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Increasing Paddy Productivity in Tidal Low Lands of South Sumatra through the Implementation of New Superior Varieties and Amator

Peningkatan Produktivitas Padi di Lahan Pasang Surut Sumatera Selatan melalui Penerapan Varietas Unggul Baru dan Alat Tanam Benih Langsung Ditarik Traktor

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ABSTRAK

Upaya peningkatan produktivitas padi sawah di lahan pasang surut dapat dilakukan melalui perbaikan cara tanam dan penggunaan padi varietas unggul baru (VUB). Tujuan penelitian ini adalah untuk mengetahui pengaruh penggunaan alat tanam benih langsung yang ditarik traktor (Amator) dan penanaman padi varietas unggul baru (VUB) di lahan sawah pasang surut. Penelitian ini menggunakan rancangan Split Plot, dengan petak utama yaitu alat tanam: menggunakan Amator dan Sonor, dan sebagai anak petak yaitu penggunaan padi VUB: Hipa-18, Hipa-20, Hipa-21, dan Inpari 22, dengan 3 ulangan. Hasil penelitian menunjukkan bahwa rata-rata produktivitas padi VUB dengan menggunakan Amator sebesar 5.2 t/ha, sedangkan dengan Sonor dapat mencapai 6.5 t/ha. Varietas hibrida (Hipa 18, Hipa 20, Hipa 21) yang ditanam menuggunakan Amator menghasilkan postur tanaman padi yang tinggi, jumlah anakan yang lebih banyak dan panjang malai yang lebih panjang dibanding dengan varietas inbrida (Inpari 22) yang ditanam dengan Sonor. Produktivitas dari empat padi VUB yang diujikan memberikan hasil GKP yang cukup tinggi yaitu sebesar 5.6 – 6.2 t/ha.

Kata kunci: amator, benih hibrida, lahan pasang surut

ABSTRACT

Efforts to increase the productivity of lowland paddy in tidal low land can be conducted through improving planting methods and the use of new superior varieties (NSV). This study aimed to find out the effect of using Amator on the cultivation of new high yielding varieties (NSV) in tidal paddy fields. This study used a Split Plot design, with the main plots namely planting equipment: using Amator and Sonor, and as subplots using NSV paddy: Hipa-18, Hipa-20, Hipa-21, and Inpari 22, with 3 replications. The results showed that the average productivity of NSV paddy using Amator was 5.2 t/ha, while that of Sonor reached 6.5 t/ha. Hybrid varieties (Hipa 18, Hipa 20, Hipa 21) grown using Amator produced taller paddy plants, more tillers and longer panicles than the inbred variety

(Inpari 22) grown with Sonor. The productivity of the four NSV paddy tested gave a fairly high GDH (Grain Dry Harvest) yield of 5.6 – 6.2 t/ha.

Keywords: amator, hybrid seed, tidal low land

INTRODUCTION

Tidal swamp land is one type of land that is currently being developed as a food-producing agricultural area in South Sumatra. The development of wetlands as food areas needs to consider various factors such as land characteristics, agronomic characteristics, technological development and optimization, and community development (Imanudin et al., 2019; Sulaiman et al., 2019). The development of tidal swamp land is still constrained by low land productivity, the indications can be seen from the low level of paddy productivity and farmers still live in poverty due to low income (Fauzi, 2016). Low swamp land productivity is constrained by various biotic and abiotic stresses such as acid soil, high pyrite, iron content and aluminum solubility (Ratmini et al., 2021). Another factor that is currently still a problem is the method of planting because the farmers are still planting the conventional direct seed (tabela) method scatter manually method ("sonor") (Siregar et al., 2018), and using paddy varieties that are intolerant to stress in wetlands (Rumanti et al., 2018).

