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Research Article
Vegetative, Physiological and Yield Components Observation of Rice Varieties with Specific Plant Spacing in Integrated Mature-4 by Smallholder of Oil Palm

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Abstract

Background and Objective: The effort of lowland rice need to be supported by the program integration of lowland rice with oil palm plants to food self-sufficiency. The research was aimed to obtain the vegetative, physiological and yield components of several varieties of lowland rice with specific plant spacing in integrated mature-4 by smallholder of oil palm. **Materials and Methods:** The research used the split-plot design with the main-plot is the plant spacing (J_1 = 25×20 cm, J_2 = 25 ×25 cm, J_3 = 25×30 cm and J_4 = 25×35 cm) and sub-plots is the rice varieties (V_1 = Inpara 2, V_2 = Inpari 4, V_3 = Inpari 10 and V_4 = Inpari Sidenuk). Parameters were analyzed by ANOVA and the means effect was followed by DMRT at a level of 5%. **Results:** The Inpari Sidenuk variety significantly increased the highest grain yield plot^{-1} and yield ha^{-1} of 0.42 kg and 3.36 ton, respectively compared to other varieties. The plant spacing of 25×25 cm (J_2), 25×30 cm (J_3) and 25×35 cm (J_4) can significantly increase the fresh weight stover/clump of 13.53, 13.29 and 13.22 g, respectively. In overall, plant spacing of 25×25 cm can increase the panicle length, number of grain/panicle, percentage of filled grain, 1000 grains weight, grain yield plot^{-1} and yield ha^{-1} compared to other plant spacing. **Conclusion:** The use of Inpari Sidenuk variety with the plant spacing of 25×25 cm has the potential to be recommended in integration with mature-4 of smallholder oil palm to increasing yield and food self-sufficiency.

Key words: Growth, integration, physiological, plant spacing, lowland rice varieties, smallholder oil palm, yield

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The national rice field conversion is estimated at around 96,512 ha per year from 2000 until 2015. The rice field currently cover 8.1 million ha are predicted to decrease be around 5.1 million ha in 2045 based on the high-resolution image analysis[1]. The decrease in low land rice area in Setia Janji Sub-district, Asahan District, North Sumatra from 2005 to 2012 is related to the increase in area plantation, which has an impact on decreasing lowland rice yield[2]. The decrease in the area of lowland rice harvesting can be caused by the conversion of lowland rice to oil palm plantations. The conversion of lowland rice to plantation plants such as oil palm and rubber. Anggari *et al.*[3] stated that the cause of the public executes the conversion of lowland rice into oil palm plantations such as the risk in lowland rice farming is higher and economic factors are more profitable in Trumon sub-District, South Aceh District. Wildayana[4] reported that the dominant consideration of farmers in converting rice fields to oil palm plantations was found in economic aspect by 51.35% such as low selling prices for rice, oil palm can be harvested every two weeks, the price of fresh fruit bunches is guaranteed or stable, the higher profit from oil palm plantations and lower costs maintaining of oil palm.

The decrease in the lowland rice land will have an impact on the deficit of rice stocks in Indonesia. Rice demand in 2025 is expected to increase by 60%. In supply to food demand then the government through the ministry of agriculture has been focusing on seven major commodities in the program to achieve self-sufficiency and increased yield at the 2017 year through the program "UPSUS PAJALE" and plans to form 1 million ha of lowland rice land until 2019 year[5].

The effort to form 1 million ha of lowland rice need to be supported by the use mature of oil palm plantations through the program integration of lowland rice with oil palm plants. The application of lowland rice as intercropping among oil palm has been reviewed by previous researchers without harming the plantations. Bratkovich *et al.*[6] stated that the oil palm can survive in flooded for 3 months. Corley and Tinker[7] stated that the oil palms are well adapted to waterlogged conditions, but do not tolerate continuous flood. Rivera-Mendes *et al.*[8] also stated that the oil palm seedlings will develop root aerenchyma and pneumatophores as an adaptation mechanism in waterlogged conditions. Holidi *et al.*[9] stated that the oil palm can survive in inundation conditions up to 50 days. The results showed that oil palm in flooded conditions is very beneficial for the growth and development of lowland rice with ±3 months to harvest.

