition, where the plants were usually cultivated by the farmers. No-fertilizer, no-herbicide, and no other pesticide were applied to the land. This method, actually, has been practiced by generations of local farmers to grow rice in non-tidal lowland swamp area (Ar-Rhiza *et al*. 2012). Indeed, in-situevaluation is important subject, since, such method is still exist and practiced by many local farmers to grow rice in non-tidal lowland swamp in South Sumatera .The farmers perceive, this method is effective and efficient to grow rice in the area (Dinas Pertanian Tanaman Pangan Sumsel, 1998). As shown on Tabel 3, this research indicated the growth rate of the rice plants and some their yield components of several rice accessions of non-tidal lowland swamp of South Sumatera were significantly different (α=005) as follows:

a. Growth Rate of the Plants

The growth rate of the plants, which was measured as additional plant height per week for 16 weeks period, varied from 4.68 cm to 6.99 cm per week. The LSD test at α=0.05 indicated that some of these values were significantly different from others (Table 4). The growth rate is a critical trait to help swamp rice plants to keep up with the rate of increasing water surface, during flooding period. When the growth rate of the plant is small, the plants might be drowned under water surface. This

situation may hinder the plants from light, oxygen, and carbon dioxide that will lead to death of the plants (Jackson and Ram, 2003). Furthermore, Jackson (2004) stated that the growth-rate ability plays an important factor in plant recovery from the stress after flooding.

With respect to the rice accessions of non-tidal lowland swamp of South Sumatera, their growth rate might be classified in to 3 groups of Low, Intermediate, and High Growth Rate (Table 5). The first group is Low Growth Rate Accessions (LGRA) that has value of growth rate of less than 5 cm per week. This LGRA group consists of 2 accession of Petek (A5) and Senia (A6). This LGRA group performed well in area of non-tidal swamp with low increase of water surface during flooding (<5 cm per week). The second group is Intermediate Rate Accessions (IGRA) that has value of growth rate of 5-6 cm per week. This IGRA group consists of 3 accession of Bone (A1), Pelita Rampak (A2), and Sawo Rimbo (A7). This IGRA group performed well in area of non-tidal swamp with intermediate increase of water surface during flooding (5-6 cm per week). The third group is High Growth Rate Accessions (HGRA) that has value of growth rate of more than 6 cm per week. This HGRA group consists of 4 accessions of Kuning (A3), Siam (A4), Sawah Beling (A8) and Putih Olak (A9). This HGRA group, can be expected to perform well in area of non-tidal swamp with high increase of water surface during flooding (>6 cm per week). As stated by Mackill *et al*. (1982) and Setter *et al*. (1997), in order to survive, the grow rate of rice varieties of non-tidal lowland should correspond to rate of the water surface, when flooding is coming to the area.

b. Yield Components

The yield components measured in this research varied among the accessions (Table 4). Results of the Anova analysis (Table 3) indicated, the maximum number of tillers per clump was significantly different. The values range from 8 to 12 tiller per clump with percentage of number productive tillers range from 87 to 100 %. Maximum number of tiller and percentage of productive tillers per clump are important factor to determine yield. Setter *et al*. (1997), stated that formation of productive tillers of rice plant were highly effected by several factors including soil nutrition, light, and planting distance. Furthermore, superiority of high-yielding rice varieties should have large number of tiller as well as higher percentage of productive tiller per clump. On other hand, inferiority of local rice varieties usually have less number of tiller as well as less percentage of productive tiller per clump (Jumery *et al*. 1991). Apparently, the inferiority of rice accession of non-tidal swamp of having have less number of tiller was compensated by large percentage of productive tillers per clump and taller plant height to keep up with water level during certain period of flooding. In this research, number of tillers of the LGRA group ranged from 9-10 tillers with percentage of productive tillers range from 91.7 to 100%,in general, were higher than respected values on HGRA group which ranged from 9-10 tillers per clump with percentage of productive tillers of 88.9 to 100% (Table 6).

Result of the Anova analysis (Table 3) also indicated that measurements on the average number of grain formation and number of productive grain per floret were significant. Number of grain formation and percentage of productive on LGRA, IGRA, and HGRA were shown on Table 7. The values on LGRA, IGRA, and HGRA tend to decrease. Those values range from 1022-1745 grain per floret and 81.15-88 %), on LGRA and 595-966 grain per floret 64.74-73.78 % on HGRA. Similar to number and percentage of productive tillers per clump, number of grain and percentage of productive grain in each classification of growth rate of the accessions, tend to decrease from LGRA, IGRA to HGRA (Table 7). As stated by Jackson (2004) and Setter *et al*. (1997), water flooding level

and period played as main limiting factors in cultivation sub-emerge rice.