Sonor paddy planting method being carried out to reduce production costs and shorten time (Chandrasekhararao et al., 2013). However, it has disadvantage of requiring a large number of seeds up to 60 kg/ha. When using direct seed planting equipment (atabela) the seed requirement is only 40 kg/ha (Hara et al., 2015), and it produces a dense population of paddy (Baloch et al., 2007). The method of planting will also affect the abundance of pests and diseases in paddy cultivation (Herlinda et al., 2019). The denser the plant population is, the lower the plant production will be because there is competition for having nutrients among plants (Hara et al., 2015). Atabela has been widely used to replace the sonor planting method because is a solution for areas with minimal labor (Wang et al., 2021), reduces planting and maintenance costs (Siregar et al., 2018), shortens planting time to 8−10 days faster than the sonor method (Chandrasekhararao et al., 2013). Setting the spacing using atabela can increase paddy productivity by 43% (Ningsih et al., 2020). The use and trials of superior rice varieties that can increase paddy productivity in swamps have been carried out such as the use of Inpara (Inbrida padi rawa-swamp paddy inbred) 8 and Inpara 9 varieties with yields of 4.13–6.02 tons/ha and tolerant to Fe poisoning and resistant to green leafhopper virus, Inpari 30 which is resistant to immersion (Rumanti et al., 2018; Sembiring et al., 2020; Sitaresmi et al., 2019; Subekti et al., 2020).

Most farmers in tidal lands still use local varieties of paddy and inbred paddy, which are grown sonorically and some of them use atabela. The atabela still uses human power as the driving force, namely being pulled with hand. Most farmers have not use atabela anymore because it is considered less practical and less ergonomic. To overcome these usage problems, atabela pulled by a tractor was designed called an amator that was adapted on tidal lowland. The Amator is made more efficient and ergonomic than the atabela used by the farmers. Based on the potential that can be obtained from the use of superior and amator varieties of paddy above, it is necessary to conduct this study aimed to finding out the effect of using tractor-drawn atabela on the cultivation of new superior varieties of paddy (NSV) in tidal paddy fields.

MATERIALS AND METHODS

The study was conducted in a paddy field owned by two local farmers in Telang

Sari Village, Tanjung Lago Subdistrict, Banyuasin District, South Sumatra-Indonesia. It was conducted in the rainy season (RS) from October 2020 to March 2021, planting season (PS) II in 2020/2021.

Materials and Tools

The materials used in this study included paddy seeds, urea fertilizer, SP-18 and KCl, as well as herbicides and insecticides. The tools used hoe, soil drill, leaf color chart, four-wheel tractor, hand sprayer, combined harvester, amator (Figure 1).

Figure 1. Amator

Land Processing

Land preparation was carried out by making circular trenches and boundary trenches between the treatment plots. Soil tillage was carried out perfectly (OTS), namely the first tillage used a plow and the second tillage used a rake. During the second tillage, 500 kg/ha CaCO3 agricultural lime (kaptan) was added by scattering.

Paddy Cultivation Techniques

Seed treatment, namely paddy seeds that had been given insecticide and Growth Regulator Substance were soaked for one night. Furthermore, the seeds were planted according to the treatment, namely using Amator and sonor. The seed requirement using amator was 40 kg/ha, while the sonor was 60 kg/ha. The fertilizer used was a single fertilizer with a dose of N fertilizer of 300 kg Urea/ha, P fertilizer of 150 kg SP-18/ha, and K fertilizer of 125 kg KCl/ha. The fertilizer was appliedtwice, namely at the age of 15 days after sowing (DAS). The dose of fertilizer given was 150 kg Urea/ha, 150 kg SP-18/ha and 125 kg KCl/ha. The supplementary fertilization was applied at the age of 35 DAS, which was 150 kg Urea/ha. Weed control used systemic herbicide at a dose of 4 l/ha, at the age of 30 DAS.

Research Method

This study used a Split Plot design, with the main plot being the planting method using amator and sonor, and the sub-plots being NSV paddy, namely Hipa-18, Hipa-20, Hipa-21, and Inpari 22 varieties as comparing varieties. The treatment was repeated 3 times, so there were 24 experimental plots of tidal paddy fields. The variables observed included: vegetative growth (plant height and number of tillers) and generative growth (panicle length, number of empty grains, number of filled grains, weight of 1000 grains, yield of dry grain harvest). Observations of plant height and number of tillers were carried out at the age of 30 and 60 DAS, with a sample of 6 clumps of plants per plot. The observations of productive tillers were carried out in the generative phase, namely the age of 60 DAS, while the yield component parameters were carried out after harvest.

Data Analysis

The data were analyzed using analysis of variance (ANNOVA) at 5% level, and if there was a significant difference, it was continued with the Duncan's Multiple Range Test (DMRT) at 5% level. Meanwhile, to see the relationship between parameters using correlation analysis. The

data analysis used SAS application version 9.00 Copyright (c) 2002 by SAS Institute Inc., Cary, NC, USA.