Therefore, the existence of previous research, it is expected that lowland rice plants will also be able to grow and produce until harvesting even though several shaded by oil palm canopy. However, lowland rice in the conditions of shaded will experience disruption of physiological and biochemical processes. Chozin *et al.*[10] stated that one of the inhibitors to the growth and yield of upland rice in intercropping is the occurrence of light deficits reaching the rice canopy. Low light intensity results in disruption of the rate of photosynthesis and carbohydrate synthesis and results in a decrease in the rate of growth and yield of plants.

Therefore, several alternatives are needed to increase the yield of lowland rice with the integration of oil palms including the use of shade-tolerant varieties and plant spacing. It is very difficult to find publications and references of research results with the planting system of lowland rice in the oil palm plants. According to Cabuslay *et al.*[11] the planting upland rice in the immature of oil palm area as land use can decrease the yield of 70 until 90% in shade conditions >50% compared to un-shaded. Alridiwirsah *et al.*[12] stated that the rice varieties of Kuku Balam, Ramos, Inpari 10 and Inpari Sidenuk varieties resulting the yield ha^{-1} of 4.47, 3.80, 3.63 and 3.48 t ha^{-1} respectively were integrated with oil palm. Dass and Chandra[13] stated that the plant spacing of 25×25 cm of two varieties (Hybrid 6444 and Pant Dhan 4) significantly different in the net photosynthesis rate compared to plant spacing of 20×20 cm. The net photosynthesis rate in the tillering and flowering of Hybrid 6444 variety with plant spacing of 25×25 cm was higher by 8.63 and 4.60% compared to plant spacing of 20×20 cm. Anwari *et al.*[14] stated that the spacing of 25×25 cm had produced the highest characteristics for most of the Bara rice agro-morphological.

This research was aimed to obtain high-yielding lowland rice varieties at plant spacing with integrated mature-4 of smallholder oil palm.

MATERIALS AND METHODS

Land management: The research integration of lowland rice and mature-4 of oil palm oil with the number population of 72 trees or 0.50 ha which is located at Titi Payung Street, Hamparan Perak sub-District, Deli Serdang District, North Sumatra Province, Indonesia in April until August, 2017. This research was conducted with the processing of the land using the hand tractor. The soil was cultivated three folds as deep as 20 cm, using the rotary plow.

Plot size and research design: The plot was made with a size of 10×20 m. The research used the split-plot design with the main-plot is the plant spacing (J_1 = 25×20 cm, J_2 = 25×25 cm, J_3 = 25×30 cm and J_4 = 25×35 cm) and sub-plots is the rice varieties (V_1 = Inpara 2, V_2 = Inpari 4, V_3 = Inpari 10 and V_4 = Inpari Sidenuk). The treatment of this research was used the three replications.

Seeding and planting process: Seed rice was soaked in water for 24 hrs and then drained for 12 hrs. The seeds that have germinated are then sown in the nursery and after 2 weeks were moved to the plot. After the seedlings are 3 weeks and planting was conducted in the plot following the treatment in manually, each hole only one plant. The number of plants in the sub-plot was 24 plants with five plant samples.

Plant management: The transfer of seedlings, water has flowed into the plot with the height of 5 cm until the plant is 45 days old. The insertion was performed during 2 Weeks After Planting (WAP) or before the basic fertilization. Weeding was conducted in the initial period until 21 and 42 WAP used manually when weeds have 3-4 leaves, then flooded for 1 day. Fertilization was conducted with N 90 kg ha^{-1}, TSP 50 kg ha^{-1} and KCl 50 kg ha^{-1}. The phosphorus and potassium fertilizer are given before transplanting seedlings, while N fertilizer is given 3 folds such as a week after transplanting, 40 days after transplanting and 65-70 days old. Pest and disease control is only conducted when the symptoms of an attack have reached the economic threshold using insecticides and fungicides that are adjusted to pests or diseases.

Harvesting: Two weeks before harvesting the lowland rice water is drained so that the rice grains mature quickly. Harvesting was conducted manually using the sickle at the mature plant physiology marked visually in lowland rice, such as rice grains were yellowed ranged from 90 until 95% or grain moisture content ranged from 22 until 27%.

Parameters and data analysis

Vegetative components: The parameters of the vegetative components such as plant height (cm), number of tillers and leaf area (cm^2). Plant height and number of tillers were measured at 4 and 6 WAP. Leaf area was measured at harvest by taking a flag leaf from each sample and calculated by the formula p×l×0.75[15].

