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Increasing Growth and Production on Two Rice Varieties of Submersion Stress Condition on Two Lowland Swamp Types

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***Abstract*— *This study aims to determine the best fertilizer treatment at vegetative stage for the growth and yield of rice submergence stress conditions on two types of swampy lowland. The experimental design used in this research was spilt-plot design with three replications. The main plot was fertilization treatment consisting of P1 = base fertilization, P2 = fertilizer before being submerged, P3 = fertilizer after being submerged + PPC Micro, P4 = fertilization before and after being submerged. The subplots are varieties of rice, V1 = Inpara 5, V2 = IR 64. The subplot was rice variety which consisted of V1 = Inpara 5, V2 = IR 64. The results showed fertilization treatment can increase rice production growth and submergence stress conditions, varieties of Inpara 5 added with fertilization before flooded can suppress a decrease in grain yield for 16 % in the shallow-back swamp and 6 % in middle-back swamps or with each production of 2.9 and 5.1 tons per hectare, varieties of Inpara 5 which is giving fertilization before flooded, tends to be a good treatment to be developed in rice submergence cultivation both in the the shallow-back swamp and middle-back swamps.*

Keywords*— *Fertilization, Submergence stress, Rice varieties, Lowland Swamp.

I. INTRODUCTION

The production of the cultivation of rice (*Oryza Sativa L.*) needs to be developed from year by year based on the growth of people's composition. The growth of production can be done by the repairing of productivity in the regions that affected in the submersion in which become the main problem in the cultivation of the rice. The wide area of the rice planting that affected the gripping of submersion because of the flood is seen perfectly increasing. This is rooted by the flowing of the rain and the increasing of the water flooding because of the global warming [3]. The remains that caused the gripping toward the rice in the areas of South Asia and Southern Asia is seen 15 million hectare every year [4], meanwhile in South Sumatera the wide of the rice that easily affected the flood is about 124.465 ha [2]. Besides, the potential of the areal that comes in a problem, i.e., the gripping of the submersion to be developed into the field of agriculture is very large, especially in the area of lowland swamps. According to [10], the potential of lowland swamp area in Indonesia that can be developed into the field of agriculture is about 13 million has, meanwhile in South Sumatera is seen about 2,0 million ha [13]

The main problem that is faced in the operation of the agriculture cultivation in the field of lowland area is the case of the submersion that limits the growth and production of the plant. Besides, the pH of the soil and KTK, also the content of the low element of substance, e.g. N, P, and K [9]. Besides, the farmers in lowland swamps still find the difficulties in predicting the high amount of water puddle, so that they faced the risk of the submersion of rice planting at the phase of vegetative growth.

The decreasing of the submerged rice crops at the furrows/varieties that contained *Sub-1* gene less than the contrast of the decreasing of the crops of varieties without *Sub-1* gene. The decreasing of the crop in variety of IR 64 Sub-1 is 16 % while the variety of IR 64 without Sub-1 gene the decreasing of crops reaches 39 % [7]. According to [1], the lost of rice crops reaches 30 % because of the submersion, whenever it can be ceased into the less of 10 % through the agronomic treatment that means bigger for the farmers and the increasing of the productivity of national rice.

By knowing that the wide are that is oftentimes submerged because of the flood is seen more large, hence the founding of technology through this study will be more beneficial in the increasing of the productivity of rice in lowland swamps in term of enhancing the endurance of national food.

II. MATERIALS AND METHODS

2.1. Experiment site

This study was conducted in two locations, i.e., shallow-back swamp and middle-back swamp areas at Kebun Percobaan Padi Rawa Lebak BPTP South Sumatera in Kayu Agung, Ogan Komering Ilir (OKI) sub district.

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2.2. Experiment design

This study used the *split plot design* with three repetitions. The main plot was fertilization treatment consisting of P1 = base fertilization, P2 = fertilizer before being submerged, P3 = fertilizer after being submerged + PPC Micro, P4 = fertilization before and after being submerged. The subplot was rice variety which consisted of V_1 =Inpara 5, V2= IR 64 .

2.3. Implementation of field research

The shallow-back swamp and middle-back swamp were used as the study plot. This area was then cleared and divider ridge was improved. Installation of the plastic wall with 1 m height as the divider of study plot was conducted during land preparation.

The germs of Inpara 5 variety and IR 64 rice was firstly submerged along 24 hours, then it was incubated for 48 hours, after it germinating was seeded at particular place that have been prepared. After more than at least 2 weeks, the germs was moved and kept at its place whose size was 1.2 m x 8 m for about 10 days, by relating that the height of the water was still in a high quantity so that the germs were re-moved and kept for 10 days at the fields' bund. After the germs were moved from its place to every plot sides (units) of trial whose size was 1,5 m x 2 m after the height of the water was in the rice field for about 5-10 cm, by withdrawing from its seedbed and was planted in the position of standing in which the space of planting was 25 cm x 25 cm, and used 2-3 seeds per 2 cm holes.

