Reduction of Fe with Application of Saturated Soil Culture Technology and Biomass Ameliorant on Organic Rice Farming in Tidal Swamp

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Indonesia has tidal swamp areas of about 20.1 million ha and 9.53 million ha suitable for agriculture. The main constrain of rice cultivation on tidal swamps is pyrite (FeS2). Iron from pyrite reaction in the flooded (reductive) soil condition will be changed from Fe3+ to Fe2+, and Fe2+ is more absorbed than Fe3+, and causes poisoning on rice plants. Saturated soil culture (SSC) is a cultivation technology that gives continuous irrigation and maintains water depth constantly and makes soil layer under root in saturated condition. This technology is more appropriate to prevent pyrite over reduction than conventional culture (flooded culture).

This research were conducted in Banyuasin District, South Sumatera Province ; and in Tanjung Jabung Timur District, Jambi Province from 2009-2022. This objective of this research are to study : 1) the rice adaptation mechanism to the soil with high Fe content, and 2) the efficiency of production input of rice cultivation with biomass ameliorant, 3) farmer response to the application of innovation. This research used field and green house experimentation designs. This research consisted of : 1) study of rice adaptation mechanism, 2) response of rice varieties under SSC and Flooded Culture (FC) , 3) the effect of biomass ameliorant on the rice productivity. 4) dissemination of technological innovation to the farmer.

The rice adaptation mechanism on SSC (Fig1) was begun with the increasing of root ethylene content, aerenchym formation, Fe deposit on soil layer and Fe leaching on the ditch, and the decreasing of Fe in the leaf and bronzing percentage, and then the increase of productive tiller and grain dry weight per plant (Fig 2, 3).

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| DSCN1901Fig.1. Rice growth. Left :FC. Right : SSC  |  Fig.2. Shoot Fe content |

The highest productivity on sensitive until medium tolerance were obtained on under SSC, but on tolerance genotype was obtained on flooded with drainage . Indragiri was grouped as tolerance, IRH108 as medium, and IR64 as sensitive to the high Fe in tidal swamps (Table1)

Application of rice straw in the soil (equivalent 7-10 tons ha-1) will improve soil fertility in tidal swamps , because in the decomposition process, the straw will release humic acid, which will then chelate Fe and Al solubility. Application of rice straw will decrease NPK doses by 50 %.

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| Fig.3. Bronzing percentage |

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|   | Water Management  |
| Geno-type | SSC+Drainage | SSC | FC+ Drainage | FC  |
|  Grain Dry Weight (ton ha-1) |
| IR64 | 4.41f | 4.56ef | 0.00h | 0.00h |
| IRH108 | 5.46c | 4.81de | 3.80g | 0.00h |
| Indragiri | 6.23b | 5.96b | 6.83a | 5.13d |

Table 1. Rice productivity |

In the other research the application of peat humic acid increased rice productivity by as much as 30 kg ha-1 . The highest productivity was obtained on Inpara-2 at with humic acid under SSC compare to FC without humic acid. If we use high-tolerance rice under SSC on soil Fe content under 10 000 ppm, the rice productivity will increase to 7-9 tons ha-1. The productivity of Inpari16-Pasundan, Sertani, Inpara2 and IR64 on soil Fe content 3000 ppm was obtained : 9.35, 8.35, 7.73, 6.55 ton ha-1 , and on soil Fe content 6000 ppm was obtained : 7.66, 6.20. 5.90, and 4.51 ton ha-1.

Local farmer usually use local varieties with a long age of about 180 days, but transmigration farmer (who move from Java to Sumatera) usually high-yielding varieties with a short age of about 115-120 days. The production input from local farmers was lower than that from transmigration farmers. High yielding varieties were more responsive to the fertilizer than local varieties, thus, the transmigration farmer usually applied chemical fertilizer and pesticides, while the farmer local only used seed input. The productivity of rice on a local farmer is only 1.5-2.0 ton ha-1, and on transmigration farmer 2.5-3.0 ton ha-1. After we introduced our technology with SSC in combination with biomass ameliorant and NPK, the productivity increased to 5-6 tons ha-1.

We are cooperating with private company (FKS Multi Agro) to implement the SSC technology on farmer land in tidal swamp. The private company gave production input (seed, ameliorant, and fertilizer) and the farmer conducted it with SOP (Standard Operational Procedure) of SSC technology. The farmer gets 75 % and private company 25 % from the benefit. The farmer was responsive to following this project in Jambi Province.

The recommendations to implement of organic rice farming in tidal swamp are : 1) use high yielding variety with high tolerance to high soil Fe content, 2) land preparation with minimum tillage, 3) use SSC with wide bed 4 m and wide ditch 30 cm and depth ditch 20 cm, 4) use biomass ameliorant (straw biomass, soybean biomass, humic acid) combination with dung and bio-chart, 5) use microorganism FMA (Fungy Micorrhyza Arbuscular) to increase P availability, 6) use *Azospirillum sp* to increase N fixation. We have obtained FMA from the genus of Acaulospora and Glomus, and in the next time we will develop research to study of isolation, characterization of *Azospirilum sp* from tidal swamps.

**Key words:** pyrite, saturated soil culture, organic rice farming, tidal swamp

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