Physiological components: The parameters of the physiological component such as leaf chlorophyll content (chlorophyll a, b and total), fresh weight stover/clump (g) and dry weight stover/clump (g). The chlorophyll a, b and total were measured using the UV-Vis spectrophotometer[16]. The extraction of chlorophyll was conducted with acetone 80%, the leaves are weighed 0.1 g, then crushed in the mortal, inserted 10 mL acetone, filtered with Whatman filter paper. The filtrate was measured for absorbance at 645 and 663 nm. The calculation of chlorophyll a, b and total were used the Eq:

$$\text{Chlorophyll a} = (12.7\times A663\text{-}2.69\times A645)\times 10^{-1} \quad (1)$$

$$\text{Chlorophyll b} = (22.9\times A645\text{-}4.68\times A663)\times 10^{-1} \quad (2)$$

$$\text{Chlorophyll total} = (8.02\times A663+20.2\times A645)\times 10^{-1} \quad (3)$$

Fresh weight stover/clump was cut from the base of the stem at the end of the research, be weighed, then put into a brown envelope and dried in the sun for 3 days and oven at 60°C for 72 hrs to obtain the dry weight stover/clump after which it was weighed using analytical scales.

Yield components: The parameters of the yield component such as the number of productive tillers, panicle length (cm), number of grain/panicle$^-$, filled grain (%), empty grain (%), 1000 grains weight (g), grain yield/plot (kg) and yield/ha (t). The number of productive tillers was measured when the plants were flowered, by counting the tillers produce panicles. Panicle length was measured when the plant has been harvested by measuring the panicle formed/clump from the base to the end of the panicle. The number of grains $panicle^{-1}$ was calculated by dividing the total number of grains in the sample by the total number of panicles. The percentage of filled grains was calculated by dividing the number of filled grains from all panicles of the sample by the total number of grains. The percentage of empty grains was calculated by dividing the number of empty grains from all panicles of the sample by the total number of grains. The 1000 grains weight was measured by drying up to moisture content of 14% and take by 1000 rice grains randomly then weighed. The grain yield/plot was calculated by weighing the filled grain in each plot and weighed using analytical scales. The yield/ha was calculated by converting the average grain yield/plot using the Eq.[17]:

$$\text{Yield ha}^{-1} = \frac{\text{Average yield plot}^{-1}}{\text{Plot area}}\times \text{Area of 1 ha} \quad (4)$$

Parameters were analyzed with analysis of variance (ANOVA) and the significant effect was followed by Duncan Multiple Range Test (DMRT) at the level of 5%.

RESULTS AND DISCUSSION

Growth components: The results of the ANOVA showed that the varieties, plant spacing and their interaction did not significantly influence the increase in plant height, number of tillers and leaf area of lowland rice in integrated with mature-4 of smallholder oil palm (Table 1).

The results showed that the plant height of lowland rice varieties was integrated with mature-4 of smallholder oil palm highest were found in the Inpari Sidenuk variety (V_4) of 70.85 and 90.36 cm, respectively at 4 and 6 WAP. The plant spacing of 25×35 cm (J_4) is the spacing that the highest of plant height amounted to 68.90 and 87.26 cm, respectively at 4 and 6 WAP. The number of tillers of lowland rice varieties was integrated with mature-4 of smallholder oil palm the highest was found in Inpari 4 variety (V_2) of 7.15 and 12.23 tillers, respectively at 4 and 6 WAP. The number of tillers of lowland rice varieties was integrated with mature-4 of smallholder oil palm the highest was found in the plant spacing of 25×30 cm (J_3) of 7.18 tillers at 4 WAP and found in 25×35 cm (J_4) of 12.08 tillers at 6 WAP. The leaf area of lowland rice varieties was integrated with mature-4 of smallholder oil palm the highest was found in the Inpari Sidenuk variety (V_4) of 26.27 cm^2 and plant spacing of 25×25 cm (J_2) amounted to 36.04 cm^2.

Rice variety of Inpari Sidenuk (V_4) and plant spacing of 25×25 cm (J_2) in integration with mature-4 of smallholder oil palm can adapt to the low light intensity, this is evidenced by the highest leaf area compared to the others treatment. According to Levitt[18] stated that the plant adaptation to shade can be conducted through avoidance that is associated with response to changes in the anatomy and morphology of leaves for photosynthesis efficient. The efficiency of increasing light capture can be conducted by increasing the area of light capture, by increasing the leaf area. Li *et al.*[19] stated that the SPAD value, internal CO_2 concentration, stomatal conductance, actual photochemical efficiency, PSII photochemical efficiency and photochemical quenching in rice leaves of Shennong 265 and Shennong 9816 varieties were increased significantly under shading, however were decreased significantly in the net photosynthetic rate, electron transport rate and non-photochemical quenching. Qiu *et al.*[20] stated that the shade level >45% caused by the growth of grapes to be inhibited. In addition, the soluble protein content, catalase activity, peroxidase and superoxide dismutase, chlorophyll content, net photosynthesis level, stomatal conductance, transpiration rate, PSII photochemical efficiency, PSII potential activity of grape plant (*Vitis vinifera*) were decreased on the shade level >45%.