The basic fertilizing was done when the planting with fertilizing dosage for one hectare was Urea 100 Kg, SP36 128 Kg, and KC1 100 Kg. At that treatment of fertilizing before the submersion, the dosage used for 1 hectare was Urea 50 Kg, TSP 100 Kg, and KC1 100 Kg when the planting, the remnant urea of 50 Kg was given at the age of 42 hst. The fertilizing after submersion, with the dosage N, P, and K for each 50, 30, and 30 (Kg ha^{-1}), by spreading to the inside of the plot treatment whose size was 6 x8 m, meanwhile for the PPC micro 2 ml/1 water, by spraying to the plants, its giving was done for 7 days after submersion. The fertilizing treatment before and after submersion were the combination of both treatments.

The seeds of rice that have reached the age of 7 HST was done the submersion by putting the water into the plots whether through the rising water or by using the pump of the close well from the plots. The duration of the submersion was 7 days that belonged to the height of water that have reached the crown of the plant. The caring includes the activity to maintain the high submersion of water at the minimum quantity of 15 cm from the crown until the treatment, by putting the water to the plots through the pump frequently.

2.4. Yield and observation

Observation of agronomical characteristics were consisted of percentage of survive plant (%), plant height (cm), number of productive tillers numbers per clump, plant dry matter weight per clump (g) and grain yield per clump (g). Yield components were consisted of number of grains per panicle (grains), percentage of filled grains per panicle (%) and 100 grain weight (g).

2.5. Statistical analysis

Mean values were calculated for each of the measured variables, and ANOVA was used to assess the treatment effects. Data were processed using SAS program Portable 9.1.3 for the F test.

III. RESULTS AND DISCUSSION

Results of variance analysis (Table 1) showed that every altering among varieties influences obviously except at the altering for the height of the plants, the amount of productive offspring and the weight of 100 grains of rice for the shallow-back swamp , meanwhile the middle-back swamp toward the altering, Plant height and weight of 100 grains of rice. Next, for each of the altering among the treatment influences obviously except at the altering, the height of plants, percentage of spirited rice, the amount of rice per malai and the weight of 100 grains of rice to the shallow-back swamp, meanwhile middle-back swamp toward the altering of the plant height, the weight of dried plants, the amount of rice per malai, percentage of spirited rice and the weight of 100 grains of rice. The interaction among the varieties and the treatment of fertilizing influences not obviously, except at the altering of the weight of dried plants at shallow-back swamp , meanwhile middle-back swamp toward the altering the percentage of live plants and weight of dried plants.

Table.1: The result of analyzing the diversity of influence to various fertilizing at two varieties of rice to the altering observed

Altering Observed	Shallow-back swamp			Middle-back swamp		
	V	F	V x F	V	F	VxF
Percentage of Survive Plant	*	*	ns	*	*	*
Plant height	ns	ns	ns	ns	ns	ns
Number of productive tillers	ns	*	ns	*	*	ns

Plant dry matter weight	*	*	*	*	ns	*
Percentage of filled grains per panicle	*	ns	ns	*	ns	ns
Number of grains per panicle	*	ns	ns	*	ns	ns
100 grains weight	ns	ns	ns	ns	ns	ns
Grain yield per plot converted into yield per hectare	*	*	ns	*	*	ns

Notes : V= Variety; F= Fertilization; * = significant effect; ns = no significant effect

3.1 **Percentage of Survive Plant** In condition of the submersion gripping, the influence of treatment of fertilizing influence toward the percentage of survives plants from two varieties of rice that were tested in two lowland swamps fields (Table 2). The Inpara 5 variety produced the average percentage of live plants that were higher than the variety of IR 64 at all fertilizing treatment. This showed that repaired power of variety of Inpara 5 (V2) were higher than the variety of IR 64. The capability of restoration highly depended on the capability of plants to adapted fast to the condition after experiencing the submersion gripping. According to [1], the live powers of plants were also influenced by aerobic shock when the plants did not submerge. The change of concentration of antioxidant and enzymes like superoxide dismutase (SOD) in rice cultivars that were submersion tolerant to produce protection systems toward the air after exporting the surrounding of hypo sic or agnostic. Next, the fertilizing treatment before and/or after being submerged can enhance the percentage of live plants. This is seen as the setting of fertilizer giving before and/or after being submerged can enhance the plants' vigor, so that it can enhance the percentage of survives plants. According to [11], the extending of fertilizer, especially nitrogen before and after being submerged was very influential toward the germs vigor.