Weight of 1000 seeds, and yield per clump (Table 8), flowering and harvesting timer (Table 4) were varied depending on accessions. Values of weight of 1000 seeds ranged 20 to 25 g, while values of yield per clump ranged 19 to 35 g. Statistical analysis on variable of weight of 1000 seeds indicated the values were significantly different, while on values of variable yield per clump were not significant at α=0.05. The Highest values of weight of 1000 seeds of Pelita Rampak (A2) and Sawah Beling (A8) accessions of >25 g indicated those accessions produced larger seed size than others. On other hand, the highest values of yield per clump of Bone (A1) and Pete (A5) accessions indicated that these accessions considered as high yielding accession. As other non-tidal lowland swamp rice variety, the flowering and harvesting time of the accessions considered long that ranged from 109 to 123 days and 170 to 195 days, respectively (Table 4). Badan Penelitian dan Pengembangan Pertanian (2007) noted that harvesting time of several non-tidal lowland rice varieties ranged from 115 to 140 days. Setter *et al*. (1997) and Jones (1986) stated that yield potential, flowering, and harvesting time of individual plant of rice were strongly determined by genetic factor. The farmers, indeed, should decide an approriate accession to be cultivated in certain location of non-tidal lowland swamp, based on class of growth rate, yield potential, flowering, and harvesting time of the accessions.

Table 3. F-value of Analysis of Variance in each variable measured

No.	Variables	F-Value	CV
1.	Growth rate (cm per week)	80.07 **	2.75
2.	Maximum number of tiller per clump (tiller per clump)	-	-
3.	Productive tiller per clump (tiller per clump)	-	-
4.	Average number of grain formation per floret (grain perfloret)	4.05 **	21.86
5.	Average number of productive grain per floret (grain per floret)	2.74 **	31.24
6.	Average weight of 1000 seeds measured at the sample (gr).	2.84 **	7.93
7	Average yield per clump (g per clump)	1.98 ns	25.51
8.	Flowering time (days)	-	-
9.	Harvesting time (days)	-	-

** and ns indicated the F-value significant and not significant, respectively at α=0.05.

Table 4. Values of variables measured in this research

No	Variable measured	Rice Accessions ¶								
		A1	A2	A3	A4	A5	A6	A7	A8	A9
1.	Growth rate (cm per week)	5.89 (cd)	(5.17 (b)	6.17 (d)	6.99 (f)	4.68 (a)	4.68 (a)	5.69 (c)	6.62 (e)	6.35 (de)
2.	Maximum number of tiller per clump (tillerper clump)	11	10	10	10	12	9	8	9	9
3.	Number of Productive tillers per clump (tiller per clump)	11	9	9	10	11	9	7	8	8
4.	Percent of productive tiller per clum (%)	100.0.	90.0	90.0	100.0	91.7	100.0	87.5	88.9	88.9
5.	Average number of Grain formation per floret (grain per floret)	1386 (bc)	1261 (b)	1228 (b)	1264 (b)	1745 (c)	1022 (ab)	766 (a)	919 (ab)	925 (ab)
6.	Average number of Productive grain per floret (grain per floret)	1206 (b)	966 (ab)	906 (ab)	1133 (b)	1416 (b)	900 (ab)	588 (a)	595 (a)	726 (ab)
7.	Percentage of Average number of productive grain per floret (%)	87.01	76.24	73.78	89.64	81.15	88.06	76.76	64.74	78.49
8.	Average weight of 1000 Seeds measured at the sample (gr).	21.63 (ab)	25.17 (b)	24.27 (b)	24.26 (b)	20.73 (a)	21.70 (ab)	21.10 (ab)	25.13 (b)	23.83 (ab)
10	Average yield per clump(g per clump)	30.48	26.35	25.56	26.90	35.12	24.71	19.40	21.87	22.44
11.	Flowering time (days)	118	109	121	121	107	121	122	122	123
12.	Harvesting time (days)	189	195	181	179	170	181	182	187	185

¶ Rice accession consisted of A1=Bone; A2=Pelita Rampak; A3=Kuning; A4=Siam; A5=Petek; A6=Senia; A7=Sawo Rimbo; A8=Sawah Beling; A9=Putih Olak. Values followed by the same letter indicated the values are not significantly different according to LSD test at α=0.05.