Table 1: Growth components of lowland rice varieties in integrated with mature-4 of smallholder oil palm

Treatments	Plant height (cm) 4 WAP	Plant height (cm) 6 WAP	Number of tillers 4 WAP	Number of tillers 6 WAP	Leaf area (cm^2)
Varieties (V)					
V_1 = Inpara 2	61.08^{ns}	83.37^{ns}	6.28^{ns}	10.00^{ns}	24.40^{ns}
V_2 = Inpari 4	66.73^{ns}	84.31^{ns}	7.15^{ns}	12.23^{ns}	22.90^{ns}
V_3 = Inpari 10	68.53^{ns}	85.55^{ns}	6.85^{ns}	12.00^{ns}	25.41^{ns}
V_4 = Inpari sidenuk	70.85^{ns}	90.36^{ns}	6.81^{ns}	11.60^{ns}	26.27^{ns}
Plant spacing (J)					
J_1 = (25×20 cm)	66.28^{ns}	84.38^{ns}	6.41^{ns}	11.05^{ns}	23.04^{ns}
J_2 = (25×25 cm)	67.12^{ns}	86.64^{ns}	6.68^{ns}	11.06^{ns}	36.04^{ns}
J_3 = (25×30 cm)	64.91^{ns}	85.30^{ns}	7.18^{ns}	11.64^{ns}	20.09^{ns}
J_4 = (25×35 cm)	68.90^{ns}	87.26^{ns}	6.83^{ns}	12.08^{ns}	19.81^{ns}

Means followed by the same letter are not significantly different at the 5% level by DMRT. WAP: Weeks after planting, ns: Not significant

Physiological components: The results of the ANOVA showed that the plant spacing significantly increased the fresh weight stover/clump, but did not significantly increased the chlorophyll a, b, total and dry weight stover/clump of lowland rice. Varieties and their interactions not significant effect in increasing the physiological component of lowland rice in integration with mature-4 of smallholder oil palm (Table 2).

The results showed that the Inpari 4 variety had higher levels of chlorophyll a, b and total of 3.57, 4.54 and 8.11 mg cm^{-2}, respectively compared to other varieties. The chlorophyll a, b and total of lowland rice varieties were integrated with mature-4 of smallholder oil palm the highest was found in the plant spacing of 25×35 cm (J_4) of 3.59, 4.59 and 8.18 mg cm^{-2}, respectively compared to other plant spacing. Lowland rice varieties are very tolerant of shading were showed that the change in morphological character (leaf area) as lower compared to sensitive varieties. The effect of plant spacing of 25×35 cm (J_4) has an impact on the amount of light that can be absorbed by lowland rice because the spacing between plants is relatively wider compared to others plant spacing. Chozin *et al.*[10], Liu *et al.*[21] stated that the character of rice was decreased in low light conditions both sensitive and tolerant varieties, but the tolerant varieties, the decrease is relatively lower. Asmamaw[22] stated that the plant spacing of 30×20 cm for rice variety Nerica-4 has higher chlorophyll content of 1.35-fold compared to the plant spacing of 20×10 cm at 107 days after treatment.

The results showed that the fresh weight stover/clumpof lowland rice varieties the highest in integrated with mature-4 of smallholder oil palm was found in the Inpari Sidenuk (V_4) variety and was not significantly different of the other varieties. The plant spacing of J_2-J_4 (25×25, 25×30 and 25×35 cm) can significantly increase the fresh weight stover/clump of 13.53, 13.29 and 13.22 g, respectively. The plant spacing of J_2-J_4 is the plant spacing were wider

Table 2: Physiological component of lowland rice varieties in integrated with mature-4 of smallholder oil palm