RESULTS

Vegetative Phase Planting Performance (Paddy Growth)

The results showed that there was an interaction between the method of planting and the type of NSV on the growth of plant height and the number of tillers per plant clump. Table 1 showed that the Hipa-21 variety grown using amator have the highest plant height, reaching 90.5 cm, and the lowest plant height was the Inpari 22 variety using sonor method. The observing of the number of tillers showed that the Hipa-18 variety grown using amator produced the highest number of tillers, reaching 16.9 tillers per clump of paddy plants. Meanwhile, the Inpari 22 variety planted sonorically produced the least number of tillers, which was only 11.7 tillers per plant clump (Table 1).

Table 1. Plant height and number of tillers

Parameter	Plant Height (cm)		Rate	Number of Tillers		Rate
Treatment	T1	T2		T1	T2	
V1	77.8^{d}	77.7^{d}	77.8	14.0^{bcd}	11.7^{d}	12.9
V2	90.5^{a}	88.0^{abc}	89.3	16.7^{ab}	12.8^{cd}	14.7
V3	85.5^{bc}	83.8^{c}	84.6	16.9^{a}	15.2^{abc}	16.1
V4	86.6^{abc}	88.7^{ab}	87.6	16.5^{ab}	13.1^{cd}	14.8
Rate	85.1	84.6	+	16,0	13,2	+
CV			2.82			6.84

Note: (+) There is interaction between the tested factors, the numbers in the same parameter column and followed by the same letter were not significantly different at the 5% Duncan test, T1=amator, T2=*sonor*, V1=Inpari 22, V2= Hipa-21, V3=HIPA-18, V4=HIPA-20

Table 2. Panicle length, number of filled seeds and number of empty grains

Parameter	Panicle Length (cm)		Rate	Number of Filled Seeds		Rate	Number of Empty Grains		Rate
Treatment	T1	T2		T1	T2		T1	T2	
V1	24.9	24.4	24.6^{b}	106.4	98.4	102.4^{a}	33.2	35.1	34.1^{a}
V2	27.7	26.8	27.3^{a}	115.1	125.5	120.3^{a}	67.5	59.3	63.4^{a}
V3	25.3	25.0	25.1^{b}	99.4	105.8	102.6^{a}	72.2	60.2	66.2^{a}
V4	25.9	27.3	26.6^{ab}	124.3	126.4	125.3^{a}	50.8	54.1	52.4^{a}
Rate	25.9^{a}	25.8^{a}	-	111.3^{a}	114.0^{a}	-	55.9^{a}	52.1^{a}	-
CV			6.29			17.12			19.86

Note: (-) There is no interaction between the tested factors, the numbers in the same parameter column and followed by the same letter were not significantly different at the 5% Duncan test, T1=amator, T2=sonor, V1=Inpari 22, V2= Hipa-21, V3=HIPA-18, V4=HIPA-20

Table 3. 1000 grain weight and HDG-harvested dry grain

Parameter	1000 Grain Weight (g)		Rate	Harvested Dry Grain (t/ha)		Rate
Treatment	T1	T2		T1	T2	
V1	24.5	24.5	24.5^{a}	4.8	6.4	5.6^{a}
V2	25.5	16.0	20.8^{a}	5.4	5.7	5.6^{a}
V3	26.8	26.3	26.6^{a}	5.0	6.9	6.0^{a}
V4	24.8	24.5	24.7^{a}	5.6	6.9	6.2^{a}
Rate	25.4^{a}	22.8^{a}	-	5.2^{b}	6.5^{a}	-
CV			17.27			16.59

Note : (-) There is no interaction between the tested factors, the numbers in the same parameter column and followed by the same letter were not significantly different at the 5% Duncan test, T1=amator, T2=sonor, V1=Inpari 22, V2= Hipa-21, V3=HIPA-18, V4=HIPA-20

Table 4. The results of the correlation analysis between the observed parameters and the HDG results

Character	TT	JA	PM	JGI	JGH	Bbt	GKP	GKG
TT	1	0.29919	0.31313	-0.0186	0.36573	-0.12237	-0.05873	-0.07962
JA		1	0.01055	-0.08025	0.29006	0.35673	-0.40638*	-0.41304
PM			1	0.6843**	0.2075	-0.09397	-0.17325	-0.17418
JGI				1	-0.15212	0.14396	0.02996	0.07193
JGH					1	0.27598	-0.16922	-0.19410
Bbt						1	0.01557	0.03736
GKP							1	0.98423