Table.2: Percentage of survive plants (%) of two varieties of rice at some treatments of fertilizing in the condition of the submersion gripping at various lowland swamps

Vari	Shallow-back swamp					Middle-back swamp				
eties	P0	P1	P2	P3	P4	P0	P1	P2	P3	P4
Inpara 5	100	84.6	92.0	86.0	89.0	100	75	96	97	88
IR 64	100	72.5	76.2	72.4	75.0	100	29	83	87	71

Notes: **P0:** Basic fertilizing without submersion, **P1**: Basic fertilizing, **P2**: Fertilizing before being submerged, **P3**: Fertilizing after being submerged, **P4**: Fertilizing before and after being submerged.

Percentage of survive plant for IR 64 rice variety which experienced two times submergence tend to be lower than that of one time submergence (Table 3), whereas Inpara 5 rice variety still had high percentage of survive plant although experienced two times submergence. This fact showed that Inpara 5 rice variety (V2) had higher recovery capacity than that of other variety.

3.2 ***Plant height***

The height of two varieties of rice that were given the treatment in the condition of submersion gripping indicated that the various responds, yet the extending of fertilizer before being submerged was higher than another fertilizing treatment (Table 3). Varieties IR 64 (V2) with the extending of fertilizing treatment before being submerged (P2) at shallow-back swamp had the highest plant height, that was 81.1 cm meanwhile at the middle-back swamp, the variety Inpara 5 (V1) with the extending of fertilizing treatment before being submerged (P2) had the highest plant height , that was 85 cm.

Table 3.Plant height (cm) of two varieties of rice at some treatments of fertilizing in the condition of submersion gripping at various Lowland Swamp

Vari	Shallow-back swamp					Middle-back swamp				
eties	P0	P1	P2	P3	P4	P0	P1	P2	P3	P4
Inpara 5	74.7	72.1	80.7	72.7	71.8	77	80	85	78	79
IR 64	79.5	74.9	81.1	77.0	70.3	74	83	83	79	81

Notes: **P0:** Basic fertilizing without submersion, **P1**: Basic submersion, **P2**: Fertilizing before being submerged, **P3**: Fertilizing after being submerged, **P4**: Fertilizing before and after being submerged.

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This was be caused of the extending of fertilizing before and/or after being submerged can provide enough nutrition to the next growth, after having the condition of fertilizer gripping at the both types of valley field. According to [12], treatment of the extending of fertilizer setting, especially nitrogen will give the influence toward plant height and the increasing of the rice height. Besides, according to [5], plant height after the period of the submersion gripping was perfectly influenced by the variety of rice rather than the fertilizing treatment.

3.2. Number of productive tillers

Number of productive tillers at two varieties of rice with the giving of fertilizing treatment for the second types of lowland swamp field (Table 4). Variety IR 64 (V2) that was given fertilizing treatment after being submerged (P3) had the highest number of productive tillers, that was 12.9 steam at the shallow-backswamp , meanwhile at the middle-back swamp, variety of IR 64 that was given the fertilizing treatment before being submerged (P2) had the highest number of productive tillers, that was 24 steam. According to [6], the high number of productive tillers at the variety of IR 64 (without Sub-1 gene) was caused of the small percentage of live plants or some was not live at this variety that caused the steams goodly grow, there were so many tillers because of enough space to get the shine, water, and elements, and at the last will increase number of productive tillers per steam.

The research result of [1] showed that variety of IR 64 that experienced the submersion gripping, there were so many died steams, yet the live steams made the growth of the plants very good with the high number of productive tillers, rather than the plants that were not submerged.

Table 4.Number of productive tillers of two varieties of rice at some treatments of fertilizing in the condition of submersion gripping at lowland swamp

Varieties	Shallow-back swamp					Middle-back swamp				
	P0	P1	P2	P3	P4	P0	P1	P2	P3	P4
Inpara 5	13.2	9.2	12.0	10.6	10.4	20	14	23	15	15
IR 64	13.8	9.6	12.4	12.9	10.6	19	22	24	20	19

Notes: **P0:** Basic fertilizing without submersion, **P1**: Basic fertilizing, **P2**: Fertilizing before being submerged, **P3**: Fertilizing after being submerged, **P4**: Fertilizing before and after being submerged

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3.4. Plant dry matter weight

Plant dry matter weight with two varieties of rice tends to increase by the extending of fertilizing treatment before and/or after being submerged whether in the shallow-back swamp or in the middle-back swamp (Table 4).