Perlakuan	Chlorophyll (mg cm^{-2}) a	b	Total	Fresh weight stover/clump (g)	Dry weight stover/clump (g)
Varieties (V)					
V_1 = Inpara 2	3.25^{ns}	4.52^{ns}	7.77^{ns}	12.70^{ns}	3.30^{ns}
V_2 = Inpari 4	3.57^{ns}	4.54^{ns}	8.11^{ns}	12.44^{ns}	3.45^{ns}
V_3 = Inpari 10	3.53^{ns}	4.17^{ns}	7.70^{ns}	12.18^{ns}	3.95^{ns}
V_4 = Inpari sidenuk	3.48^{ns}	4.16^{ns}	7.64^{ns}	13.51^{ns}	3.55^{ns}
Plant spacing (J)					
J_1 = (25×20 cm)	3.32^{ns}	4.00^{ns}	7.32^{ns}	10.80^{b}	3.08^{ns}
J_2 = (25×25 cm)	3.35^{ns}	4.37^{ns}	7.72^{ns}	13.53^{a}	3.78^{ns}
J_3 = (25×30 cm)	3.57^{ns}	4.44^{ns}	8.00^{ns}	13.29^{a}	3.73^{ns}
J_4 = (25×35 cm)	3.59^{ns}	4.59^{ns}	8.18^{ns}	13.22^{a}	3.66^{ns}

Means followed by the same letter are not significantly different at the 5% level by DMRT, ns: Not significant

Table 3: Yield components of lowland rice varieties in integrated with mature-4 of smallholder oil palm

Yield components	Treatments V_1	V_2	V_3	V_4
Number of productive tillers	8.00^{ns}	7.24^{ns}	8.41^{ns}	10.05^{ns}
Panicle length (cm)	21.98^{ns}	22.34^{ns}	22.83^{ns}	22.46^{ns}
Number of grain/panicle	118.70^{ns}	122.05^{ns}	134.38^{ns}	140.27^{ns}
Filled grain (%)	72.52^{ns}	77.81^{ns}	87.39^{ns}	87.25^{ns}
Empty grain (%)	32.05^{ns}	27.97^{ns}	9.76^{ns}	8.08^{ns}
1000 grains weight (g)	20.66^{ns}	22.20^{ns}	24.04^{ns}	24.89^{ns}
Grain yield plot^{-1} (kg)	0.11^{d}	0.10^{c}	0.38^{b}	0.42^{a}
Yield ha^{-1} (t)	0.85^{c}	0.83^{c}	3.02^{b}	3.36^{a}
	J_1	J_2	J_3	J_4
Number of productive tillers	6.80^{ns}	10.28^{ns}	9.00^{ns}	7.61^{ns}
Panicle length (cm)	19.88^{d}	24.68^{a}	23.09^{b}	21.97^{c}
Number of grain/panicle	108.35^{d}	145.00^{a}	137.40^{b}	124.65^{c}
Filled grain (%)	72.09^{d}	89.76^{a}	85.05^{b}	78.07^{c}
Empty grain (%)	29.62^{a}	17.56^{b}	16.04^{c}	14.64^{d}
1000 grains weight (g)	19.77^{c}	25.31^{a}	23.54^{b}	23.18^{b}
Grain yield plot^{-1} (kg)	0.22^{d}	0.31^{a}	0.25^{b}	0.23^{c}
Yield ha^{-1} (t)	1.76^{d}	2.50^{a}	2.00^{b}	1.81^{c}

Means followed by the same letter are not significantly different at the 5% level by DMRT, ns = not significant. Plant spacing (J_1 = 25×20 cm, J_2 = 25 ×25 cm, J_3 = 25×30 cm and J_4 = 25×35 cm) and sub-plots is the rice varieties (V_1 = Inpara 2, V_2 = Inpari 4, V_3 = Inpari 10 and V_4 = Inpari Sidenuk)

compared to J_1. The extent of plant spacing used will have an impact on the ability of rice plants to absorb light, nutrients and water. According to Raza *et al.*[23] the plant spacing system affects the light, wind and nutrients obtained by plants which in turn gives a different effect on plant growth and yield parameters. Pedersen and Lauer[24] stated that the soybean yield was increased by 4% with increasing row spacing from 19-76 cm in the first year.

The results showed that the dry weight stover/clump of lowland rice varieties in integrated with mature-4 of smallholder oil palm the highest was found in the Inpari 10 variety (V_3) of 3.95 g and was not significant compared to other varieties. The plant spacing of 25×25 cm (J_2) affected the dry weight stover/clump the highest of 3.78 g and was not significant compared to other plant spacing.

