Proceedings of the 9th International Symposium

on

LOWLAND TECHNOLOGY

International Association of Lowland Technology

Institute of Lowland and Marine Research (ILMR)

Saga University

Organized By:

International Association of Lowland Technology (IALT)
Institute of Lowland and Marine Research (ILMR)
Saga University, Saga, Japan

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Preface

The International Symposium on Lowland Technology has been held biennially from 1998 and we reached the 9th meeting at ISLT2014. During the last 18 years, most were held in Saga, Japan. However for this decade it was held in Bangkok, Busan and Bali in 2004, 2008 and 2012, respectively.

When this event was held in attractive cities outside Japan, many participants in the symposium enjoy the atmosphere and ambience of these cities as well as deepen their knowledge on issues involving Lowland. Saga is also still one of typical lowlands in the world, however, touching different features in other lowland areas are also very interesting and informative. Especially, comparing to previous symposium in Bali 2012, that collected 160 papers from 17 countries, the ILMR local organizing committee made great effort for the preparation of the symposium so that we will obtain the result as good as Bali. Finally and fortunately, a total of 130 papers from 11 countries are published in this proceedings.

On average, around 120 papers have been constantly submitted to every past ISLT. It means that many researchers and engineers are interested in lowlands. Furthermore, the term of "lowland" is becoming popular and increasingly has more significant meaning in the era of climate change. Following the same direction, the official journal of IALT, Lowland Technology International, also continues to develop with expanding fields of (i) Geotechnical/Geoenvironmental Engineering, (ii) Water/Environmental Engineering, (iii) City/Urban Planning and Management, (iv) Coastal Science and Engineering and (v) Remedial Measures for Lowland Management.

Those academic publications had played important role in the development of academic disciplines concerning lowlands and thus are essential activities. I hope ISLT2014 in Saga will successfully give fruitful outcome and contribute knowledge to all the participants.

Prof. Hiroyuki Araki
Chairman of Organizing Committee
ISLT 2014 Saga

President's Address

It gives me immense pleasure to welcome all to the 9^{th} International Symposium on Lowland Technology at Saga University, Saga. This symposium follows after the very successful ones at Saga, Busan, Bangkok and Bali. All of us have very fond memories of the very fruitful 8^{th} Symposium in the picturesque resort in Bali. The current one also promises to be equally valuable if not more with more than hundred papers accepted and included for presentation.

ISLT showcases the progress and developments in the field of Lowland and Marine Research with the theme **'Problems and Remedial Measures of Lowlands'** under various topics such as (i) Geotechnical/Geoenvironmental Engineering, (ii) Water/Environmental Engineering, (iii) City/Urban Planning and Management, (iv) Coastal Science and Engineering and (v) Remedial Measures for Lowland Management. More than hundred papers have been received, accepted for publication and presentation. ISLTians can thus look forward to an update on various topics during the Symposium Sept. 29^{th} to Oct. 1^{st}, 2014 in the home grounds of Saga University, the fount for the genesis, nurturing, developing and spreading the knowledge in this area.

It should be noted that nearly twenty five years after the topic is identified for study, the International Society of Soil Mechanics and Geotechnical Engineering is now proposing to have a new Technical Committee on 'Land Reclamation'. I have always felt that just as humans give birth to life and nurture the baby/infant to life, we at IALT, ILMR and erstwhile ILT have been working diligently to create land and making it functional with all attendant concerns in terms of improving the ground, water, environmental, city/urban planning, coastal and sustainability issues.

While remembering the creators and sustainers of IALT, Prof. Miura, Prof. Poorooshasb, Prof. Hayashi, Prof. Kim, etc. we all should compliment the present team of Prof. Araki, Prof. Bergado, Prof. Yamanishi, Prof. Hino, Dr. Azizul, Dr. Suman, Dr. Lam and several others for their untiring efforts to make this Symposium a success. Ms Mariko Yahiro, the ubiquitous worker behind the scenes, is a great asset to all our efforts.