Table 5. The classification of growth rate of rice accessions of non-tidal lowland swamp of south Sumatera.

No.	Growth Rate Classification	Value of Growth Rate (cm per week)	Accessions included
1.	Low Growth Rate Accession (LGRA)	< 5	Pete (A5); Senia (A6)
2.	IntermediateGrowth Rate Accession (IGRA)	5-6	Bone (A1); Pelita Rampak (A2); Sawo Rimbo (A7)
3.	High Growth Rate Accession (HGRA)	> 6	Kuning (A3); Siam (A4): Sawah Beling (A8); Putih Olak (A9).

Table 6. Range of maximum number and percentage of productive tillers per clump in each classification of growth rate of rice accessions of non-tidal lowland swamp of South Sumatera.

No.	Growth Rate Classification	Accession included	Maximum number of tiller per clump	Percentage of productive tiller per clump
1.	Low Growth Rate Accession (LGRA)	Pete (A5); Senia (A6)	9-12	91.7-100.0 %
2.	Intermediate Growth Rate Accession (IGRA)	Bone (A1); Pelita Rampak (A2); Sawo Rimbo (A7)	8-11	87.5-100.0 %
3.	High Growth Rate Accession (HGRA)	Kuning (A3); Siam (A4): Sawah Beling (A8); Putih Olak (A9).	9-10	88.9-100.0 %

Table 7. Range of number of grains and percentage of productive grain per floret in each classification of growth rate of rice accessions of non-tidal lowland swamp of South Sumatera.

No.	Growth Rate Classification	Accession included	Number of grain per floret	Percentage of productive grain per floret
1.	Low Growth Rate Accession (LGRA)	Pete (A5); Senia (A6)	1022-1745	81.15-88.06 %
2.	Intermediate Growth Rate Accession (IGRA)	Bone (A1); Pelita Rampak (A2); Sawo Rimbo (A7)	766-1386	76.76-87.01%
3.	High Growth Rate Accession (HGRA)	Kuning (A3); Siam (A4): Sawah Beling (A8); Putih Olak (A9).	595-966	64.74-73.78

Table 8. Range of average weight of 1000 seeds and average yield per clumps in each classification of growth rate of rice accessions of non-tidal lowland swamp of South Sumatera.

No.	Growth Rate Classification	Accession included	Weight of 1000 seeds (g)	Yield per clump (g)
1.	Low Growth Rate Accession (LGRA)	Pete (A5); Senia (A6)	20.73-21.70	24.71-35.12
2.	Intermediate Growth Rate Accession (IGRA)	Bone (A1); Pelita Rampak (A2); Sawo Rimbo (A7)	21.10-25.17	19.40-30.48
3.	High Growth Rate Accession (HGRA)	Kuning (A3); Siam (A4); Sawah Beling (A8); Putih Olak (A9).	23.83-25.13	21.87-26.90

CONCLUSSION

The conclusions of this research were as follows:The growth rate of non-tidal lowland swamp rice accessions of South Sumatera might be classified into 3 groups of Low Growth Rate (LGRA), Intermediate Growth Rate (IGRA), and High Growth Rate accession (HGRA), that were capable to keep up with up the increase in water surface, during flooding season, of < 5 cm, 5 to 6 cm, and >6 cm per week, respectively. The LGRA group consisted of Petek (A5) and Senia (A6), the IGRA group consisted of Bone (A1), Pelita Rampak

(A2), and Sawo Rimbo (A7), and the HGRA group consisted of Kuning (A3), Siam (A4), Sawah Beling (A8) and Putih Olak (A9). Some yield components of number and percentage productive grain seemed to decrease as the growth rate increase, but weight of 1000 seeds, yield per clump, flowering, and harvesting time were varied depending on the accessions. Apparently, farmers should consider growth rate and yield potential to decide which rice accessions to grow in their swamp.

ACKNOWLEDGEMENTS

Financial support of this research was provided by research incentif program, Ministry for Research and Technology (RISTEK), Republic of Indonesia, Budget Year 2011.

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