Yield components: The lowland rice varieties in integrated with mature-4 of smallholder oil palm can significantly increase grain yield plot^{-1} and yield ha^{-1}. Plant spacing can significantly increase the lowland rice yield components except for the number of productive tillers, while their interaction had not significantly affect on yield components (Table 3).

The results were indicated that the Inpari Sidenuk variety can increase the highest grain yield plot^{-1} and yield ha^{-1} of 0.42 kg and 3.36 t, respectively and was significantly different from other varieties. While the other yield components were not significantly different between the varieties tested. This is caused the highest leaf area found in the Inpari Sidenuk variety of 26.27 cm^2 compared to the others (Table 1). The extent of the leaves will affect the amount of chlorophyll in forming photosynthates and increased lowland rice grain yield. According to Johnston and Onwueme[25] stated that the plants will adapt to the stress of low light intensity by increasing the efficiency of light capture through increasing the amount of chlorophyll per unit leaf area. The increasing rate of photosynthesis the higher carbohydrates are formed. The carbohydrates that are available in large quantities will increase chlorophyll synthesis will result the chlorophyll rate is higher in shaded leaves.

The results were indicated that the highest percentage of empty grain was found in the plant spacing of 25×20 cm amounted to 29.61%. The plant spacing of 25×25 cm (J_2) can significantly increase the panicle length, number of grains panicles^{-1}, percentage of filled grain, 1000 grains weight, grain yield/plot and yield/ha compared to other plant spacing. This causes the plant spacing of 25×25 cm (J_2) contributing to the highest increase in the physiological character (fresh weight stover/clump) of lowland rice plants compared to other plant spacing (Table 2). The effect of plant spacing on the physiological response will have an impact on the yield component of lowland rice yield in integrated with mature-4 of smallholder oil palm. Rice plants are shaded stress or low light intensity will experience changes in morphological, anatomical, physiological and biochemical characters that will have an impact on crop production. According to Vogelmann and Martin[26] the light intensity will affect the shape and anatomy of leaves including epidermal and mesophyll cell types. Taiz and Zeiger[27] stated that the shaded leaves of plants will be thinner and wider compared to leaves of plants in normal light intensity, which is caused by the reduction in the palisade layer and mesophyll cells. Okada *et al*.[28] stated that the physiological response of plants to shaded-stress, namely increasing the number of chloroplasts per leaf area and increasing the amount of chlorophyll in chloroplasts. Maxwell *et al*.[29] stated that the low light intensity will affect chloroplasts in plants, such as an increase in the number of chloroplasts per cell, the volume of chloroplasts and thylakoid membranes and stack granum as in *Guzmania monostachia*. Brüggemann and Dauborn[30] stated that the shade was caused by the low activity of Rubisco whereas functions to bind CO_2 and Ribulose bisphosphate (RuBP) in the Calvin cycle which produces 3-PGA. Sopandie *et al*.[31] stated that the low light intensity during flowering in rice caused a decrease in carbohydrate, protein, auxin, proline and cytokinin content. However, it was increased the gibberellins and dissolved N content in panicles. Thorne and Koller[32] stated that the reduction of photosynthate at low light intensity can be related to the high resistance of stomata and mesophyll cells to CO_2 exchange. In low light conditions were decreased the carboxylase and RuBP activity.

CONCLUSION

Inpari Sidenuk variety can increase the highest grain yield plot^{-1} and yield ha^{-1} of 0.42 kg and 3.36 t, respectively compared to other varieties. The plant spacing of J_2-J_4 (25×25, 25×30 and 25×35 cm) can increase the fresh weight stover clump^{-1} of 13.53, 13.29 and 13.22 g, respectively. In overall, plant spacing of 25×25 cm (J_2) can increase the panicle length, number of grain/panicles, percentage of filled grain, 1000 grains weight, grain yield plot^{-1} and yield ha^{-1} compared to others plant spacing. The interaction of lowland rice varieties with plant spacing was not significantly the vegetative, physiological and yield components in integrated with mature-4 of smallholder oil palm. The use of Inpari Sidenuk variety with the plant spacing of 25×25 cm can be used in integrated with mature-4 of smallholder oil palm in support of increased yield ha^{-1} and food self-sufficiency.

SIGNIFICANCE STATEMENT

The research discovered the integration of lowland rice varieties with oil palm which can be beneficial for smallholder and plantations of oil palmforhelping the government in order to support the food self-sufficiency.

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