The variety of IR 64 (V2) that was given the fertilizing treatment had the highest plant dry matter weight that was 33 g per clump the shallow-back swamp meanwhile at the middle-back swamp, the variety of Inpara 5 (V1) that was given the fertilizing treatment before being submerged had the highest weight that was 55.8 g per clump. This was caused of both varieties tends to have number of productive tillers and plant height that treatment, so that it affected plant dry matter weight high.

Table 4.Plant dry matter weight (g) of two varieties of rice at some fertilizing treatments in the condition of submersion gripping at lowland swamp

Varieties	Shallow-back swamp					Middle-back swamp				
	P0	P1	P2	P3	P4	P0	P1	P2	P3	P4
Inpara 5	29	14	20	16	16	27.6	38	55.8	30.6	40.8
IR 64	37	19	24	33	24	29.8	37.9	42.1	37.3	33.5

Notes:**P0:** Basic fertilizing without submersion, **P1**: Basic fertilizing, **P2**: Fertilizing before being submerged, **P3**: Fertilizing after being submerged, **P4**: Fertilizing before and after being submerged.

3.5 Yield and yield components

The Yield and yield components of rice indicated various responds at two varieties of rice by fertilizing treatment before and/or after being submerged whether at the shallow-back swamp or at the middle-back swamp (Table 6 and Table 7). The variety of Inpara 5 (V2) with the extending of fertilizing treatment before being submerged (P2) had the highest yield of rice, that was 2.9 ton ha^{-1} at the shallow-back swamp or experienced the decreasing of result 16% toward without submersion and 5.1 ton ha^{-1} at the shallow-back swamp or experienced the decreasing of result 6% toward without submersion . Besides, some yield components at two varieties of rice tend to increase with the fertilizing treatment before and/or after being submerged whether at the shallow-back swamp or at the middle-back swamp, yet the result of rice produced at every variety for each hectare was determined by the percentage of survive plants varieties. This was caused of the high result of Inpara 5 rice variety for the both types of swamp field because of the percentage of survive plants was 92% for the shallow-back swamp and 97 % for middle-back swamp, so that the population per wide unit became higher. According to [8], the potential of result was determined by the prediction of all result components per clump was timed of the amount of population per hectare and the percentage of survive plants.

Table.6: The Yield with two varieties of rice per hectare (ton) at some fertilizing treatments to the condition of submersion gripping at lowland swamp

Vari	Shallow-back swamp					Middle-back swamp				
eties	P0	P1	P2	P3	P4	P0	P1	P2	P3	P4
Inpara 5	3.4	2.4	2.9	2.2	2.4	5.4	2.9	5.1	4.5	4.0
IR 64	3.4	2.1	2.4	2.3	2.0	5.8	1.8	5.0	5.2	3.7

Notes: **P0 :** Basic fertilizing without submersion, **P1**: Basic fertilizing, **P2**: Fertilizing before being submerged, **P3**: Fertilizing after being submerged, **P4**: Fertilizing before and after being submerged.

Table 7. The influence of fertilizing and varieties toward some component result at various lowland swamp

Treat	Shallow-back swamp			Middle-back swamp		
ment	1	2	3	1	2	3
V1P0	170.0	82.5	2.6	173.4	83	2.3
V2P0	132.0	79.2	2.3	164.5	77	2.6
V1PI	140.8	77.6	2.2	140.3	76	2.4
V2P1	147.9	54.9	2.4	132.1	73	2.2
V1P2	148.0	79.3	2.4	176.3	82	2.5
V2P2	155.9	78.4	2.2	163.6	81	2.3
V1P3	155.3	80.6	2.3	143.6	79	2.2
V2P3	150.0	79.7	2.2	156.3	75	2.3
V1P4	135.5	75.3	2.1	154.0	77	2.3
V2P4	127.8	76.2	2.1	161.8	75	2.4

Notes: 1 = Number of grains per panicle (grains), 2= Percentage of filled grains per panicle (%) , and 3 = 100 grains weight (g). V1: Inpara 5, 2: IR 64, P0: without submersion, P1: basic fertilizing, P2: fertilizing before being submerged, P3: fertilizing after being submerged, P4: Fertilizing before and after being submerged.

IV. CONCLUSIONS

Fertilization treatment can increase rice production growth and submergence stress conditions, varieties of Inpara 5 added with fertilization before flooded can suppress a decrease in grain yield for 16 % in the shallow-back swamp and 6 % in middle-back swamps or with each production of 2.9 and 5.1 tons per hectare, varieties of Inpara 5 which is giving fertilization before flooded, tends to be a good treatment to be developed in rice submergence cultivation both in the shallow-back swamp and middle-back swamps.

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