Wishing the Symposium a great success with all your presence and participation and looking forward to meet you,

M R Madhav

President, IALT

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THE INFLUENCE OF GIVING LIME AND FERTILIZER TO THE WATER QUALITY OF THE ACID-SULPHATE AGRICULTURE LAND MODEL

A. Rusdiansyah[1], N. Helda[2] and Rismawidha[3]

ABSTRACT: Low pH and pyrite layer are the most frequent problems found in the acid sulphate land. It can be found in many lowland regions in South Kalimantan Province i.e Barito Kuala Regency. The value of pH, iron (Fe) and sulphate $(SO_4)^{2-}$ concentration for the case study in barito Kuala Regency were about 4.00, 8.40 mg/l and 2100.00 mg/l respectively. This study is done to learn more about the influence of pH, Fe and sulphate concentration before and after conducting amelioration treatment and which will be the best dosage for lowering the acidity of acid sulphate land. The research was done in the green house with the agriculture land model using acid sulphate soil. There were some variations of lime dosages i.e. 24 gram, 36 gram, 48 gram, 60 gram and 72 gram, respectively. One box was left without any treatment as a control. Fertilizing dosages were 6.00 gram of Urea, 3.24 gram of SP36 and 2.40 gram of KCl. The water height was maintained 5 cm above the soil surface. From the result, it was indicated that by giving lime (as ameliorant), it can improve the water quality significantly. The pH values changed from 4.00 to 5.50. Fe concentration has decreased from 8.40 mg/l to 0.64 mg/l. Sulphate concentration also has decreased from 2100.00 mg/l to 1401.00 mg/l. From Duncan Multiple Range Test (DMRT), it was determined that by giving 48 gram of ameliorant can improve water quality significantly.

Keywords: pH, iron (Fe), sulphate, acid-sulphate agriculture land

INTRODUCTION

Recently, the agriculture land in Barito Kuala Regency, South Kalimantan Province, has been decreased continuously and it influenced the food productivity. Many efforts have to done to solve the problem, such as the optimum use of acid-sulphate agriculture land (Khairullah et al. 2011). Frequently, the problems found in acid-sulphate agriculture land are low pH, pyrite layer existence and minimum mineral element111s. The occurrence of pyrite oxidation will produce H^+ ion and SO_4^{2-} ion which will increase the iron (Fe^{2+}) solubility. In stagnant condition, the acidity of soil can be lessened, however the iron (Fe^{2+}) poisoned occurs; and also Al, Mn, H_2S, CO_2 and organic acids poisoned (Suriadikarta dan Setyorin 2006 in DEPTAN 2006). The iron poisoned can be prevented by managing soil and water by using variety of plants and fertilizer and also amelioration treatment (Khairullah et al. 2011).

In Barito Kuala Regency, South Kalimantan Province, to protect plants from iron poisoned, the farmers use lime and also fertilizer to increase the soil mineral elements. The amelioration treatment has to be conducted before giving fertilizer to the plants. Giving fertilizer before amelioration treatment will not effective and end with no significant result (Balai Besar Penelitian dan Pengembangan Sumberdaya Lahan Pertanian 2006).

Dolomite is used extensively for acid sulphate land. It consists of 40% Calcium Oxide and 18-22% Magnesium Oxide. Not only to increase the pH values, Lime is also used as the soil buffer so that the acidity is in stable condition (Lingga dan Marsono 2007). The dosage of giving fertilizer should correspond to the soil minerals status. The dolomite dosage of 1000-3000 kg/ha is recommended for fertilizing acid-sulphate land (Masganti 2009). Urea fertilizer of 250 kg/ha is distributed for 3 times as follows: (i) planting time, (ii) 4 weeks after planting time and (iii) 7 weeks after planting time. SP36 of 135 kg/ha and KCl of 100 kg/ha are all given at planting time (Suastika et al.; Badan Penelitian dan Pengembangan Pertanian 1997).

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The dosage of lime for every meter of the land can be calculated as follows:

$$\text{dosage} = \frac{\text{lime dosage}}{10000\,\text{m}^2} \qquad (1)$$

For Indonesian condition, fertilizing application is recommended to be given at the same time (constant time). The first fertilizing is given 14 days before planting, the second is 23-28 days after planting and the third is 38-42 days after planting respectively (DEPTAN 2007).

OBJECTIVES

The study was conducted in order to:

(a) To identify the influence of water quality parameters (pH, Fe and sulphate concentration) before and after conducting amelioration treatment.

(b) To determine the best dosage for lowering the acidity of acid sulphate land.

METHODOLOGY

Location and Time of Study

The study was conducted in laboratory scale, in green house of Lambung Mangkurat University with the agriculture land model using acid sulphate soil. The study was carried out during May – September 2012. The soil and water sample were taken from Puntik Tengah Village, Barito Kuala Regency, South Kalimantan Province, Indonesia.