Note: PH = plant height, NT = number of tillers, PL = panicle length, NFG = number of filled grain, NEG = number of empty grain, Weight = 1000 grain weight, HDG = harvested dry grain, DMG = dry milled grain * = real, ** = very real

Planting Performance of the Generative Phase and Components of Paddy Yield (Paddy Productivity)

The results of observations of the components of paddy yield were showed in Table 2 and Table 3. The results showed that there was no interaction between the planting method and the type of NSV on panicle length, number of empty grains and paddy plant contents. The results showed that the Hipa-21 variety have the longest panicle length, which reached 27.3 cm and the Inpari 22 variety had the shortest panicle length, which was 24.6 cm. The observation of the number of filled and empty grain gave results in the range of 99–126 filled grains and 33-72 empty grains, respectively (Table 2). The results showed that there was no interaction between the method of planting and the type of NSV on the 1000 grain weight parameter and the yield of Harvested Dry Grain paddy plants. The weight of 1000 grains of paddy was in the range of 16.0–26.8 g. The HDG yields for paddy were in the range of 4.8 – 6.9 t/ha (Table 3).

The relationship between the characters of the growth components, and the component of how to plant and paddy varieties could be seen from the correlation value. The results of the correlation analysis between the various characters of the yield components were showed in Table 4.

DISCUSSION

The treatment of planting methods on various varieties affects the growth of paddy which is seen in the height of the paddy plant and the number of tillers. Planting paddy seed with amator have better plant growth than that of sonor because there is a regular spacing between the clumps (Figure 2). Planting seeds with an amator made in the seeds come out through the hole and fall according to the spacing that had been set so as to form neat rows of plants with a distance of about 20 cm. The working principle of the amator is to place the seeds in an array according to the spacing that be adjusted in the seed outlet hole and fell on the surface of the land, so that the paddy seeds grew regularly and got better nutrition because the initial phase of paddy population growth is not dense. These results are reinforced from several research results that the application of seed dispersal with planting tools will grow uniform rows of paddy seedlings (Minghua et al., 2021), resulting in better plant growth (Huang et al., 2017) such as the number of productive tillers, volume and total root length, increasing plant dry weight and weight of grain per clump (Lin et al., 2009).

Figure 2. The performance of paddy plants using the amator tool

The results shows that the use of hybrid varieties resulted in lower productivity than

that of inbred varieties. This result is different from the results of several studies which show that hybrid varieties produce higher paddy productivity than that of inbred paddy (Huang et al., 2011). Grain yield is a complex trait and highly dependent on the agronomic characters (Hairmansis et al., 2013) and hybrid variety varies greatly between locations and depends on soil and climatic factors (Huang et al., 2011), especially site-specific planting on tidal lands that have low nutrient content and pH.

The results of soil analysis using the swamp soil test device (PUTR) at the study site revealed that the NPK nutrient content is low with a pH of 4-5. Unleveled land conditions at the research site are also one of the factors that caused the operation of the amator to be not optimal so that the paddy productivity is lower than that of the sonor planting method.

The unleveled land caused a jam in one of the amator wheels so that it did not rotate. If the wheel did not turn, the axle or the axle associated with seed dispensing did not turn either. This condition caused the drop of seeds to the ground to be not optimal. These results are reinforced from several research results that wheel slip also affects the spacing produced by the machine, because the finger of the planter will continue to constantly move to plant seeds when the machine loses mileage because the wheels do not get traction (Behera et al., 2009; Hossen et al., 2018)

Based on the calculation of the correlation between components, the character of the yield component that correlated is the number of tillers with HDG and panicle length with the number of filled grains. The panicle length character had a positive and significant correlation with the number of filled grains. In other words, paddy that has long panicles will produce a greater amount of grain content. This is in line with the results of several studies showing that an increase in panicle length supports an increase in the number of grain contents and the number of total grains per panicle (Babu et al., 2012; Meng et al., 2016).

CONCLUSSION

Hybrid varieties (Hipa 18, Hipa 20, Hipa 21) grown using Amator produced taller paddy plants, more tillers and longer panicles than the inbred variety (Inpari 22) grown with Sonor. The productivity of the four NSV paddy tested gave a fairly high GDH (Grain Dry Harvest) yield of 5.6 – 6.2 t/ha.

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