Methods of Study

The study was carried out with the agriculture land model using acid sulphate soil. There were some variations of lime dosages i.e. 24 gram, 36 gram, 48 gram, 60 gram and 72 gram, respectively. One box was left without any treatment as a control. Fertilizing dosages were 6.00 gram of Urea, 3.24 gram of SP36 and 2.40 gram of KCl. The water height was maintained 5 cm above the soil surface.

Amelioration treatment was done two (2) weeks before planting and fertilizing treatment was conducted by following the constant time method. The first fertilizing is given 0 days before planting, the second is 28 days after planting and the third is 42 days after planting respectively. The first fertilizing used one third of Urea and all SP36 and KCl. The second and the third fertilizing used the rest of Urea. Water sample was taken before fertilizing.

Data Analyses used to identify the influence of amelioration and fertilizing treatment was a complete random design (RAL= Rancangan Acak Lengkap faktorial). Then, it is followed by Duncan Multiple Range Test (DMRT).

RESULTS AND DISCUSSIONS

Amelioration treatment especially giving lime and fertilizing can improve the water quality of acil-sulphate agriculture land. The changes of water quality parameters (pH, Fe and sulphate concentration) are presented in the following graphs (Figs. 1, 2, 3 and 4).

Based on Fig. 1, it can be concluded that the higher the lime and fertilizer dosages given, the higher the pH

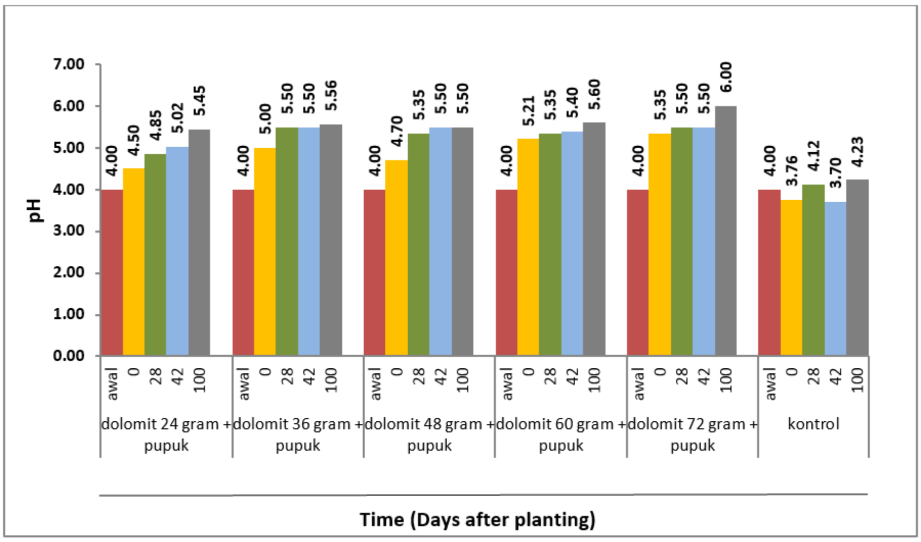

Fig. 1 The water quality changes for pH

values. The pH values range from 4.5 to 5.35. This result shows that the water sample after treatment becomes good and can be used for agriculture land.

Dolomite is known to be an agent to rise the pH values because of its base characteristics and capable of neutralizing poisoned ion such as SO_4^{2-}. The pH values after fertilizing treatment show no significant increase. The base characteristics of Urea were not give big influence to raise the pH values. Therefore, amelioration treatment should be done to improve the quality of the soil.

Stagnant condition resulted high pH caused by H^+ ion consumption by Al, formed molecule of $Al(OH)_3$, then $AlPO_4$ released P. The higher values of pH were also caused by OH^- ion was released resulted from the changes of Fe^{2+} to Fe^{3+}. The changes of Fe concentration is presented in Fig. 2 below.

As shown in Fig. 2, it can be explained that after amelioration treatment for 100 days after planting, the Fe concentration ranges from 0.52 – 0.31 mg/l. This result indicates that the treatment with some stages capable of improving the water quality, so that iron poisoned could be prevented.

The decrease of Fe concentration has correlation with the decrease of Fe solubility caused by the raise of pH values. The next Fig. 3 describes the relationship between pH and Fe solubility.

From Fig. 3, it is shown that Fe concentration has reverse condition with pH values. The lower the Fe concentration, the higher the pH values. Amelioration treatment by giving lime increased the pH values so that Fe concentration decreased.

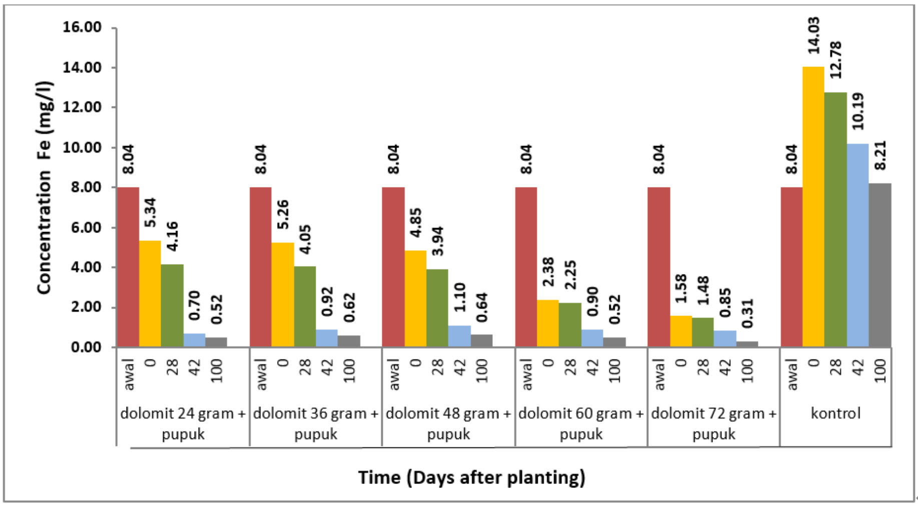

Fig. 2 The changes of Fe concentration

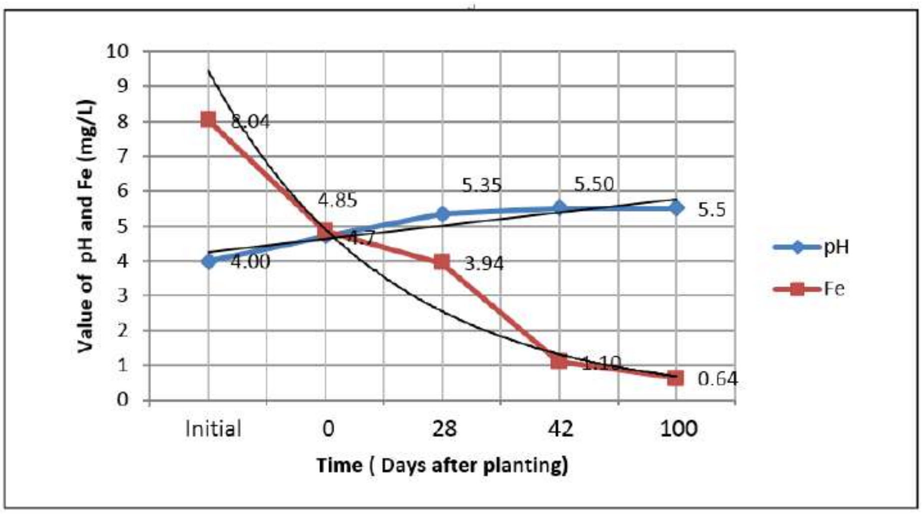

Fig. 3 The relationship between pH values and Fe solubility

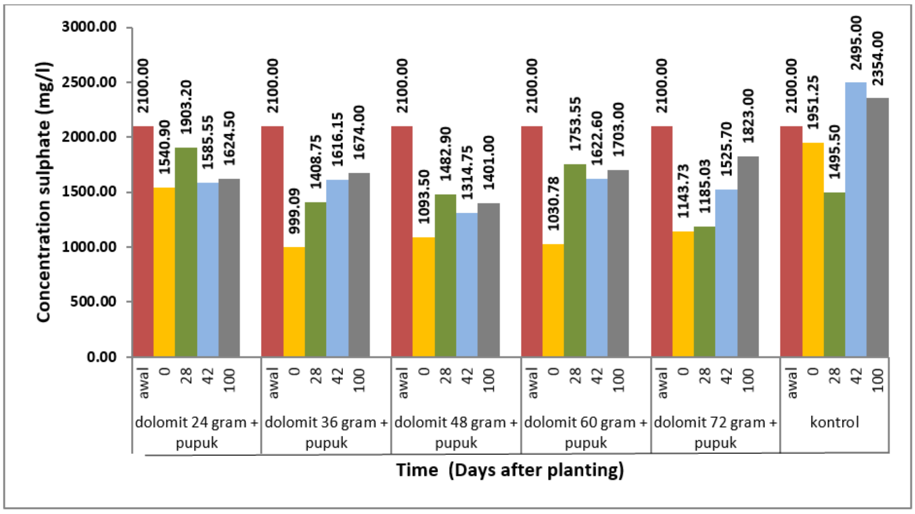

Fig. 4 The changes of sulphate concentration for different treatment

The changes of sulphate concentration is presented in Fig. 4. From Fig. 4, it can be explained that sulphate concentrations were not stable. The decrease of sulphate concentration was caused by giving ameliorant i.e. Dolomite ($CaCO_3MgCO_3$) so that SO_4^{2-} would form deposits of insoluble $CaSO_4$ and $MgSO_4$.

The addition of Urea fertilizer will influence (NO_3^-) which soluble in water. The decomposition of Urea which was further oxidized, would produce Nitrate. These would cause NO_3^- and Fe^{2+} ions react with H_2SO_4 to form Fe^{3+} and SO_4^{2-} ions, also Nitrogen Oxide gas. This condition made SO_4^{2-} to increase.

The result of variety analysis shows that there is real influence for the treatment and the time of water sample taken (Table 1.) and the influence between water quality and time (Table 2).

Based on Table 1, it can be concluded that by giving 48 grams of lime and fertilizer, the water quality can be improved. Table 1 shows the rank of ameliorant and fertilizer dosages based on the lowest Fe concentration after treatment.

Therefore, the highest rank is the lowest Fe concentration. The numbers which were followed by the same letters are indifferent real based on DMRT 0.05. As conclusion, to determine the best dosage of ameliorant and fertilizer it can be assumed that it is the dosage with the highest rank which has the lowest Fe concentration.

From Table 2, it can described that time of water sample was taken with the best result is day-0 after planting. According to DMRT 0.05, day-0 after planting occupies the first place of the rank.

Based on statistical analysis, by giving ameliorant, it has given the influence to the water quality. The test result indicates that at day-0 after planting showed that pH values tend to increase with significant decrease of Fe and SO_4^{2-} concentration. However, after the next treatment by giving fertilizer of Urea, SP36 and KCl, the decrease of Fe concentration was not significant. This was caused by Phosphate solubilization that reduces Fe^{3+} to become Fe^{2+}. Therefore the element of Phosporus (P) would reduce. The increase of sulphate concentration after giving fertilizer predominantly was caused by the decomposition of Urea. If it is further oxidized, it would produce Nitrate. These would cause NO^{3-} and Fe^{2+} ions react with H_2SO^4 to form Fe^{3+} and SO_4^{2-} ions, also Nitrogen Oxide gas. This condition made SO_4^{2-} to increase.

Table 1 The influence of giving lime and fertilizer for water quality parameters

Giving Ameliorant and Fertilizer (Treatment)	Subset
Lime 48 grams + Fertilizer	443.6617a
Lime 72 grams + Fertilizer	454.4558a
Lime 36 grams + Fertilizer	477.4438a
Lime 60 grams + Fertilizer	511.4062a
Lime 24 grams + Fertilizer	557.0492a
Control	696.4767b

Table 2 The influence of water quality to time of water sample was taken

Time of water sample was taken (Days after Planting / DAP)	Subset
0	434.5044a
28	515.9797ab
42	566.9583b
100	576.2197b

CONCLUSIONS

Based on the study results, it can be concluded as follows:

1. The water quality parameters (pH, Fe and sulphate concentration) on tidal agriculture land, before and after treatment were experienced changes such as: the pH values raised from 4.00-5.50, Fe concentration were declined from 8.40 mg/l to 0.64 mg/l, and sulphate concentration were decreased from 2100 mg/l menjadi 1401 mg/l. The decrease of Fe and sulphate concentration were caused by giving ameliorant which was Dolomite ($CaCO_3MgCO_3$). It raised the pH values which made Fe^{2+} and SO_4^{2-} solubility tend to decline. The fertilizing treatment was capable of reducing plant sensitivity of iron poisoned.
2. Based on statistical analysis, the 48 grams of ameliorant (lime) was the best dosage which occupied the first rank.

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